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WAR DEPARTMENT

TECHNICAL MANUAL

METHODS FOR PHARMACY TECHNICIANS

October 13, 1941

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TECHNICAL MANUAL
No. 8–233

WAR DEPARTMENT,
WASHINGTON, October 13, 1941.

METHODS FOR PHARMACY TECHNICIANS

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Prepared under direction of
The Surgeon General

	Paragraphs
CHAPTER 1. General	1–2
CHAPTER 2. Pharmaceutical mathematics.	
Section I. Metrology	3–10
II. Specific gravity	11–14
III. Specific volume	15
IV. Density	16
V. Thermometers	17–18
VI. Ratio and proportion	19–21
VII. Preparation of solutions	22–26
VIII. Alligation	27–28
IX. Reducing and enlarging formulas	29–31
X. Calculation of doses	32–33
CHAPTER 3. Chemistry.	
Section I. General	34–35
II. Chemical and physical phenomena of matter	36–42
III. Inorganic chemistry	43–55
IV. Organic chemistry	56–58
CHAPTER 4. Pharmaceutical operations and apparatus	59–68
CHAPTER 5. Pharmaceutical preparations.	
Section I. Aquae or waters	69–85
II. Liquors (solutions)	86–116
III. Emulsions	117–123
IV. Syrups	124–139
V. Mucilages	140–142
VI. Mixtures	143–146
VII. Magmas	147–148
VIII. Lotions	149–151
IX. Glycerites	152–155
X. Spirits	156–171
XI. Elixirs	172–185
XII. Collodions	186–189
XIII. Liniments	190–195

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CHAPTER 5. Pharmaceutical preparations—Continued. Paragraphs
Section XIV. Oleates ---- 196–197
XV. Infusions ---- 198–200
XVI. Tinctures ---- 201–228
XVII. Fluidextracts ---- 229–241
XVIII. Oleoresins ---- 242–244
XIX. Extracts ---- 245–258
XX. Powders ---- 259–262
XXI. Pills ---- 263–266
XXII. Tablets ---- 267–270
XXIII. Ointments ---- 271–293
XXIV. Pastes ---- 294–296
XXV. Suppositories ---- 297–301
CHAPTER 6. Materia medica.
Section I. General ---- 302
II. Classification of active principles ---- 303
III. Table of uses and doses ---- 304
IV. Toxicology ---- 305–308
CHAPTER 7. Prescription study.
Section I. The prescription ---- 309–311
II. Definitions of medical terms ---- 312
III. Incompatibility ---- 313–315
IV. Hints in practical pharmacy ---- 316–325
CHAPTER 8. Supply and administration.
Section I. General ---- 326
II. Supply ---- 327–331
III. Administration of the pharmacy ---- 332–335
Page
APPENDIX ---- 191
INDEX ---- 193

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TECHNICAL MANUAL

METHODS FOR PHARMACY TECHNICIANS

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON, June 16, 1942.

TM 8–233, October 13, 1941, is changed as follows:

CHAPTER 9 (ADDED)

VETERINARY PHARMACOLOGY

Paragraphs
SECTION I. General 336
II. Dosage and administration of drugs 337–340
III. Physical properties, action, and purpose of certain drugs 341

SECTION I

GENERAL

Paragraph
General 336

336. General.—The training of the veterinary pharmacy technician should be along the same lines as any other pharmacist; and, with relatively few changes, the preceding chapters of this text are applicable for both purposes. The management of a pharmacy, the care and use of equipment, and the art of compounding are not influenced by the question of whether a medicine is intended for a human being or for an animal. In general, the action of a drug is the same for all species, although there are some exceptions. Morphine derivatives, used as a hypnotic for the human, may cause intense excitement in the horse. Dogs are highly susceptible to strychnine, and cats will not tolerate the cresylic acid (cresol) disinfectants commonly used for other animals. Such peculiarities are known as species idiosyncrasy. The greatest, and perhaps the most important difference in drugs intended for human use and those intended for animals is in the dosage.

SECTION II

DOSAGE AND ADMINISTRATION OF DRUGS

Paragraph
Size of dose 337
Factors influencing dose 338
Absorption 339
Channels of administration 340

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337. Size of dose.—The action of drugs is governed to a great extent by the size of the dose; thus, magnesium sulfate in small doses is alterative and diuretic while in large doses it is purgative; strychnine in small doses is a tonic, in moderate doses a stimulant, while in large doses it causes paralysis of the nervous system and death.

a. The *maximum dose* is the largest amount of a drug which may be safely administered.

b. The *minimum dose* is the smallest amount of a drug which will give the desired physiological action.

c. The *toxic dose* is the amount sufficient to produce poisoning.

d. The *lethal dose* is the amount necessary to cause death.

Caution: Most drugs are toxic and many are lethal in large enough doses.

338. Factors influencing dose.—In addition to the species of the patient, many other factors will influence the dosage of the same drug. Such factors include the following:

a. Method of administration.—The influence of dosage in this instance is due to the difference in the absorption rate by the various channels through which medicines are administered. As a general rule, the hypodermic dose is one-half that by mouth; the intravenous dose, one-fourth; and the dose per rectum one to two times that per mouth.

b. Age.—The dose for a 1-year old colt is about one-third the adult dose; a 2-year old colt, one-half, and a 3-year old, two-thirds the dose for an adult horse.

c. Temperament.—Nervous, high-strung, pure bred animals are usually more susceptible to the action of drugs than phlegmatic ones, and consequently should receive slightly smaller doses of active drugs.

d. Idiosyncrasy.—Some animals are much more susceptible to the action of certain drugs than other animals, while some are much less susceptible. This is an individual characteristic, wherein one animal may react violently to an ordinary dose of medicine, while in another animal unusually large doses will be required to cause the usual reaction.

e. Nature of disease.—Sometimes the nature of the disease present has considerable influence on the dose and action of drugs. Example: The usual sedatives may have little or no effect in cases of severe pain.

f. Form of medicine.—The influence in this instance is due to the rate of absorption of the medicant. As a rule, liquids are absorbed more rapidly than solids; alcoholic solutions more rapidly than aqueous; uncoated pills more rapidly than coated ones.

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g. Time of administration.—The action of drugs given by mouth is usually more rapid when given before a meal than when given immediately afterwards. The repetition of a dose is determined to a considerable extent by the duration and rapidity of a drug's action. Agents used for their immediate effect, as those relieving pain or stimulating the circulation and respiration, are repeated frequently till the desired effect is attained. Medicines improving the condition of the digestion, blood, and nutrition, as tonics of various kinds, require time for the accomplishment of their mission and are usually given two or three times daily for a period of some weeks.

339. Absorption.—Absorption is the process by which a drug is taken into the circulation. The interval between the time of administration of a drug and the appearance of its effects will depend upon the rapidity of absorption. The rate of absorption will in turn influence the degree or force of action. The more rapid the absorption, the more immediate and more powerful the action of the drug. The rate of absorption will depend principally upon the channel of administration and to some extent upon the condition of the animal.

340. Channels of administration.—Medicines may be administered to animals through any of the following channels:

a. By mouth (per os).—This is the most common mode of administering medicines. When given by mouth, medicine in powder form may be mixed with the food or given in capsules. Liquids are given with a dose syringe or a stomach tube. When administered by mouth, the rate of absorption in the stomach and intestines is comparatively slow and depends upon the form in which the drug is given and the stage of digestion. If given immediately subsequent to a meal when the stomach is full, the rate of absorption is slow.

b. Hypodermically.—Hypodermic administration is suitable for soluble, nonirritating drugs of small bulk. Rapid absorption and prompt action results when drugs are administered in this form. The solution to be injected should be free from solid particles and micro-organisms in order to prevent subsequent abscess formation. The injection may be made intradermally, subcutaneously, or intermuscularly, depending on the particular drug used and the action desired.

c. Intravenously.—Medicines may be administered by injection into a vein when rapid action is required.

d. Per rectum.—Medicines may be administered per rectum when the animal is unable to swallow; also, to destroy worms in the rectum, and to cause evacuation of the bowel. Absorption of drugs introduced per rectum takes place quite rapidly but the solution should be nonirritating and at body temperature.

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e. Inhalation.—Diluted aqueous solutions of volatile drugs may be vaporized by heating and administered by inhalation for their local effect upon the respiratory mucous membranes. Since the respiratory mucous membrane is active in absorbing medicines, a systemic action sometimes occurs when the drug is given in this manner. If the drug is administered too frequently or in too large a quantity, undesirable effects may be produced. The absorbing power of the respiratory mucous membrane is shown in chloroform and in ether anaesthesia.

f. Applied to skin.—In veterinary practice, medicines are applied to the skin for their local action only—

(1) To destroy parasites.
(2) For their antiseptic action.
(3) For their soothing or stimulating effect.
(4) For their blistering action.

SECTION III

PHYSICAL PROPERTIES, ACTION, AND PURPOSE OF CERTAIN DRUGS

Paragraph
Physical properties, action, and purpose of certain drugs..... 341

341. Physical properties, action, and purpose of certain drugs.—The following list includes drugs commonly used in veterinary medicine. Dose shown is for an *adult horse.*

a. Acetanilid.—(1) *Properties.*—White, shining, crystalline powder; odorless; faintly burning taste; permanent in air; soluble in 194 parts of water and in 5 parts of alcohol.

(2) *Use.*—Internally in high fevers, as an antipyretic. Externally as an antiseptic, usually in combination with other drugs to form a dusting powder for wounds.

(3) *Average dose for horse.*—15 to 30 grams.

b. Acid boric (boracic acid).—(1) *Properties.*—Transparent, colorless scales; odorless; faintly bitterish taste; permanent in air; soluble in 25.6 parts water and in 15 parts alcohol. It is slightly acid.

(2) *Use.*—Externally in 2 to 4 percent aqueous solution as antiseptic in diseases of the eye; also in form of ointment (10 percent) and as dusting powder for wounds.

c. Acid salicylic.—(1) *Properties.*—Light, fine powder or prismatic needles; odorless; sweetish followed by acrid taste; permanent in air; soluble in 450 parts water and in 2.4 parts of alcohol.

(2) *Use.*—Internally to prevent and allay gastric and intestinal fermentation and for acute rheumatism. Externally, antiseptic, 2-to 5-percent alcoholic solution in the treatment of ringworm and ulcers.

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(3) *Average dose for horse.*—5 to 15 grams.

d. Acid tannic.—(1) *Properties.*—A light, yellowish powder in the form of glistening scales or a spongy mass; odorless or possessing a faint odor; astringent taste. It turns darker on exposure to the air and light. Soluble in 1 part water and in 0.6 parts alcohol.

(2) *Use.*—Internally in the treatment of diarrhea; antidote for alkaloids and metallic salts. Externally, astringent and hemostatic; used to check slight hemorrhages; in dusting powder and ointment (10 percent) as astringent; in alcoholic solution (5 to 10 percent) as astringent.

(3) *Average dose for horse.*—2 to 6 grams.

e. Alcohol.—(1) *Properties.*—Absolute alcohol is a transparent, colorless, volatile liquid, with an agreeable odor and a pungent taste; contains not more than 1 percent by weight of water.

(2) *Use.*—Internally as stimulant (30 to 60 cc in 500 cc water), and as antipyretic (60 to 120 cc in 500 cc water); useful in treatment of debilitating diseases. Externally, antiseptic (50 to 70 percent).

f. Aloes.—(1) *Properties.*—Hard masses, orange-brown and opaque, or powder; bitter taste; entirely soluble in alcohol.

(2) *Use.*—Purgative; contraindicated in respiratory diseases.

(3) *Average dose for horse.*—30 to 40 grams usually administered in capsule or ball.

g. Alum.—(1) *Properties.*—Large, colorless, crystals, without odor, but having a sweetish, astringent taste; on exposure to air the crystals are liable to absorb ammonia and acquire a whitish coating; soluble in 9 parts water; insoluble in alcohol; acid reaction.

(2) *Action.*—Astringent and styptic; used in dusting powders; aqueous solutions (2 to 5 percent) as astringent on mucous membranes.

h. Ammonia, aromatic spirits.—(1) *Properties.*—Nearly colorless liquid when fresh, but acquires a dark tint with age; has a pungent, ammoniacal odor and taste.

(2) *Use.*—Stimulant in depression, exhaustion, and collapse; antacid and carminative in digestive disturbances.

(3) *Average dose for horse.*—30 to 60 cc in 500 cc water.

i. Ammonium carbonate.—(1) *Properties.*—White, hard, translucent mass, having an ammoniacal odor and sharp saline taste; on exposure to air, the salt loses both ammonia and carbon dioxide, becoming a white, opaque powder; soluble in 5 parts water.

(2) *Use.*—Antacid in digestive disturbances; circulatory and respiratory stimulant; expectorant in pneumonia and bronchitis; useful in collapse.

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(3) *Average dose for horse.*—10 to 25 grams in bolus or mucilaginous fluids.

j. Ammonium chloride.—(1) *Properties.*—White crystalline powder without odor, having a saline taste; permanent in air; soluble in 3 parts water; practically insoluble in alcohol; reaction neutral.

(2) *Use.*—Expectorant in bronchitis, pneumonia, and strangles.

(3) *Average dose for horse.*—8 to 15 grams.

k. Ammonia water.—(1) *Properties.*—A colorless, transparent liquid, having a pungent odor, acrid alkaline taste, and a strongly alkaline reaction; sp gr 0.960.

(2) *Use.*—Externally in form of liniment, combined with other drugs.

l. Arecoline hydrobromide.—(1) *Properties.*—Colorless, anhydrous, needle-shaped prisms; soluble in water and alcohol.

(2) *Action.*—Contracts the pupil of the eye, stimulates sweating, saliva, and intestinal secretion. Given hypodermically acts as a quick and drastic purgative.

(3) *Average dose for horse.*—One-half to 1 gram.

m. Arsenic trioxide.—(1) *Properties.*—A heavy solid, occurring either as an opaque white powder, or in irregular masses of two varieties, the one amorphous, transparent, and colorless; the other crystalline, opaque, or white, resembling porcelain. Both are odorless and tasteless; the first variety dissolves slowly in 30 parts of water; the porcelain-like in 80 parts water.

(2) *Use.*—Alterative, tonic, vermifuge; generally used in form of potassium arsenate solution (Fowler's solution), which contains 1 percent arsenic.

(3) *Average dose for horse.*—Fowler's solution, 15 to 30 cc.

n. Balsam peru.—(1) *Properties.*—A reddish-brown, syrupy liquid free from stringiness or stickiness, having a vanilla-like, somewhat smoky odor and bitter taste.

(2) *Use.*—Externally, parasiticide (10 percent alcoholic solution); stimulates healing of wounds (10 percent ointment); internally, expectorant in bronchitis, rarely used internally.

(3) *Average dose for horse.*—10 to 25 cc.

o. Benzoin.—(1) *Properties.*—Lumps of yellowish-brown tears, milk-white in the middle, or somewhat mottled from white tears imbedded in it. Almost completely soluble in 5 parts of warm alcohol and in solutions of fixed alkalies. It has a balsamic odor and aromatic taste.

(2) *Use.*—The compound tincture (10 percent benzoin) is employed externally on wounds, and for inhalation in respiratory diseases (1:100). Internally, used in chronic bronchitis.

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(3) *Average dose for horse.*—15 to 30 cc.

p. Bismuth subnitrate.—(1) *Properties.*—A heavy, white powder of varying chemical composition; odorless and almost tasteless; permanent in air; almost insoluble in water and insoluble in alcohol, but readily soluble in nitric or hydrochloric acids.

(2) *Use.*—Internally as antiseptic and astringent in inflammation of the digestive tract; externally, as mild antiseptic in dusting powder or ointment.

(3) *Average dose for horse.*—8 to 15 grams.

q. Camphor.—(1) *Properties.*—White, tough, crystalline mass readily pulverizable in the presence of a little alcohol, ether, or chloroform; having a pungent odor and aromatic taste; sparingly soluble in water. Evaporates on exposure to air.

(2) *Use.*—Internally is antispasmodic, stimulant, expectorant, carminative, and antipyretic. Useful in treatment of digestive disturbances. Externally, rubefacient and stimulant. Used in form of liniment in sprains and bruises. Useful also as stimulant when dissolved in sterile cotton seed or olive oil and administered hypodermically.

(3) *Average dose for horse.*—4 to 8 grams.

r. Cannabis indica.—(1) *Properties.*—Greenish-brown color, a peculiar narcotic odor, and a slightly acrid taste.

(2) *Use.*—Employed internally in the form of the fluid extract as narcotic, anodyne, and antispasmodic in the relief of colics.

(3) *Average dose for horse.*—8 to 24 cc.

s. Cantharides.—(1) *Properties.*—A grayish-brown powder containing green shining particles, having a strong and disagreeable odor, and slight, afterwards acrid, taste.

(2) *Use.*—Externally as a vesicant (4 to 6 parts vaseline).

t. Chalk, prepared.—(1) *Properties.*—A white, amorphous powder without odor or taste; insoluble in water.

(2) *Use.*—Internally is antacid and mild astringent; used in diarrhea.

(3) *Average dose for horse.*—15 to 60 grams.

u. Charcoal.—(1) *Properties.*—Black, odorless, and tasteless powder, free from gritty matter; insoluble in water or alcohol.

(2) *Use.*—Deodorant, absorbent, and desiccant; used in combination with other drugs as dusting powder for treatment of wounds.

v. Chloral hydrate.—(1) *Properties.*—Separate, colorless, and transparent crystal having an aromatic odor and bitterish caustic taste; slowly volatilizes when exposed to air; freely soluble in water, alcohol, ether, and chloroform.

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(2) *Use.*—Antispasmodic and sedative. Narcotic per orum or per rectum for surgical operations.

(3) *Average dose for horse.*—30 to 60 grams in 500 cc water.

w. Chloroform.—(1) *Properties.*—A heavy, clear, colorless, diffusible liquid of a characteristic, ethereal odor, and a burning sweet taste. It is not inflammable but its vapors and in the presence of a naked flame undergo decomposition with the formation of poisonous gases, mostly chlorine. Chloroform is a solvent for fats, resins, balsams, wax, and many alkaloids.

(2) *Use.*—Internally as an antispasmodic, anodyne, and carminative; externally as a rubefacient and analgesic in liniments. General anesthetic when inhaled.

(3) *Average dose for horse.*—4 to 8 cc.

x. Collodion.—Used alone or in combination with antiseptics or astringents as protective dressing for wounds; useful to retain small cotton dressings or to protect small sutured wounds.

y. Copper sulfate.—(1) *Properties.*—Transparent, deep blue crystals; odorless, metallic taste; slowly efflorescent in air; soluble in 2 to 6 parts water; almost insoluble in alcohol; acid reaction.

(2) *Use.*—Externally, antiseptic and caustic; used in treatment of ulcers, hoof-rot, and stomatitis.

z. Creosote.—(1) *Properties.*—Almost colorless, yellowish, or pinkish, oily liquid, having a smoky odor and burning taste; soluble in 150 parts of water, but not completely; readily soluble in ether, chloroform, alcohol, and acetic acid.

(2) *Use.*—Internally as expectorant in bronchitis and pneumonia; intestinal antiseptic.

(3) *Average dose for horse.*—5 to 15 cc in capsule.

aa. Ether.—(1) *Use.*—Internally as a stimulant, antispasmodic, and carminative; general anesthetic when inhaled.

(2) *Average dose for horse.*—15 to 30 cc.

ab. Ferrous sulfate.—(1) *Properties.*—Large, bluish-green prisms without odor and having a saline, biting taste; efflorescent in dry air; in moist air the crystals absorb oxygen and become coated with brownish-yellow, basic ferric sulfate. Soluble in 1.8 parts of water; insoluble in alcohol.

(2) *Use.*—Internally, as a tonic, astringent, and vermifuge.

(3) *Average dose for horse.*—2 to 5 grams as tonic; 10 to 20 grams as astringent or vermifuge.

ac. Formalin (formaldehyde).—(1) *Properties.*—A pungent gas with specific gravity of 1.6; soluble in water and volatile unless kept in glass-stoppered bottles. "Formalin" is the trade name for a 40 percent aqueous solution of formaldehyde gas.

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(2) *Use.*—Is caustic, disinfectant, and deodorant; used in canker and thrush in 10 to 50 percent solution; as disinfectant in 2- to 5-percent solution.

ad. Gentian.—(1) *Properties.*—Yellowish-brown powder; peculiar odor; sweetish-bitter taste.

(2) *Use.*—Stomachic and bitter tonic.

(3) *Average dose for horse.*—Powder, 12 to 25 grams; fluid extract, 12 to 25 cc.

ae. Ginger.—(1) *Properties.*—Pale buff-colored roots or powder having an aromatic odor and a warm taste.

(2) *Use.*—Stomachic and carminative.

(3) *Average dose for horse.*—8 to 30 grams.

af. Glycerin.—(1) *Properties.*—Colorless liquid of a thick syrupy consistency, oily, odorless, sweet, and warm taste; soluble in all proportions in water or alcohol, but insoluble in ether, chloroform, and volatile oils.

(2) *Use.*—Internally as a base for cough mixtures. Externally, combined with other drugs, for the treatment of inflammatory skin diseases.

ag. Hydrogen peroxide (*dioxide*).—(1) *Properties.*—A colorless, odorless liquid; acid taste and producing a peculiar sensation and soapy froth in the mouth. It deteriorates with age or on exposure to heat. When exposed to tissue, the more the product effervesces the better the peroxide.

(2) *Use.*—Externally as antiseptic in cleaning wounds, abscesses, etc. It should not be injected into closed cavities.

ah. Iodine.—(1) *Properties.*—Heavy, bluish-black, dry, rhombic plates, having a metallic lustre, distinctive odor, and sharp acrid taste. Soluble in 5,000 parts water and in about 10 parts of alcohol; very soluble in ether.

(2) *Use.*—Used externally in alcoholic solution (tincture) or aqueous solution (Lugol's—1 part iodine, 3 parts potassium iodide, and 16 parts water) as an antiseptic, parasiticide, and counterirritant.

ai. Iodoform.—(1) *Properties.*—A lemon-yellow powder having a peculiar and very penetrating persistent odor, and an unpleasant and slightly sweetish, iodine-like taste. Slightly soluble in water; soluble in 52 parts of alcohol and in 5.2 parts ether.

(2) *Use.*—Used externally, either alone or in combination with other drugs as dusting powder; also in 5 to 10 percent solutions of ether in the treatment of wounds.

aj. Lead acetate (*sugar of lead*).—(1) *Properties.*—Colorless, shining, transparent plates or heavy, white crystalline masses having

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a faintly acrid odor and a sweetish, biting, metallic taste. Soluble in 2.3 parts water and 21 parts alcohol.

(2) *Use.*—Externally in combination with zinc sulfate as "white lotion"; sedative and astringent antiseptic on bruises, wounds, strains, and skin diseases.

ak. Licorice (glycyrrhiza).—(1) *Properties.*—A yellow powder having a pleasant odor and sweetish somewhat acrid taste.

(2) *Use.*—Expectorant in cough.

(3) *Average dose for horse.*—30 to 60 grams.

al. Liquor cresolis compound.—(1) *Properties.*—A clear, brown oily liquid of a creosote-like odor; soluble in water.

(2) *Use.*—As an antiseptic on wounds, hands, instruments, etc., 1 to 2 percent aqueous solution. As disinfectant, 3 to 5 percent solution.

am. Mercuric chloride (bichloride of mercury, corrosive sublimate).—(1) *Properties.*—Heavy, colorless, crystalline mass; odorless; having an acrid and persistently metallic taste.

(2) *Use.*—Caustic, antiseptic, disinfectant. Antiseptic in wounds, 1 to 1,000 aqueous solution. As disinfectant, 1 to 500 aqueous solution.

an. Mercuric iodide, red (biniodide of mercury).—(1) *Properties.*—Heavy, orange-red, crystalline scales or powder; odorless and having a slight metallic taste; almost insoluble in water and insoluble in alcohol.

(2) *Use.*—As a vesicant in form of ointment (1.3–5) in the treatment of bony enlargements.

ao. Mercurous chloride (calomel).—(1) *Properties.*—A white powder; odorless and tasteless; insoluble in water or alcohol.

(2) *Use.*—Internally as an intestinal antiseptic, chologogue, and purgative; usually combined with aloes to make a physic ball. Externally, is antiseptic and desiccant.

ap. Nitrous ether, spirit (sweet spirit of niter).—(1) *Properties.*—A clear, volatile, inflammable liquid of a pale-yellowish or faintly greenish-yellow tint, having a fragrant, ethereal, and pungent odor; free from acidity, having a sharp burning taste. Mixes freely with water and alcohol.

(2) *Use.*—Diaphoretic and diuretic in first stages of fever; antispasmodic in intestinal derangements; stimulant.

(3) *Average dose for horse.*—30 to 90 cc in water or capsule.

aq. Nux-vomica.—(1) *Properties.*—Powdered ripe seed of strychnos nux-vomica.

(2) *Use.*—Stimulant to nervous and respiratory systems; stomachic and tonic; usually given with other drugs as gentian, iron sulfate, etc.

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(3) *Average dose for horse.*—2 to 8 grams. Has cumulative effect so should not be administered for more than six consecutive days.

ar. Oil, cottonseed.—(1) *Properties.*—Light yellow, oily liquid, odorless, and having a mild nutty taste. Sparingly soluble in alcohol, but readily soluble in ether, chloroform, or carbon disulfide.

(2) *Use.*—Internally, mild laxative; externally, in preparation of liniments.

(3) *Average dose for horse.*—500 to 1,000 cc.

as. Oil, linseed.—(1) *Properties.*—A fixed raw oil obtained from linseed or flax seed. Boiled linseed oil is poisonous and must not be used medicinally.

(2) *Use.*—Internally, laxative; used in treatment of intestinal derangements.

(3) *Average dose for horse.*—500 to 1,000 cc.

at. Oil, tar, rectified.—(1) *Properties.*—An almost colorless liquid when freshly distilled, but soon acquires a dull, reddish-brown color having a strong tarry odor and taste. Soluble in alcohol.

(2) *Use.*—Externally, antiseptic and parasiticide; used in combination with other drugs. Internally, expectorant.

(3) *Average dose for horse.*—8 to 15 cc.

au. Oil turpentine.—(1) *Properties.*—A thin, colorless liquid, having a characteristic odor and taste; soluble in three times its volume of alcohol; also soluble in an equal quantity of glacial acetic acid.

(2) *Use.*—Carminative and antispasmodic in colic; expectorant in bronchitis; circulatory stimulant; diuretic and anthelmintic. Externally, rubefacient in liniments.

(3) *Average dose for horse.*—25 to 60 cc well diluted with oil.

av. Petrolatum (cosmoline, vaseline).—(1) *Properties.*—A yellowish fat-like mass, transparent in thin layers; amorphous, with slight oily odor and taste. Soluble in ether, chloroform, oil of turpentine, and benzine.

(2) *Use.*—Used as a base for ointments.

aw. Phenol (carbolic acid).—(1) *Properties.*—Colorless, crystalline mass having a characteristic odor and, when well diluted in water, a sweetish taste. Soluble in about 15 parts water and readily soluble in alcohol, ether, chloroform, and glycerin. Slight acid reaction. Crystals melt when heated, but solidify on cooling.

(2) *Use.*—Caustic, antiseptic, disinfectant; used in 2 to 5 percent aqueous solution. Caustic in strong solutions; caustic action may be limited by use of alcohol.

ax. Pine tar.—(1) *Properties.*—A thick, blackish-brown, semifluid, heavier than water; sharp taste and transparent in thin layers.

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Slightly soluble in water; soluble in alcohol and fixed or volatile oils.

(2) *Use.*—Expectorant in chronic bronchitis and pharyngitis per os or inhalation. Externally as protective dressing of wounds and in treatment of skin diseases.

(3) *Average dose for horse.*—10 to 25 grams.

ay. Potassium chlorate.—(1) *Properties.*—A colorless, lustrous, white powder, without odor and having a saline taste. Soluble in about 16.7 parts of water; insoluble in absolute alcohol. Explodes when triturated with sugar, charcoal, or glycerin.

(2) *Use.*—Antiseptic in stomatitis and pharyngitis; diuretic; externally, mild antiseptic.

(3) *Average dose for horse.*—5 to 10 grams in diluted aqueous solution; externally, used in 2- to 5-percent aqueous solution.

az. Potassium iodide.—(1) *Properties.*—A white, transparent, granular powder or crystals, having an odor suggestive of iodine and a bitter, saline taste. Soluble in 0.75 parts water; in 18 parts alcohol, and in 2.5 parts of glycerin.

(2) *Use.*—Alterative, diuretic, expectorant.

(3) *Average dose for horse.*—5 to 10 grams in aqueous solution.

ba. Potassium nitrate (saltpeter).—(1) *Properties.*—Colorless crystals or powder; odorless and having a saline taste. Permanent in air. Soluble in 3.8 parts of water; slightly soluble in alcohol.

(2) *Use.*—Febrifuge, diuretic.

(3) *Average dose for horse.*—5 to 20 grams in aqueous solution.

bb. Potassium permanganate.—(1) *Properties.*—Slender prisms of dark purple color, odorless, and having a primary sweetish, followed by a disagreeable and biting taste; soluble in 16 parts of water; decomposes in alcohol.

(2) *Use.*—Antiseptic (1- to 2-percent aqueous solution); disinfectant and deodorant (3- to 5-percent aqueous solution).

bc. Pyoktanin (methylene blue).—(1) *Properties.*—Dark green crystals with metallic lustre which make a deep blue solution when dissolved in water.

(2) *Use.*—Antiseptic on wounds and abrasions, in 2- to 5-percent aqueous solution.

bd. Quinine sulfate.—(1) *Properties.*—White, needle-like crystals having a bitter taste. Soluble in 34 parts water, in 3 parts alcohol, in 1 part boiling water, and in 2 parts chloroform.

(2) *Use.*—Antipyretic, tonic, stomachic.

(3) *Average dose for horse.*—5 to 15 grams.

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be. Sapo mollis (soft soap, green soap).—(1) *Properties.*—A soft, yellowish-brown mass, soluble in about 5 parts of hot water or 2 parts of alcohol.

(2) *Use.*—Used in liniments and ointments; and to cleanse and soften the skin.

bf. Silver nitrate.—(1) *Properties.*—Colorless, transparent crystals which may become grayish-black on exposure to light. It has no odor but has a bitter and strongly metallic taste. Reaction is neutral. Soluble in 0.6 parts of water and in 25 parts of alcohol.

(2) *Use.*—In 1- to 2-percent solution (aqueous) in conjunctivitis; for wounds 2- to 10-percent aqueous solution; for removal of excessive granulations and to stimulate healing of ulcers, it is used in the form of a caustic pencil.

bg. Silver nucleinate.—(1) *Properties.*—A light brownish-white powder, readily soluble in water and containing 10 percent silver.

(2) *Use.*—Antiseptic. Used in 5- to 20-percent aqueous solution for conjunctivitis. Solution should be freshly prepared.

bh. Sodium bicarbonate.—(1) *Properties.*—Colorless, opaque, odorless powder having a slightly alkaline taste. Permanent in dry air but decomposes in moist air. Soluble in 11.3 parts water; insoluble in alcohol and ether. Reaction slightly alkaline.

(2) *Use.*—Stomachic and antacid, used alone or in combination with other drugs. Externally, antiseptic and solvent of albumen in irrigation of wounds.

(3) *Average dose for horse.*—15 to 45 grams.

bi. Sodium borate (borax).—(1) *Properties.*—White powder, without color, and having a sweetish, alkaline taste; soluble in 16 parts of water at 59° F. and 0.5 parts of boiling water; insoluble in alcohol. It is slightly alkaline.

(2) *Use.*—Used to preserve tissues during shipment.

bj. Sodium chloride (common table salt).—(1) *Properties.*—White crystalline powder without odor and having a distinct saline taste. Permanent in dry air. Soluble in 2.8 parts of water; nearly insoluble in alcohol; insoluble in ether or chloroform.

(2) *Use.*—Stimulant intravenously in heart weakness, severe hemorrhage, debilitating diseases, collapse; externally, antiseptic and albumen solvent in catarrhal inflammation of mucous membranes.

(3) *Average dose for horse.*—Per os, 15 to 45 grams intravenously, 1 to 4 liters of a 0.6-percent solution; externally on mucous membranes, 1- to 2-percent solution.

bk. Sodium sulfate (Glauber's salt).—(1) *Properties.*—Relatively large, colorless, granular crystals, without odor and having a bitter

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saline taste. It effloresces in the air. It is soluble in 2.8 parts of water; insoluble in alcohol; soluble in glycerin.

(2) *Use.*—Cathartic, stomachic, laxative.

(3) *Average dose for horse.*—As cathartic, 250 to 500 grams in water; as stomachic and laxative, 30 to 90 grams.

bl. Strychnine sulfate.—(1) *Properties.*—White, odorless powder having an intensely bitter taste. Efflorescent in dry air. Soluble in 50 parts of water; in 109 parts of alcohol; or in 2 parts of boiling water; insoluble in ether.

(2) *Use.*—Circulatory and respiratory stimulant.

(3) *Average dose for horse.*—One-half to 1 grain hypodermically. Has cumulative effect and its action should be carefully watched after 2 or 3 days consecutive use.

bm. Sulfocarbolate compound.—(1) *Properties.*—Tablets prepared of calcium, sodium, and zinc sulfocarbolate.

(2) *Use.*—Gastro-intestinal antiseptic and astringent; used in diarrhoea.

(3) *Average dose for horse.*—1 to 3 tablets (30 grains each).

bn. Sulfur (sublimed).—(1) *Properties.*—A fine, yellow powder with slight odor and faintly acid taste. Insoluble in water; slightly soluble in absolute alcohol, benzine, oil of turpentine, and other oils. chloroform, and ether.

(2) *Use.*—Parasiticide—used in form of ointment (10 to 20 percent) in the treatment of skin diseases.

bo. Wool fat, hydrous.—(1) *Properties.*—A light-yellow fatty mass. Insoluble in water but may be incorporated with twice the weight of the latter.

(2) *Use.*—Used as base for ointments.

bp. Zinc chloride.—(1) *Properties.*—A colorless, odorless powder possessing intensely caustic properties, and having an astringent taste when greatly diluted in water. Soluble in about 0.3 parts of water; readily soluble in alcohol.

(2) *Use.*—Caustic, antiseptic, and astringent. As caustic in fistulae, canker, ulcers, is used in a paste (1.1–3), alcoholic solution (40 percent) or aqueous solution (10 to 20 percent).

bq. Zinc oxide.—(1) *Properties.*—A white powder, without odor or taste; insoluble in water or alcohol.

(2) *Use.*—Astringent and antiseptic; used as dusting powder or in ointment.

br. Zinc sulfate.—(1) *Properties.*—White, transparent crystals, odorless, and having a biting, metallic taste. Reaction acid. Soluble in 0.6 parts of water and in 3 parts of glycerin; insoluble in alcohol.

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(2) *Use.*—Antiseptic and astringent. It is used in combination with lead acetate to form "white lotion." Useful in the treatment of suppurative conjunctivitis in 0.5 to 2 percent aqueous solution.

[A. G. 062.11 (2–3–42). (C 1, June 16, 1942.)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

U. S. GOVERNMENT PRINTING OFFICE. 1942

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WAR DEPARTMENT
APR 4 1944
DOCUMENTS

TECHNICAL MANUAL

METHODS FOR PHARMACY TECHNICIANS

CHANGES No. 2

WAR DEPARTMENT,
WASHINGTON 25, D. C., 28 February 1944.

TM 8-233, 13 October 1941, is changed as follows:

10. Addition, subtraction, multiplication, and division of weights and measures.—*a. Metric system.*—To simplify procedures, express all lengths in meters, all volumes in cubic centimeters, all weights in grams.

(1) *Addition.*—Add 3 kg, 33 Gm, 3 cg, 433 mg.

Solution:

3 kg=	3×1,000=	3,000	Gm
33 Gm=		33	Gm
3 cg=	**3÷ 100=**	**.03**	**Gm**
433 mg=	**433÷1,000=**	**.433**	**Gm**
		3,033.463	Gm

* * * * * * *

(3) *Multiplication.*—Multiply 325 mg by 5.

Solution: 325 mg×5=1,625 mg
1,625 mg÷1,000=1.625 Gm

* * * * * * *

[A. G. 300.7 (18 Feb 44).] (C 2, 28 Feb 44.)

55. Chemical change.

* * * * * * *

b.

* * * * * * *

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(2) The quantities of * * * relative weights involved:

$HgNO_3$	$+KI=$	$HgI+$	KNO_3
Hg=1×200.6=200.6	K=1× 39.1	Hg=200.6	K= 39.1
N=1× 14.0= 14.0	I=1×126.92	I=126.92	N= 14.0
O_3=3× 16 = 48.0			O_3=3×16=48.0
262.6			101.1

* * * * * * *

[A. G. 300.7 (18 Feb 44).] (C 2, 28 Feb 44.)

59. Methods of heating.

* * * * * * *

d. Salt solution baths are nearly or quite saturated solutions of salts in water. Temperatures up to about **108°** C. can be obtained by selecting the proper salt.

[A. G. 300.7 (18 Feb 44).] (C 2, 28 Feb 44.)

255. Extractum hyoscyami.—Extract of hyoscyamus, U. S. P. XI (extract of henbane).

* * * * * * *

c. Average dose.—**0.05 Gm**

[A. G. 300.7 (18 Feb 44).] (C 2, 28 Feb 44.)

323. Triturations.—*a.* ***Triturations*** consist of one part of medicine intimately mixed with varying parts of sugar of milk, depending upon the strength desired. Other inert diluents are sometimes used.

* * * * * * *

c. **Triturations** are used to a great extent in dispensing potent drugs such as strychnine, atropine, and arsenic, obviating the necessity of weighing out minute quantities of such drugs.

[A. G. 300.7 (18 Feb 44).] (C 2, 28 Feb 44.)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General.

U. S. GOVERNMENT PRINTING OFFICE: 1944

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CHAPTER 1

GENERAL

	Paragraph
Scope	1
Definitions	2

1. Scope.—*a.* This manual is limited in scope and is intended only for use by enlisted pharmacy technicians who will operate in a pharmacy under the supervision of a commissioned officer.

b. The practice of pharmacy demands knowledge, skill, and integrity on the part of those engaged in it.

c. Pharmacy has for its primary object the service which it can render to the Army in safeguarding the compounding and dispensing of medicinal substances. The technician should uphold the approved legal standards of the United States Pharmacopoeia and the National Formulary for articles which are official in either of these works.

2. Definitions.—*a. Pharmacy* is the art and science of compounding and dispensing medicinal substances. It is a science which encompasses phases of other sciences in its scope such as chemistry, bacteriology, biology, physics, etc. It may be subdivided into two major considerations, namely—

(1) Practical pharmacy or that branch of pharmacy which embraces the mechanics or operative procedures used in applying the principles of the theories of pharmacy.

(2) Theoretical pharmacy may be defined as that branch of pharmacy which embraces the exposition of the general principles without view to practice. The theories of pharmacy are founded on inferences drawn from principles which have been established on independent evidence. The theory of pharmacy is dependent on knowledge of other sciences, since all matter from which drugs may be drawn is classified in one of three "kingdoms," namely—animal, vegetable, or mineral. Each of these kingdoms has at least one science, and sometimes several, which is restricted to a consideration of matter falling under its field of classification. We see, then, that—

(*a*) *Zoology* is the science which treats of the natural history of all *animals*, their structure, physiology, classification, descent, habits, etc.

(*b*) *Botany* is the science which treats of the structure of *plants*, the functions of their parts, their places of growth, their classifications, etc.

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(*c*) *Mineralogy* is the science which treats of the properties of *mineral* substances and teaches how to characterize, distinguish, and classify them according to their properties.

(3) In addition to these sciences of the kingdoms, there are a number of other sciences embraced in the field of pharmacy which may involve two or more classes of matter, or which may be sciences of some phase of the primary classes.

(*a*) *Physics* may be defined as the science of energy, dealing with matter and its properties, insofar as they are intimately associated with the transformations of energy. Physics, therefore, includes dynamics, and the branches of science that deal with light, heat, electricity, magnetism, and sound.

(*b*) *Chemistry* is the science which investigates the composition of all substances, together with the combinations and decompositions resulting from their action upon one another under the influence of chemical force.

(*c*) *Biology* is the science of living organisms, their morphology, physiology, origin or development, and distribution.

(*d*) *Physiology* may be considered as that branch of biology which treats of the functions of the living organisms, plant or animal, and correlates these functions as to cause and effect, and traces out their dependence upon the physical states of the organs by which these functions are exercised.

(*e*) *Pharmacology* is the science or knowledge of drugs, usually interpreted as being the actions of drugs on the body, including materia medica, pharmacodynamics, and therapeutics.

(*f*) *Materia medica* is the science which treats of the origin, composition, and properties of medicinal agents.

(*g*) *Pharmacodynamics* deals with the actions of drugs on undiseased living organisms.

(*h*) *Therapeutics* is a consideration of the actions of drugs in the treatment of disease.

(*i*) *Toxicology* is the scientific study of poisons, their actions, their detection, and the treatment of the conditions produced by them.

(*j*) *Bacteriology* is the science which treats of micro-organisms.

(*k*) *Posology* is the study of doses of drugs.

(*l*) *Pharmacognosy* is the study of crude drugs, their source, botanical origins, parts used, active constituents, collection, and storage.

b. The *United States Pharmacopoeia* is an official publication containing a list of vegetable drugs, chemicals, and pharmaceutical preparations, with descriptions, tests, and formulas for preparing

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them. The medicinal substances listed in it are recognized as official and the word "official" as applied to a drug or preparation means that it is listed in the Pharmacopoeia (or National Formulary). It was first published in the year 1820 by the doctors of the United States who before that time had no national standard for the medicines and preparations they were using. It has been revised every 10 years since 1820 and the present revision is known as the eleventh, abbreviated U.S.P. XI. The Pharmacopoeia is owned, edited, and revised by the United States Pharmacopoeial Convention, which is incorporated under the laws of the District of Columbia. This convention is made up of delegates appointed from the professions of medicine, dentistry, pharmacy, and chemistry.

The United States Pharmacopoeia recognizes nearly all the drugs and preparations that are considered by the medical profession as essential in the treatment of sick or in the prevention of disease. Exceptions are some of the valuable medicines of recent discovery and medicines whose composition or method of preparation is kept secret or that are controlled by patent rights.

The names of various substances are indicated as follows:

(1) *Official Latin title.* Example: ELIXIR AROMATICUM.

(2) *Official English title.* Example: AROMATIC ELIXIR.

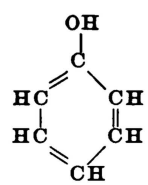
(3) *Abbreviated title.* Example: ELIX. AROM.

(4) *Synonym.* Example: SIMPLE ELIXIR.

(5) *Botanical name* (in the case of plants). Example: ATROPA BELLADONNA.

(6) *Symbolic formula* (in the case of chemicals). Example: $BaSO_4$.

(7) *Structural formula* (in the case of organic chemicals wherever generally accepted by chemists). Example: PHENOL



(8) *Official definition.*—In order that no question shall arise as to the exact meaning of the official Latin title, or any other name by which an official substance is known, it is necessary to state explicitly what kind of variety of the substance should be used. Example: FERRUM. Elementary Iron (Fe) in the form of fine, bright wire filings or powder.

(9) *Purity rubric.*—This term indicates the paragraph which limits the quantity of innocuous impurities in chemicals, drugs, and

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other substances, by stating in terms of percentage the amount of pure substance that must be present. Example: SODII SALICYLAS Sodium Salicylate, when dried to constant weight at 100° C., contains not less than 99.5 percent of C_6H_4. OH . COONa .

(10) *Official description.*—Immediately following the official definition of the substances there will be noticed in the Pharmacopoeia, in smaller type, what has been termed the official description. This consists usually, for drugs, of a concise statement of their physical characteristics, when entire, and also, in most instances, the structure of the same drug when sectioned or powdered. In the chemicals the official definition usually includes the symbolic formula, the "purity rubric," and the official description, which are printed in smaller type, exactly as in the case of vegetable drugs. To the descriptions of the chemical drugs are usually added the solubility statements.

(11) *Tests for identity and purity.*—In the U.S.P. the tests which establish the identity of a chemical and those which insure the pharmacopoeial minimum degree of purity are grouped under the appropriate headings.

(12) *Assay.*—Chemicals, preparations, and certain crude drugs have assays included in their monograph which are intended to insure their contents to be in accord with the purity rubric.

(13) *Storage.*—Certain official drugs and preparations of the Pharmacopoeia have storage specifications set forth designed to maintain their medicinal activity for a maximum period of time.

(14) *Preparations.*—Where a pharmacopoeial substance is an item in the manufacture of official pharmaceuticals, these preparations are listed.

(15) *Doses.*—The doses are given in both the metric and apothecaries' systems. The figures are neither interchangeable, nor are they to be considered as exact equivalents. Under "Average Dose" is stated the doses which may be expected ordinarily to produce the therapeutic effect for which the drug or preparation is most commonly employed. The doses, unless otherwise indicated, are intended to mean oral doses when administered to adults.

c. The National Formulary is an official publication containing a list of substances and preparations, some of which have been deleted from the Pharmacopoea, but are found to be used sufficiently by physicians to deserve recognition in a publication other than the Pharmacopoea.

d. New and Nonofficial Remedies (*N.N.R.*) is a book published by the American Medical Association through its Council on Pharmacy

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and Chemistry. It lists such unofficial representatives of the newer materia medica, chiefly synthetic or biological, as have been accepted under the rules of the Council.

e. A *dispensatory* is a commentary on a pharmacopoeia. Dispensatories comment on substances, giving their physical, medical, and pharmaceutical history, with their doses, properties, and uses.

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CHAPTER 2

PHARMACEUTICAL MATHEMATICS

		Paragraphs
SECTION I.	Metrology	3–10
II.	Specific gravity	11–14
III.	Specific volume	15
IV.	Density	16
V.	Thermometers	17–18
VI.	Ratio and proportion	19–21
VII.	Preparation of solutions	22–26
VIII.	Alligation	27–28
IX.	Reducing and enlarging formulas	29–31
X.	Calculation of doses	32–33

SECTION I

METROLOGY

	Paragraph
Definitions	3
Instruments for measuring	4
Metric system	5
Apothecaries' system	6
Avoirdupois weight	7
Approximate measures	8
Relationship of the systems	9
Addition, subtraction, multiplication, and division of weights and measures	10

3. Definitions.—*a. Metrology* is the art and science of measures as applied to extension, volume, and weight of matter.

b. Weight is the measure of the gravitational force of bodies and always bears a direct ratio to their bulks and density, density being the amount of matter in a given bulk of the body.

c. Measure is the determination of the bulk or extent of the body.

4. Instruments for measuring.—*a. Balances.*—A balance is an instrument for determining the relative weight of substances. If accurate results are to be obtained it should be correctly constructed, skillfully used, and carefully protected from injury. Pharmaceutical balances used in military pharmacies may be classified as follows:

(1) *Single beam, equal arm balance.*—In the construction of this balance, a beam is suspended on a knife edge, which divides it into equal arms, and knife edges are placed at each end of the beam on the same plane and at exactly equal distances from the point of suspension to support the pans which carry the substances to be weighed.

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(2) *Torsion balance.*—The chief differences between the torsion and other balances lies in the entire absence of knife edges and the location of the center of gravity above the fulcrum or point of rotation. The knife edges have been replaced by three steel bands or springs tightly stretched over the edges of the three frames supporting the beam. The center of the beam is fastened to the center of the strained band or spring and at right angles to it, under which condition, by the elasticity or torsion of the band or spring, it will vibrate exactly as the ordinary beam balanced on knife edges; the pans rest upon similar torsion bands or springs at the ends of the beam in the same manner as the central fulcrum of the beam.

b. Care of a balance.—The position chosen for the balance should be upon a level and firm counter, desk, or table, where it will be subjected to little risk of injury from dampness, dust, or corrosive vapors, and where the knife edges will not be liable to become dulled by jarring or other vibrations. The balance and scale pans should not be polished with abrasive substances but should be cleaned with a soft cloth. *The beam should never be left in oscillating position when the balance is not being used.* Weights should be put on and replaced with tweezers. The same care should be exercised in cleaning weights as the balance and scale pans. The first step in weighing is to see that the balance is balanced and that the knife edges are in position; then place a piece of pan paper in each pan and again see that the balance is balanced. Put the weights in the right-hand pan and carefully place enough of the substance in the left-hand pan to exactly balance the weights. After removing the substance, check the weights to see that the amount is correct. In weighing substances that injure the scale pans by their chemical action, always use watch glasses or wax paper. Do not exchange one scale pan for the other, as they are balanced for the scale. Do not overload the balance in excess of indicated capacity as marked on the balance.

c. Measures.—Indispensable in the prescription department are graduates used for liquid measures. The minim graduate is far from being reliable as a large amount of the liquid is retained by capillarity of the glass vessel, and, therefore, for measuring minute quantities, a pipette should be used. Pipettes are glass tubes with a constricted point and graduated on the side. They are used by applying suction to the upper end and holding the liquid in the tube by placing the finger on the upper end while reading off the contents. Owing to capillary attraction, the top of the liquid in a graduated pipette presents a cup shape. This is called the meniscus. A line drawn through

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the botttom of the meniscus of transparent and the top of opaque liquids is selected as the reading point.

5. **Metric system.**—*a. General.*—The *metric* or *decimal system* of measure is the only official system of the present United States Pharmacopoeia and National Formulary. Government departments in all medical requirements also employ the metric system. It is the standard for strictly scientific work the world over.

b. Branches.—There are five branches of the metric system, but only three of them are used in pharmacy—weight measure, linear measure, and cubic measure for liquids. In learning the following definitions for the primary units of these branches, it will be noted that all branches of the metric system are derived from the primary unit of length, the meter.

(1) The primary unit of weight, the *gram*, is the weight of a cubic 1/100 meter (cubic centimeter) of water at its greatest density, and weighed in vacuo.

(2) The primary unit of length, the *meter*, may be defined as 1/40,000,000 of the earth's circumference, measured across the poles or as 1/10,000,000 of the earth's quadrant.

(3) The primary unit of volume, the *liter*, may be defined as the cube of one-tenth of a meter (decimeter), or as the volume occupied by a kilogram of water at its greatest density.

c. Metric tables.—To simplify measuring, the primary unit of each branch was subdivided into one thousand, one hundred, and ten secondary parts; secondary units larger than the primary units were established by taking the primary units in multiples of ten, one hundred, and one thousand. *All secondary units differ from one another by some power of ten.*

Fractional parts of the primary units are expressed by adding the Latin prefixes: *milli* (1/1000), *centi* (1/100), and *deci* (1/10), to the names of the primary unit itself.

Denominations larger than the primary units are expressed by adding the Greek prefixes: *deka* (10), *hecto* (100), and *kilo* (1000), to the name of the primary unit.

Metric table of length	Abbreviated form
10 millimeters equals 1 centimeter	10 mm equals 1 cm
10 centimeters equals 1 decimeter	10 cm equals 1 dm
10 decimeters equals 1 meter	10 dm equals 1 m
10 meters equals 1 dekameter	10 m equals 1 dm
10 dekameters equals 1 hectometer	10 dm equals 1 hm
10 hectometers equals 1 kilometer	10 hm equals 1 km

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By replacing the primary unit of length with the primary unit of volume or weight, the appropriate table will be derived. The technician may more readily visualize these tables if they are compared to our monetary system which is also a system of decimal progression. Thus—

10 mils =1 cent =$0.01	10 mm=1 cm=0.01 m
10 cents =1 dime =$0.10	10 cm =1 dm=0.10 m
10 dimes=1 dollar=$1.00	10 dm =1 m =1.00 m

d. Reading the metric system.—The reading of metric quantities is similar in many respects to the reading of sums of money. The following analagous readings may serve to enlighten the technician:

$0.30 may be read as—
Three dimes.
Thirty cents.
Three hundred mils.

0.3 meter may be read as—
Three decimeters.
Thirty centimeters.
Three hundred millimeters.

0.3 gram may be read as—
Three decigrams.
Thirty centigrams.
Three hundred milligrams.

0.45 meter may be read as—
4.5 decimeters.
45 centimeters.
450 millimeters.

0.78 liter may be read as—
7.8 deciliters.
78 centiliters.
780 milliliters.

2.75 grams may be read as—
2.75 grams.
27.5 decigrams.
275 centigrams.
2,750 milligrams.

NOTE.—Since the liter is the volume of a cubic decimeter $(10\ dm)^3$, the thousandth part of a liter also may be called a cubic centimeter (abbr. cc). Sometimes the word *milliliter* is shortened to *mil*. Therefore, milliliter, mil, cubic centimeter, and cc all refer to 1/1000 of a liter.

6. Apothecaries' system.—*a. General.*—Operations in pharmacy in this country usually use the apothecaries' system with the exception

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of those listed in paragraph 5*a*. In writing prescriptions in the apothecaries' system, the various denominations for weight and volume are designated by certain symbols or abbreviations, followed by the amount indicated in Roman numerals. For example: gr=grains; ℨ=drams; ℥=ounces; ♏=minims; fl ℨ=fluidram; fl ℥=fluidounce; O=pint.

b. Tables of apothecaries' weight and measures.

(1) *Weight.*

20 grains (gr.) equals	1 scruple (℈).		
3 scruples equals	1 dram (ℨ)	equals	60 grains.
8 drams equals	1 ounce (℥)	equals	480 grains.
12 ounces equals	1 pound (℔)	equals	5,760 grains.

(2) *Fluid measure.*

60 minims (♏) equals	1 fluidram (fl ℨ).		
8 fluidrams equals	1 fluidounce (fl ℥)	equals	480 minims.
16 fluidounces equals	1 pint (O)	equals	7,680 minims.
2 pints equals	1 quart (qt.).		
4 quarts equals	1 gallon (cong.).		

7. Avoirdupois weight.—*a.* Avoirdupois weight is used entirely for commercial transactions.

b. Table of avoirdupois weight.

437.5 grains equals 1 ounce (oz.).
16 ounces equals 1 pound (lb.) equals 7,000 grains.

8. Approximate measures.—*a.*

1 tumblerful equals about 8 fluid ounces, or 240 cc.
1 teacupful equals about 4 fluid ounces, or 120 cc.
1 wineglassful equals about 2 fluid ounces, or 60 cc.
1 tablespoonful equals about 4 fluid drams, or 16 cc.
1 dessertspoonful equals about 2 fluid drams, or 8 cc.
1 teaspoonful equals about 1 fluid dram, or 4 cc.

b. One drop (L., gutta, pl., guttae, usually abbreviated gtt.) is often considered as equal to about one minim, but the size of drops varies with the character of the liquid, the temperature, and the surface from which it is dropped. Therefore, one drop should not be considered to equal one minim.

9. Relationship of the systems.—*a. General.*—The pharmacy technician must know not only the various systems of weights and measures, but he must be able to convert weights and measures from one system to those of another; in other words, he must master the relationships of the systems. The conversion of weights and measures of one system to those of another is done by means of equivalents which is presented later in the paragraph. The derivation of these

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equivalents as follows will enable the technician to arrive at an equivalent in several ways should he fail to remember a particular one.

(1) *Metric and linear measure.*

Given: 1 m=39.37 inches. 1 m=100 cm (metric table).

Therefore: $\frac{100}{39.37}$=2.54 cm in 1 inch.

Since there are 10 mm in 1 cm, 2.54 cm contains 2.54×10 or 25.4 mm.

Therefore: 1 inch=25.4 mm.

(2) *Metric and apothecary fluid measures.*

(*a*) Given: 1 liter=1,000 cc. If a liter of any liquid is poured into apothecary graduates, it will be found that the liter of liquid measures 16,230 ♏'s.

Therefore: $\frac{16{,}230}{1{,}000}$=16.23 ♏'s in 1 cc.

(*b*) Given: 1 cc=16.23 ♏'s. As an apothecary fluid ounce contains 480 ♏'s, we have—

$\frac{480}{16.23}$=29.57 cc in 1 fluid ounce.

(*c*) Given: 1 fluid ounce=29.57 cc and 1 liter=1,000 cc.

Therefore: $\frac{1{,}000}{29.57}$=33.8 fluid ounces in 1 liter.

(*d*) Given: 1 pint=16 fluid ounces and 29.57 cc=1 fluid ounce.

Therefore: 16×29.57=473 cc=1 pint.

(*e*) Given: 473 cc=1 pint and 1,000 cc=1 liter.

Therefore: $\frac{1{,}000}{473}$=2.11 pints=1 liter.

(*f*) Given: 1 cc=16.23 minims.

Therefore: $\frac{1}{16.23}$=0.06 cc=1 ♏.

(3) *Metric and apothecary weights.*—(*a*) If a gram weight is placed on a delicate balance, it will weigh 15.432 grains.

Therefore, 1 gm=15.432 grains.

(*b*) Given: 480 grains and 1 gm=15.432 grains.

Therefore: $\frac{480}{15.432}$=31.1 gm=℥ (apoth. ounce).

(*c*) Given: 1 gm=15.432 grains.

Therefore: $\frac{1}{15.432}$=0.065 gm.=1 grain.

(*d*) Since 0.0648 gm is 64.8 milligrams, one grain contains 64.8 milligrams; however, in work involving the calculation of doses, the figure is rounded to 65 mg=1 grain to facilitate calculations.

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(*e*) The following equivalents are obtained by weighing the respective quantities of water:

1 fluid ounce of water = 455 grains.
1 minim of water = 0.95 grains.
1 pint of water = 1.04 pounds avoirdupois.
1 gallon of water = 8.33 pounds avoirdupois.

(4) *Metric and avoirdupois equivalents.*—As the apothecary and avoirdupois grains are identical, the avoirdupois grain is likewise equivalent to 0.0648 gm or 64.8 mg.

(*a*) Given: 1 oz = 437.5 grains and 1 gm = 15.432 grains.

Therefore: $\frac{437.5}{15.432} = 28.35$ gm = 1 oz or ounce.

(*b*) Given: 16 oz = 1 lb and 28.35 gm = 1 oz.

Therefore: $16 \times 28.35 = 454$ gm = 1 lb.

(*c*) Given: 1,000 gm = 1 kg and 454 gm = 1 lb.

Therefore: $\frac{1{,}000}{454} = 2.2$ lb = 1 kg.

(*d*) A careful study of the derivation of equivalents will indicate their uses. To convert 12 pints to cc, multiply 12 by the number of cubic centimeters in one pint (473). Likewise, if 2,345 cc are to be converted to pints, the 2,345 cc are divided by 473 or divide 2,345 cc by 1,000 (simply by moving the decimal point three places to the left) thus converting 2,345 cc to liters and then multiply the result by 2.11 (the number of pints in a liter).

b. Table of approximate equivalents.

1 gram equals 15.432 grains.
1 cubic centimeter equals 16.23 minims.
1 grain equals 64.8 milligrams.
1 meter equals 39.37 inches.
1 liter equals 33.8 fluid ounces or 2.11 pints.
1 inch equals 25.4 millimeters or 2.54 centimeters.
1 apothecaries' ounce equals 31.1 grams (gms).
1 apothecaries' ounce equals 1.053 fluidounces.
1 avoirdupois ounce equals 28.35 grams (oz or ounce).
1 apothecaries' fluidounce equals 29.57 cubic centimeters.
1 pint equals 473 cubic centimeters.
1 minim equals 0.06 cubic centimeters.
1 congius equals 3.785 liters or 3,785 cubic centimeters.
1 pound (lb) equals 454 grams.
1 kilogram equals 2.2 pounds.

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c. Table of water equivalents.

1 fluidounce of water (fℨ) equals 455 grains.
1 minim of water equals 0.95 grains.
1 pint of water equals 1.04 pounds or 473 grams.
1 congius of water equals 8.33 pounds or 3.785 kilograms.

10. Addition, subtraction, multiplication, and division of weights and measures.—*a. Metric system.*—To simplify procedures, express all lengths in meters, all volumes in cubic centimeters, all weights in grams.

(1) *Addition.*—Add 3 kg, 33 gm, 3 cg, 433 mg.

Solution:

3	kg=	3×1,000=	3,000	gm
33	gm=		33	gm
3	cg=	3÷ 100=	.03	gm
433	mg=	433÷1,000=	.433	gm
			3,033.463	gm

(2) *Subtraction.*—Subtract 285 cubic centimeters from 5 liters.

Solution:

5 liters=5,000 cc
285 cc
4,715 cc

(3) *Multiplication.*—Multiply 325 mg by 5.

Solution:

325 mg×5=1,625 mg
1,625 mg÷1,000=1.625 gm

b. English system.—To simplify procedures express all units in the smallest unit involved.

(1) *Addition, apothecaries' weight.*—Add 5 pounds, 4 ounces, 36 drams, 720 grains.

Solution:

5	lb=	5×5,760 gr=	28,800	gr
4	oz=	4× 480 gr=	1,920	gr
36	dr=	36× 60 gr=	2,160	gr
720	gr=		720	gr
			33,600	gr

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(2) *Addition, avoirdupois weight.*—Add 10 pounds, 14 ounces, ¼ ounce, 27 grains.

Solution:	10 lb = 10 × 7,000 =	70,000	gr
	14 oz = 14 × 437.5 =	6,125	gr
	¼ oz = ¼ × 437.5 =	109.37	gr
	27 gr =	27	gr
		76,261.37	gr

(3) *Addition, fluid measure.*—To add fluid measure, the same principle is involved as in the addition of solid measure. Add 14 gallons, 7 pints, 6 fluid ounces.

Solution:	14 gal = 14 × 128 fl oz =	1,798	fl oz
	7 pt = 7 × 16 fl oz =	112	fl oz
	6 fl oz =	6	fl oz
		1,916	fl oz

(4) *Subtraction, multiplication, and division.*—The same principle is involved as in addition. Reduce weights or measures to smallest unit involved and proceed. When final answer is obtained it may be changed back to the next larger unit. Example: 600 apothecaries' grains would be changed to 600 ÷ 480 (gr in 1 oz) = 1 oz and 120 gr or 1 oz and 2 drs.

Section II

SPECIFIC GRAVITY

	Paragraph
Definition	11
Specific gravity of liquids	12
Specific gravity of solids	13
Practical applications of specific gravity	14

11. Definition.—*Specific gravity*, abbreviated sp. gr., indicates the relation in weight, expressed decimally, between equal volumes of two substances, one of which is a standard, determined at 25° C. and at normal barometric pressure. Distilled water is the standard for liquids and solids, and atmospheric air or hydrogen is the standard for gases. The specific gravity of the standards is expressed by unity, 1.000.

12. Specific gravity of liquids.—The determination of the specific gravity of liquids is far more frequently required than is that of solids, and specific gravity flasks (pycnometers), hydrometers, loaded cylinders, and the Mohr-Westphal balance are employed for

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that purpose. Only the pycnometer and hydrometer will be discussed.

a. Pycnometer.—Any small flask of 25 or 50 cc capacity with a long, narrow neck and made of thin glass will answer as a specific gravity bottle. Its weight, or tare, is first carefully ascertained and noted; pure water is then poured into the flask until it reaches a convenient distance up into the neck, when a mark should be made with a file at the upper and lower edge of the meniscus or concave surface; having noted the temperature of the water, the flask and contents are weighed, and from this weight the tare of the flask is deducted, the remainder being the weight of that particular volume of pure water at the given temperature. The tare, temperature, and weight of water are carefully etched on the side of the flask, which is now ready to be used for taking the specific gravity of any liquid by filling it to the mark in the neck with the liquid to be tested, then weighing and dividing the net weight of the liquid by the weight of the water, the quotient being the specific gravity of the liquid. Example: A flask weighs 324 grams. It holds up to the mark, 647 grams of water. Filled with sulfuric acid, it weighs 1,511.5 grams. $1{,}511.5 - 324 = 1{,}187.5$ grams as the weight of the acid.

Now apply the rule—to divide the weight of a given volume of a liquid by the weight of the same volume of water, the specific gravity is—

$1{,}187.5 \div 647 = 1.835$, the specific gravity of the acid.

b. Hydrometers.—These instruments are intended to indicate either the density or the specific gravity of liquids, and in some cases also the percentage by volume or weight of certain solutes. They consist of a glass tube having a bulb blown at one end, a little above which the tube is usually expanded cylindrically for a short distance, and then terminates in a long stem in which is securely fastened a graduated scale. The bulb is filled with mercury or small shot, so as to enable the instrument to assume a vertical position when floated in any liquid. Hydrometers, like all floating bodies, displace their own weight of a liquid and sink in it to a depth proportionate to the volume of liquid displaced, which volume is equal in weight to the weight of the instrument; thus, by comparison of volumes displaced, the densities and specific gravities of various liquids can be ascertained. Specific gravity hydrometers are made with the unit mark 1.000 at a point to which the instrument sinks in distilled water at normal temperature, and then have the scale carried above and below this point. The number on the scale at the surface of the liquid represents the specific gravity.

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13. Specific gravity of solids.—For ascertaining the specific gravity of solids the following general rule is applied:

$$\text{Specific gravity} = \frac{\text{weight of the solid in air}}{\text{weight of an equal volume of water}}$$

Because of certain physical characteristics, solids are grouped under the following heads when their specific gravity is taken:

a. Solids insoluble in and heavier than water.—A piece of iron weighs 6.6 gm in air. Suspended in water it weighs 5.2 gm. The difference between the weight of the iron in air and that in water is the weight of the water displaced by the iron. Therefore, 6.6 gm − 5.2 gm = 1.4 gm, which is the weight of the water displaced. Then the—

$$\frac{\text{weight of the substance in air}}{\text{weight of an equal volume of water}} = \frac{6.6}{1.4} = 4.714, \text{ sp gr of the iron.}$$

b. Solids insoluble in but lighter than water.—When a solid floats on water it displaces a weight of water equal to its own weight. One that *floats* on water displaces its own weight of that liquid but not its entire volume, since a part of the solid remains above the surface of the water. In order to obtain the weight of water that the entire volume of solid displaces, a sinker, that is, a heavier solid, must be attached to the light substance. This enables one to ascertain the weight of water equal to the volume of the exposed (not immersed) part of the solid. The procedure for determining the specific gravity of a light solid is as follows:

	Gm
Weight of the solid, e. g., a piece of wax, in air	= 9.01
Weight of the sinker, a piece of lead, in water	= 8.82
Weight of both in water	= 7.88
To the weight of the sinker in water	= 8.82
add the weight of the wax in air	= 9.01
	17.83
Subtract the weight of both in water	= 7.88
The weight of the water displaced by the wax	9.95

$$\text{Sp gr of the wax} = \frac{\text{weight of the wax in air}}{\text{weight of an equal volume of water}} = \frac{9.01}{9.95}\text{ gm} = 0.90.$$

c. Solids soluble in water.—The procedure in this case is the same as that previously given except that a liquid must be employed in which the solid is insoluble. This necessitates an adjustment because of the difference in the specific gravity of water and the other liquid.

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This is made by multiplying the specific gravity in reference to the liquid used by the specific gravity of the latter. The following example will illustrate:

	Gm
A piece of copper sulfate in air weighs	20.311
The same in oil of turpentine weighs	12.359
Loss of weight in oil of turpentine	7.952

This is also the weight of the oil of turpentine displaced by the copper sulfate. The specific gravity as compared with oil of turpentine is $\frac{20.311}{7.952}=2.566$. This figure must be multiplied by the specific gravity of oil of turpentine, which is 0.865. Then, $2.566\times0.865=2.119$, the actual specific gravity of copper sulfate (compared with water).

d. Powders insoluble in water.—A pycnometer is used for this purpose. The procedure is as follows: Fill the bottle with distilled water and weigh. Weigh accurately a quantity of the powder, whose specific gravity is sought, and introduce this, without loss, into the pycnometer; then fill completely with distilled water. See that there are no air bubbles in the bottle, and weigh. For example—

	Gm
The bottle filled with water weighs	24
Granulated zinc in air weighs	13.8
Bottle and zinc, filled with water weigh	35.8
Add 1 and 2 above (24+13.8)	37.8
Subtract 3, above	35.8
Weight of water displaced by zinc	2.0

Then

$$\text{sp gr}=\frac{\text{weight of the zinc in air}}{\text{weight of an equal volume of water}}=\frac{13.8}{2.0}=6.9,\text{ sp gr of zinc.}$$

e. Powders soluble in water.—For this purpose the same method is employed as given in the last paragraph, except that a liquid is selected in which the substance is not soluble. Here an adjustment must be made by multiplying the specific gravity obtained in comparison with the special liquid used by the specific gravity of that liquid.

14. Practical applications of specific gravity (reducing volume to weight).—*a. Metric.*

(1) 1 cc of water weighs 1 gm.
1 cc of any liquid with a sp gr of 1 weighs 1 gm.
1 cc of a liquid with a sp gr of 2 weighs 1×2 or 2 gm.

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1 cc of a liquid with a sp gr of 1.5 weighs 1×1.5 or 1.5 gm.

Thus: The number of cc×sp gr=weight in grams.

(2) What is the weight in grams of 1 liter of chloroform having a sp gr of 1.48?

No. of cc×sp gr=weight in grams.

1,000×1.48=1,480 gm, the weight of 1 liter of chloroform.

(3) What is the volume of 750 gm of chloroform, sp gr 1.47?

Since each cubic centimeter weighs 1.47 gm, $\frac{750}{1.47}=510.2$ cc.

b. Apothecaries' fluid measure.—There is no commensurability of the units between this system and avoirdupois.

1 fl oz of water does NOT weigh 1 ounce.

1 minim of water does NOT weigh 1 grain.

But it is known that—

1 fl oz of water at 4° C. weighs 454.6 grains, and that, therefore—

1 minim of water weighs $\frac{454.6}{480}$ or 0.95 grain.

1 fl oz of water weighs 454.6 gr.

1 fl oz of any liquid having a sp gr of 1 weighs 454.6 gr.

1 fl oz of a liquid having a sp gr of 2 weighs 454.6×2 or 909.2 gr.

Therefore the weight in grains of a fluid ounce of any liquid is 454.6×sp gr.

Further, any volume in fluid ounces may be changed to grains (and thence to higher units) according to the formula: 454.6×sp gr×number of fluid ounces=weight in grains.

(1) Calculate the weight in grains of 1 pt, 1 fl oz, and 4 dr of sulfuric acid, sp gr 1.8.

454.6×sp gr×number of fl oz=weight in grains.

1 pt, 1 fl oz, 4 fl dr=17.5 fl oz.

454.6×1.8×17.5=14,319.9 grains.

(2) What is the volume in minims of 480 grs of chloroform, sp gr 1.47?

1 ♏ of H_2O weighs 0.95 gr.

Therefore 0.95×1.45=1.3965 grs per ♏ of $CHCl_3$

$\frac{480}{1.39}=345.3$ ♏ of $CHCl_3$

(The answer may be resolved into higher units if desired.)

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SECTION III

SPECIFIC VOLUME

Paragraph
Definition 15

15. Definition.—*a.* Specific volume is the ratio of the volume of one body compared with the volume of an equal weight of another body selected as the standard, both bodies having the same temperature, water being the standard unless otherwise stated. Specific volume ratio:

$$\text{Specific volume} = \frac{\text{volume of body}}{\text{volume of an equal weight of water}}$$

b. When the specific gravity of a body is known it is unnecessary to apply the above formula, for specific volume is the reciprocal of specific gravity. Therefore: specific volume = 1 ÷ specific gravity.

c. Specific volume is used to calculate the space which a certain weight of a substance will occupy. However, if the calculations are made in the metric system, the same results are obtained by dividing the weight by the specific gravity.

SECTION IV

DENSITY

Paragraph
Definition 16

16. Definition.—Density is the relation between the weight of a substance and the volume it occupies. It is a ratio; namely, the ratio between weight and volume—W : V or W/V. Therefore, it may be stated that glycerine has a density of 1.25 gm/cc, or a specific gravity of 1.25. However, the system of weights and measures used to determine density will alter the figures obtained for the same substance. For example, the following figures have been found to be correct for the measurements of the density for water: 62.4 lb/cu ft, 1 gm/cc, 454.6 gr/fl oz, yet, the sp gr of water is 1.

SECTION V

THERMOMETERS

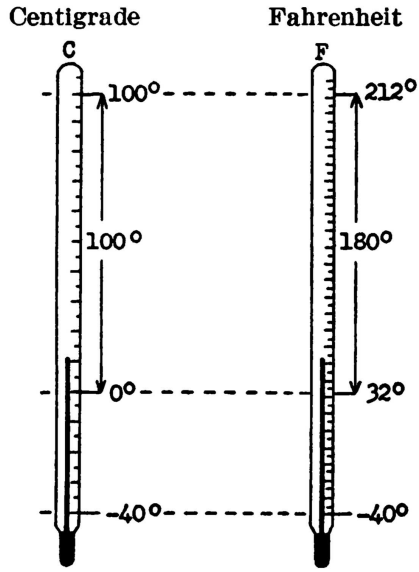
Paragraph
General 17
Rules for comparing thermometric scales 18

17. General.—*a.* Thermometers are used for measuring temperatures or intensities of heat but the term is generally limited to those instruments that measure temperature by the expansion of some medium such as mercury or alcohol. While these instruments are alike in principle and construction, they are marked in three different

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scales, but only two of these are in use in this country. The Pharmacopoeia and National Formulary recognize only the centigrade or Celsius scale, although the former book has a table of centigrade and Fahrenheit equivalents. The centigrade scale is used almost exclusively in scientific work the world over while the Fahrenheit scale is the one generally used for manufacturing and household purposes and for taking the temperature of the atmosphere in England, Canada, and the United States.

b. As may be noted on the following diagram, freezing point of water is 0° on the centigrade and 32° on the Fahrenheit scale. Boiling point is 100° on the centigrade and 212° on the Fahrenheit scale. However, −40° is the same on both scales.



18. Rules for comparing thermometric scales.—*a.* (1) *To convert Fahrenheit to centigrade.*—It is obvious from the above diagram that the difference between the freezing and the boiling point of water is 180° for the Fahrenheit, and 100° for the centigrade. Hence, 180° F. is equal to 100° C., or, 1.8° F. is equal to 1° C. Therefore, the following formula is apparent: F. to C.=F.−32÷1.8. Thus, to convert 140° F. to C.: 140°−32÷1.8=60° C.

(2) Since 5/9 is the reciprocal of 1.8, the following formula may be used: F.: C.:: F−32×5/9. Thus 140°−32×5/9=60° C.

b. To convert centigrade to Fahrenheit.—(1) Since 1° C.=1.8° F., to change centigrade degrees to Fahrenheit the following formula is used: C.: F.:: C.°×1.8+32−F. Thus: 210° C.: F.:: 210°×1.8+32= 410° F., or

(2) C.°: F.°:: C.°×9/5+32=410° F.

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SECTION VI

RATIO AND PROPORTION

Paragraph
Ratio 19
Proportion 20
Application of proportion 21

19. Ratio.—*a.* Ratio is an expression of the relation of one term to another, that is, the amount by which one term is greater or smaller than another, and may be expressed thus: 12/4 or 12:4, and is read, 12 is to 4.

b. The ratio of two numbers is the quotient obtained by dividing one term by another. The ratio of 12:4 is 3.

c. The terms of a ratio may be considered as dividend and divisor, both terms of which may be multiplied or divided by the same number without changing their value. Thus, dividing both terms of the ratio 12:4 by 4, the result is 3:1 and in each case their ratio is 3:1.

d. The terms of a ratio taken together form a couplet.

e. Ratio can exist only between numbers of the same unit value: as, the ratio of percent to percent or weight to weight, but, not weight to percent.

20. Proportion.—*a.* Proportion is the expression of equality between ratios. It is written thus: 12:6::24:12, and is read 12 is to 6 as 24 is to 12.

b. The quotients of each couplet are equal: $12 \div 6 = 2$, $24 \div 12 = 2$.

c. The first and fourth terms are called the extremes. The second and third terms are called the means.

(1) The product of the extremes is equal to the product of the means, $24 \times 6 = 144$, $12 \times 12 = 144$. Therefore, it is apparent that if three terms of a proportion are given the fourth may be found.

(2) Either extreme may be found by dividing the product of the means by the other extreme.

(3) Either mean may be found by dividing the product of the extremes by the other mean.

21. Application of proportion.—*a.* How many grams of 10 percent sulfuric acid can be made from 40 grams of 94 percent acid? Two terms of percent and one term of weight are given and the other term of weight must be determined. Write the proportion and multiply the means, 94×40 and divide by the given extreme, 10, of the proportion to find the unknown extreme. Thus: 10:94::40:X, $10X = 3{,}760$, $X = 376$ which is the number of grams of 10 percent sulfuric acid that can be made from 40 grams of 94 percent acid.

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b. Had the problem required the amount of 94 percent acid that could be made from 376 grams of 10 percent acid the following formula would be used: 10:94::X:376, 94X=3,760, X=40 grams of 94 percent acid from 376 grams of 10 percent acid.

c. Had it been required to find the strength of 40 grams of acid which, when diluted to 376 grams, would make a 10 percent acid, the following formula is used: 10:X::40:376, 40X=3,760, X=94 percent, the strength of acid, 40 grams of which when diluted to 376 grams makes a 10 percent acid.

d. If the problem had been to find the strength of acid that could be made by diluting 40 grams of 94 percent acid to 376 grams, the following formula would be used· X:94::40:376, 376X=3,760, X=10 percent, the strength of acid that could be made by diluting 40 grams 94 percent acid to 376 grams.

SECTION VII

PREPARATION OF SOLUTIONS

	Paragraph
General	22
Percentage solutions	23
Solution by ratio	24
Stock solutions	25
Solutions involving solubility	26

22. General.—*a.* A large proportion of the calculations made during compounding and dispensing is devoted to determining the strength of solutions of various nature. In very dilute solutions, slight errors in calculation may be negligible, yet as the strength of the solution increases, these errors become greater as well as deleterious.

b. The strength of a solution or mixture is the proportion of active substance of drug to the solvent, vehicle, or base, and is usually expressed in one of two ways: By the percentage method or by the ratio method. The percentage method will be considered first.

23. Percentage solutions.—*a.* "Percent" is an abbreviation of the Latin, "per centum"; "per" meaning "by" and "centum" meaning "hundred." Ten percent, therefore, means 10 parts in a hundred parts of the total (parts per hundred). A 10 percent solution would therefore contain 10 parts of solute (active ingredient) in every total 100 parts of solution, or every 90 parts of solvent (water unless otherwise indicated). Example:

Weight of solution	100 percent or	100 parts
Weight of solute	10 percent or	10 parts
Weight of solvent	90 percent or	90 parts

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b. (1) In connection with solutions, percent or percentage has different meanings under different circumstances as follows: Percent or percentage, "weight in weight" (W/W) expresses the number of grams of an active ingredient in 100 grams of the solution. Percent or percentage, "weight in volume" (W/V) expresses the number of grams of an active ingredient in 100 cubic centimeters of the solution. Percent or percentage, "volume in volume" (V/V) expresses the number of cubic centimeters of an active ingredient in 100 cubic centimeters of the solution.

(2) When the expression "percent" is used in prescriptions without qualification, it is to be interpreted to mean—for solutions of solids in liquids, percent, weight in volume; for solutions of liquids in liquids, percent, volume in volume; and for solutions of gases in liquids, percent, weight in volume. Unless otherwise stated, percentage figures in the Pharmacopoeia are understood to mean weight by weight (W/W).

c. In the calculation of percentage problems it is essential at first for the student to set up a table for each problem as shown in paragraph 23*a*. Then the actual amounts of the solute and solvent and total solution may be worked out by proportion and placed alongside corresponding figures in the table. This procedure will enable the technician to check his problem, and eventually this method will be a mental calculation with only the amounts of the actual ingredients to be placed on paper.

(1) *Weight to volume (W/V).*—(*a*) *When the amount of percentage solution wanted is given.*—Example: How many grams of silver nitrate are required to make 150 cc of a 10 percent solution?

Volume of solution	100 percent	150 cc
Volume of solvent	90 percent	x cc
Weight of solute	10 percent	x gm

A proportion having been set up, it is possible to solve for the number of grams of silver nitrate in 150 cc of solution. Substituting grams or cubic centimeters for the percent sign the following proportion is arranged:

$$100:10::150:x$$
$$100x=150$$
$$x=15 \text{ grams of silver nitrate required.}$$

(*b*) *When the amount of solute to be used is given.*—Example: How much 5 percent solution of boric acid may be prepared from

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2½ (apothecary) ounces of boric acid? (2½×31.1 grams per ounce=77.75 grams.)

Volume of solution	100 percent	x cc
Volume of solvent	95 percent	x cc
Weight of solute	5 percent	77.75 grams

5:77.75::100:x

5x=7,775

x=1,555 cc of a 5 percent solution of boric acid may be prepared.

(2) *Volume to volume (V/V).*—The same table will be used in calculating V/V solutions except "weight of solute" will be changed to "volume of solute."

(*a*) *When the amount of percentage solution wanted is given.*—Example: How much alcohol is used to prepare 150 cc of 70 percent alcohol?

Volume of solution	100 percent	150 cc
Volume of solvent	30 percent	x cc
Volume of solute	70 percent	x cc

100:150::70:x

100x=10,500

x=105 cc alcohol is required to prepare the solution.

(*b*) *For further calculations.*—With percentage solutions of V/V proceed as already demonstrated.

NOTE.—When diluting acids, refer to U.S.P. and calculate by W/V.

(3) *Weight to weight (W/W).*—When calculating solutions which are specified to be prepared by weight or W/W, proceed as outlined in paragraph 23*c*(1), substituting the word "weight" for the word "volume."

24. Solution by ratio.—*a.* This type of solution is similar to the one just discussed. It is the solution usually designated as 1 in 10, 1 in 500, or 1 in 1,000. Such a statement as 1 in 10 does not mean a total of 11 parts but means in the ratio of 1:10. A 1 in 10 solution is a solution containing 1 part of solute and 9 parts of solvent and would, therefore, be one containing 10 parts in all. This would also be a 10 percent solution. These solutions have their strengths indicated by means of ratios and may be termed "solution by parts."

b. The following are rules for preparing ratio solutions:

(1) *Weight to weight (W/W).*—Divide the number of grams of solution desired by the larger number of the ratio and the quotient

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will be the number of grams of the drug to be used; subtract the number of grams of the drug from the number of grams of finished solution and the remainder will be the number of grams of solvent to use.

(2) *Weight to volume (W/V).*—Divide the number of cubic centimeters of solution desired by the larger number of the ratio; the quotient will be the number of grams of the drug to be used and to this is added enough solvent to make the desired number of cubic centimeters of finished solution.

(3) *Volume to volume (V/V).*—Divide the number of cubic centimeters of solution desired by the larger number of the ratio; the quotient will be the number of cubic centimeters of the drug to be used and to this is added enough solvent to make the desired number of cubic centimeters of finished solution.

25. Stock solutions.—*a.* A stock solution is any solution which is too strong for ordinary use, and which therefore must be diluted down to the proper strength before using or dispensing. Stock solutions can be of two kinds:

(1) Those which may be purchased. An example of this is concentrated hydrochloric acid, which must be diluted before it can be used medicinally. Any solution of this type is not *primarily* a stock solution but has other uses. Its strength is therefore stated as weight in weight.

(2) Those which are prepared by the technician himself. In solutions of this type, unless otherwise indicated, the strength is given in form of W/V.

b. A stock solution may, for example, be said to contain 10 gm of silver nitrate in each 100 cc of solution or each cubic centimeter will contain 0.1 gm of silver nitrate. Therefore, to make up 60 cc of 1.5 percent solution using the 10 percent stock solution of silver nitrate, the following chart may be set up:

Stock solution	Prescription solution
10 percent solution or each cc contains 0.1 gm of silver nitrate.	60 cc of 1.5 percent solution or 60 cc of solution contains x grams of silver nitrate. 100:1.5::60:x 100x=90 x=0.9 gm in 60 cc of solution.

Therefore, if 0.9 gm of solute is required, and each cubic centimeter of stock solution contains 0.1 gm of silver nitrate, 9 cc of stock solu-

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tion diluted to 60 cc would give the required 1.5 percent. Or, the following formula may be used:

$$\frac{1}{\text{strength of solution on hand}} \times \frac{\text{strength of solution required}}{1} \times \frac{\text{quantity required}}{1} = \text{amount of stock solution to be used.}$$

$$\frac{1}{\frac{100}{10}} \times \frac{1.5}{\frac{100}{1}} \times \frac{6}{\frac{60}{1}} = 9.0 \text{ cc of stock solution required.}$$

26. Solutions involving solubility.—*a.* The solubility of solids is stated in the U.S.P. as follows: "One gm of boric acid is soluble in 18 cc of water . . . at 25° C." Since 18 cc of water weighs 18 grams, then 1 gram of boric acid dissolved in 18 cc of water will produce 19 grams of solution, the W/W strength can be expressed by the ratio 1:19. The percent strength of any solution is based on its total weight, and hence would be proportional to the ratio 1:19. This ratio may be changed to percent by a number of methods, all of which give the same result. In this case, for the purpose of uniformity, refer to the percentage solution table hitherto discussed:

Weight of solution	=19 gm=100 percent	=100.00 percent
Weight of solvent	=18 gm=(100−x) percent	= 94.74 percent
Weight of solute	= 1 gm=x percent	= 5.26 percent

Then by proportion, 19:1 :: 100:x
19x=100
x=5.26

b. If some solvent other than water is used, the number of cubic centimeters of liquid would have to be multiplied by its specific gravity in order to give its weight. The case of boric acid is an interesting one in this respect. Its solubility by volume is exactly the same for alcohol as that of water. The following is a repetition of the calculation of the percentage strength of a saturated solution, except that the solvent is alcohol—"One gm of boric acid is soluble in ——— 18 cc of alcohol ——— at 25° C." The specific gravity of alcohol is 0.816, so 18 cc of it will weigh 18×0.916=14.7 gm. The saturated solution is then 1: 14.7 W/W.

Weight of solution	15.7 gm=100 percent	=100.00 percent
Weight of solvent	14.7 gm=(100−x) percent	= 93.64 percent
Weight of solute	1.0 gm=x percent	= 6.36 percent

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Thus a saturated solution of boric acid in water contains 5.26 percent of boric acid, while a saturated solution in alcohol contains 6.36 percent of boric acid, although both are made by dissolving 1 gm in 18 cc of solvent.

SECTION VIII

ALLIGATION

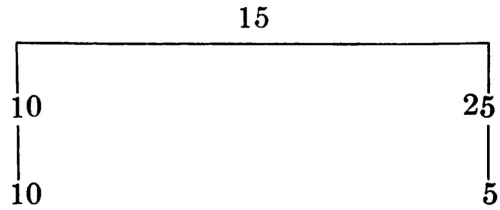
Paragraph
Definition 27
Alligation problems 28

27. Definition.—*a.* Alligation or "the rule of mixtures" is an arithmetical rule relating to the solution of problems concerning the compounding or mixing of different ingredients, or ingredients of different qualities or values, and is so named from the method of connecting together the terms in a problem by lines.

b. It is made use of in pharmacy to determine the amounts of two or more strengths of a given substance needed to blend into a new, intermediate strength of that substance. It is also applied in making adjustments of percentage or ratio strengths, and of specific gravity.

28. Alligation problems.—*a.* In what proportion must a 25 percent ointment and a 10 percent ointment be mixed to produce a 15 percent ointment? Rule: *Always link together a quantity which is less with one which is greater than the desired percentage, otherwise the answer will be wrong.*

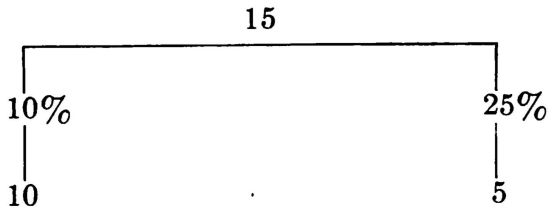
Procedure.—Subtract 10 from 15 and place the result under the 25; then subtract 15 from 25 and place the result under the 10.



The ratio obtained is 5:10 or when reduced will read: 1 part of the 25 percent ointment as to 2 parts of the 10 percent ointment.

b. To find the amount necessary to make a given quantity. Example: How many grams of a 25 percent and a 10 percent ointment are required to make 50 grams of a 15 percent ointment?

For the first step, proceed as above.



2 parts plus 1 part=3 parts or grams or cubic centimeters, when dealing with metric.

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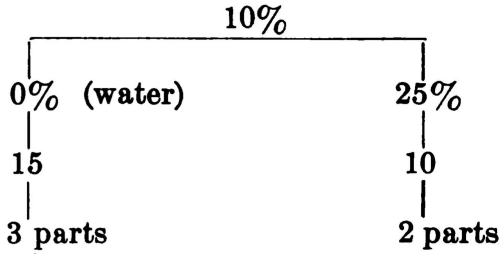
50 gm ÷ 3 gm = 16.66 gm per unit parts,
16.66 gm × 1 = 16.66 gm of 25 percent ointment,
16.66 gm × 2 = 33.32 gm of 10 percent ointment,
To make 49.98 gm of 15 percent ointment.

By proportion—

3 : 50 :: 1 : x x = 16.66 gm of 25 percent ointment,
3 : 50 :: 2 : x x = 33.32 gm of 10 percent ointment,
To make 49.98 gm of 15 percent ointment.

c. To find the amount of one ingredient when the amount of the other is given—Example: How many cubic centimeters of water must be used to make a 10 percent solution from 50 cc of a 25 percent solution?

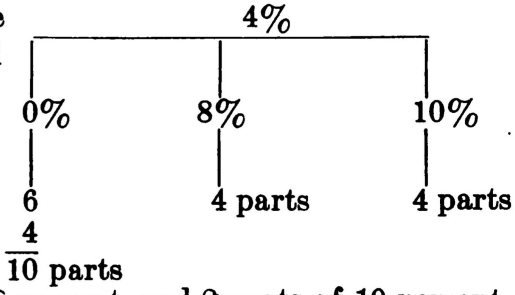
Water, starch, petrolatum, or any other diluting agents are always designated as "0" in alligation problems.



50 ÷ 2 = 25 cc, then, 25 × 3 = 75 cc of water.

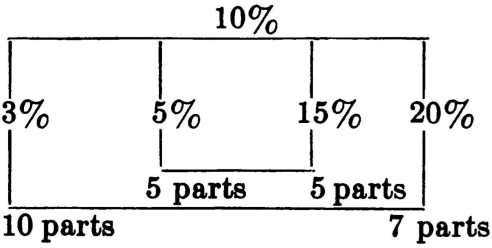
d. When more than two substances of different strengths are to be mixed—Example: In what proportion must 8 percent and 10 percent powders be mixed to produce a 4 percent powder? Eight percent and 10 percent are both greater than 4 percent, therefore, starch or some other appropriate diluent should be used as "0 percent."

The 4 is subtracted from both the 8 percent and 10 percent and placed under 0.



Or, 5 parts of diluent, 2 parts of 8 percent, and 2 parts of 10 percent.

Example: In what proportions should a 3, 5, 15, and 20 percent ointment be mixed to produce a 10 percent ointment?



10 parts of 3 percent ointment.
5 parts of 5 percent ointment.
5 parts of 15 percent ointment.
7 parts of 20 percent ointment.

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SECTION IX

REDUCING AND ENLARGING FORMULAS

Paragraph
General 29
Reducing a formula 30
Enlarging a formula 31

29. General.—When referring to pharmaceutical reference formulas, and even in prescription compounding it is often necessary to reduce or expand the formula. An error in this particular operation could cause serious damage to the patient.

30. Reducing a formula.—To reduce a formula, the amount of each ingredient is divided by the total amount specified in the formula and multiplied by the amount desired. Example: Prepare 120 cc of solution of potassium arsenite.

U.S.P. formula—

Arsenic trioxide	10 gm
Potassium bicarbonate	7.6 gm
Alcohol	30 cc
Distilled water, a sufficient quantity to make	1,000 cc

$\frac{120}{1{,}000} \times \frac{10}{X} = 1.2$ gm of arsenic trioxide for 120 cc formula.

$\frac{120}{1{,}000} \times \frac{7.6}{X} = 0.91$ gm of potassium bicarbonate for 120 cc formula.

$\frac{120}{1{,}000} \times \frac{30}{1} = 3.6$ cc of alcohol for 120 cc formula.

Distilled water, a sufficient quantity to make 120 cc.

31. Enlarging a formula.—To enlarge this same formula to 1,500 cc of solution of potassium arsenite the same procedure is followed.

$\frac{1{,}500}{1{,}000} \times \frac{10}{X} = 15$ gm of arsenic trioxide for 120 cc formula.

Continue as above for other ingredients in the formula.

SECTION X

CALCULATION OF DOSES

Paragraph
Calculation of dosage for children 32
Calculation of dosage of medicinal ingredients in prescriptions 33

32. Calculation of dosage for children.—*a.* Doses for children are most commonly calculated by means of Dr. Young's rule. By this rule the age of the child in years divided by the age plus twelve

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constitutes the fraction of the adult dose which should be given to the child. The formula may be expressed as follows:

$$\frac{\text{Age of child (in years)}}{\text{Age plus 12}} \times \text{adult dose} = \text{dose for child}$$

Children are very susceptible to narcotics and therefore should be given smaller doses of opium and other narcotic drugs than Young's rule would indicate. Laxatives may be given in somewhat larger doses than indicated.

b. Example: If the adult dose of a drug is 0.32 gm, what would the dose be for a 4-year-old child?

$$\frac{4}{4+12} \times 0.32 \text{ gm} = 0.08 \text{ gm}, \text{ the dose for a 4-year old child.}$$

33. Calculation of dosage of medicinal ingredients in prescriptions.—*a.* The technician should understand the method by which the physician builds up the prescription from the standpoint of the dose of each ingredient, indicating the number of doses to be prepared. The amount of each medicinal material to be taken at a single dose can be observed at a glance, and the total quantity of each ingredient to be used in filling the prescriptions can be found by simple multiplication. Prescriptions for powders and capsules are frequently written in this manner. Liquid prescriptions, on the other hand, are practically always written to indicate the total amount of each ingredient in a given volume. In order to calculate the dose of each ingredient, the technician must first determine the total number of doses in the prescription and then divide the indicated quantity of each ingredient by this figure.

b. Example: What is the dose of each ingredient in the following prescription?

Sodii bromidi	30
Potassium bromidi	50
Aquae destillatae, qs. ad	120

Sig: Teaspoonful at bed time.

Each teaspoonful represents approximately 4 cc. Therefore, 120÷4=30 doses. 30 grams of sodium bromide divided by 30 doses equals 1 gram of sodium bromide per dose. 50 grams of potassium bromide divided by 30 doses equals 1.66 grams of potassium bromide per dose.

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CHAPTER 3

CHEMISTRY

Paragraphs
SECTION I. General 34-35
II. Chemical and physical phenomena of matter 36-42
III. Inorganic chemistry 43-55
IV. Organic chemistry 56-58

SECTION I

GENERAL

Paragraph
Scope 34
Definitions 35

34. Scope.—A thorough explanation of the sciences of physics and chemistry is beyond the scope of this manual, and for complete information on these two sciences the technician is referred to the various textbooks on these subjects. There are, however, some facts connected with these two sciences the knowledge of which is essential to the technician. This chapter is an endeavor to present some of these essential facts.

35. Definitions.—*a. Matter* is anything that has extension (possesses length, breadth, and thickness) or is appreciable to the senses (can be seen, felt, tasted, or smelled). All matter is divided into solids, liquids, and gases.

b. A *solid* is that form of matter which holds a definite shape—whose molecules do not move among themselves.

c. A *liquid* is that form which is mobile—which assumes the shape of the vessel in which it is placed; whose molecules move freely among themselves.

d. A *gas* is that form of matter whose molecules tend to separate from one another.

e. A *mass* is any particle of matter appreciable to the senses.

f. A *molecule* is the smallest particle of matter that can exist in a free state.

g. An *atom* is the smallest particle which enters into a chemical combination. It is a particle which with one or more other atoms goes to make up a molecule.

h. Ions are atoms endowed with a charge of electricity and temporarily combined with a solvent (usually water). They do not exist

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independently, though they have become dissociated from the molecule to which they previously belonged (before being dissolved).

i. Physical change treats of the molecular changes of bodies. Thus, if an iron rod is heated, it turns red, but when allowed to cool, it is unchanged. In other words, the molecules were temporarily changed.

j. Chemical change treats of the atomic change of matter. An intimate mixture of sulfur and iron is heated, the molecules are broken up, the atoms of which they are composed enter into the play, and, through the breaking of the old association and the formation of the new, a totally new compound is formed—iron sulfide.

k. A *symbol* is an abbreviation representing the element. The abbreviation is usually the first letter of the Latin name of the element, but when that letter is already the symbol of an element, then a second letter is added to make the symbol distinctive. Thus—

Element	Latin	Symbol
Carbon	Carbo	C
Calcium	Calcium	Ca
Copper	Cuprum	Cu
Chlorine	Chlorum	Cl

A symbol does not merely mean the element in question in a general way, but when written, indicates the quantity of the element. Thus: Ca means 1 atom of calcium; Ca_2 means 2 atoms of calcium.

l. A *symbolic formula* is a combination of symbols expressing the composition of a compound molecule. Thus: H_2SO_4 means two atoms of hydrogen, one atom of sulfur, and four atoms of oxygen.

m. Indestructibility of matter means that, regardless of what chemical change or physical change has occurred, there remains as much matter as there was previous to the change, and if a substance is changed physically or chemically it still exists in another form.

n. Force is the action of one body upon another, or is that which produces changes, or stops motion. It is a manifestation of energy which may be caused in different ways, as by electricity, heat, and light.

o. Energy is a property possessed by all matter which may be defined as the capacity to do work and exists in one of two states, kinetic or potential.

p. Kinetic energy is that state recognizable as heat, light, or motion.

q. Potential energy is the latent power of all matter to produce a change, and is defined as the energy of position.

r. Heat is kinetic energy due to molecular motion.

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s. Analysis is the process by which the composition of substances is determined.

t. Synthesis is the process by which substances are produced by combining elements.

SECTION II

CHEMICAL AND PHYSICAL PHENOMENA OF MATTER

	Paragraph
Dalton's law of constant proportions	36
Dalton's law of multiple proportions	37
The law of reciprocal proportions	38
Boyle's law	39
Avogadro's hypothesis	40
Charles' law	41
Henry's law	42

36. Dalton's law of constant proportions.—*a.* Substances which take part in a chemical change always do so in the same proportion, from which it follows that in every compound the proportions, by weight, of each element in the compound are always the same. This is the principle enunciated in Dalton's law of constant proportions.

b. Thus, iron and sulfur combine to form a new substance which contains approximately 35 percent sulfur and 65 percent iron, by weight. Iron and sulfur will always combine in this same proportion when iron sulfide is formed.

37. Dalton's law of multiple proportions.—Sometimes two different compounds of the same elements are formed. Thus hydrogen and oxygen may combine in the proportion of 2 parts of the former to 16 parts of the latter to form water or in the ratio of 2 to 16. Or, hydrogen and oxygen may combine in the proportion of 1 part of the former to 16 parts of the latter to form hydrogen peroxide, or in the ratio of 1 to 16. Other elements behave similarly. However, in all cases it has been shown that if two or more elements form more than one compound, and one is considered as a constant, the different weights of the elements that combine with the constant are simple multiples of each other.

38. The law of reciprocal proportions.—The proportions in which any two elements unite with a third are the same when they unite with each other, or in simple multiples thereof. Thus: 12 parts of carbon unite with 32 parts of oxygen to form carbon dioxide; 12 parts of carbon unite with 4 parts of hydrogen to form methane; if hydrogen and oxygen form a compound, in accordance with this law, they should combine in proportions of 4 to 32 or the ratio of 1 to 8, a simple multiple thereof, as is found in water.

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39. Boyle's law.—*a.* The volume of any dry gas, the temperature remaining constant, varies inversely to the pressure applied, for example, as the pressure increases, the volume decreases.

b. The equation used in determining the volume of a gas is—

$$VP = V'P'$$

V = original volume V′ = new volume
P = original pressure P′ = new pressure

40. Avogadro's hypothesis.—If equal volumes of elements in the gaseous state are weighed under similar conditions, the relative weights will be in proportion to the molecular weight of each element. This has resulted in the establishment of a general principle which is known as Avogadro's hypothesis, to the effect that: Equal volumes of elementary gases at the same temperature and pressure contain equal numbers of molecules.

41. Charles' law.—The uniform expansion of gases is defined by Charles' law: If the pressure be constant, the volume of a given mass of dry gas is directly proportional to the absolute temperature. This law may be expressed by the equation—

$$V : V' :: T : T'$$

V = original volume T = original temperature
V′ = new volume T′ = new temperature

The centigrade temperature first must be converted into absolute temperature by adding 273° to the given centigrade temperature.

42. Henry's law.—All gases are soluble to some extent in water. When water is heated, bubbles, consisting of air which was dissolved, rise through the liquid and are liberated; hence, an increase in temperature decreases a liquid's ability to dissolve gases. This ability is increased by pressure and is employed in the manufacture of carbonated beverages. The increase in a liquid's ability to dissolve gases under pressure is governed by Henry's law: The volume of a gas that can be absorbed by a liquid is directly proportional to the pressure applied.

Section III

INORGANIC CHEMISTRY

	Paragraph
Elements	43
Chemical formula	44
Atomic weight	45
Molecular weight and percentage composition	46
Valence	47
Structural formulas	48
Radicals	49

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	Paragraph
Chemical nomenclature	50
Acids	51
Bases	52
Neutralization	53
Salts	54
Chemical change	55

43. Elements.—*a.* The word element means, fundamentally, something which cannot be changed. The term element in chemistry means a substance whose molecule cannot be broken down into more than one kind of atom.

b. Eighty-nine elements are well known to chemistry and there is reason to believe that the total number of elements is limited to ninety-two. Not all are of importance to medicine and pharmacy and of the elements listed below, the italicized ones are considered of importance.

Name	Symbol	Atomic weights (O=16)	Valence
Gaseous elements			
Hydrogen	H	1. 008	1.
Oxygen	O	16. 000	2.
Nitrogen	N	14. 008	3, 5.
Fluorine	F	19. 000	1.
Chlorine	Cl	35. 457	1.
Helium	He	4. 003	0
Neon	Ne	20. 183	0
Argon	A	39. 994	0
Krypton	Kr	83. 7	0
Xenon	Xe	131. 3	0
Radon	Rn	222. 0	0
			So-called "noble gases," and do not enter into combination with any other substance.
Liquid elements			
Bromine	Br	79. 916	1, 3, 5, 7.
Mercury	Hg	200. 61	1, 2.
Solid elements			
Lithium	Li	6. 940	1
Sodium	Na	22. 997	1
Potassium	K	56. 09	1
Rubidium	Rb	85. 48	1
Cesium	Cs	132. 61	1
			The "alkali metals."
Copper	Cu	63. 57	1, 2.
Silver	Ag	107. 880	1.
Gold	Au	197. 2	1, 2.

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Name	Symbol	Atomic weights (O=16)	Valence
Solid elements—Contd.			
Calcium	Ca	40. 08	2.
Strontium	Sr	87. 63	2.
Barium	Ba	137. 36	2.
Radium	Ra	226. 05	2.
Beryllium	Be	9. 02	2.
Magnesium	Mg	24. 32	2.
Zinc	Zn	65. 38	2.
Cadmium	Cd	112. 41	2.
Scandium	Sc	45. 10	3 } All metals except boron.
Yttrium	Y	88. 92	3
Lanthanum	La	138. 92	3
Actinium	Ac	227. 0	3
Boron	B	10. 82	3
Aluminum	Al	26. 97	3
Gallium	Ga	69. 72	3
Indium	In	114. 76	3
Thallium	Tl	204. 39	3
Carbon	C	12. 00	4 } Carbon and silicon are nonmetals.
Silicon	Si	28. 06	4
Germanium	Ge	72. 60	4
Tin	Sn	118. 70	2, 4
Lead	Pb	207. 21	2, 4
Titanium	Ti	47. 90	3, 4
Zirconium	Zr	91. 22	4
Cerium	Ce	140. 13	3, 4
Thorium	Th	232. 12	4
Phosphorus	P	31. 02	3, 5 } Phosphorus is a nonmetal.
Arsenic	As	74. 91	3, 5
Antimony	Sb	121. 76	3, 5
Bismuth	Bi	209. 60	3, 5
Vanadium	V	50. 95	3, 5.
Columbium	Cb	92. 91	3, 5.
Tantalum	Ta	180. 88	3.
Protoactinium	Pa	231. 0	3.
Sulfur	S	32. 06	2, 4, 6 } Sulfur is a nonmetal.
Selenium	Se	78. 96	2, 4, 6
Tellurium	Te	127. 61	2, 4, 6
Polonium	Po	210. 0	
Chromium	Cr	53. 01	2, 3, 6
Molybdenum	Mo	96. 95	3, 4, 6
Tungsten	W	183. 92	6
Uranium	U	238. 07	4, 6
Iodine	I	126. 92	1, 3, 5, 7.
Manganese	Mn	54. 93	2, 3, 4, 6, 7. Iodine is a nonmetal.

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Name	Symbol	Atomic weights (O=16)	Valence
Solid elements—Contd.			
Masurium	Ma	----------	
Rhenium	Re	186. 31	
Iron	Fe	55. 84	2, 3.
Cobalt	Co	92. 91	2, 3.
Nickel	Ni	58. 69	2, 3.
Ruthenium	Ru	101. 7	3, 4, 6, 8.
Rhodium	Rh	102. 91	3.
Palladium	Pd	106. 7	2, 4.
Osmium	Os	190. 2	2, 3, 4, 8.
Iridium	Ir	193. 1	3, 4.
Platinum	Pt	195. 23	2, 4.

The technician will find in his reading of textbooks, references to "families of elements." The above list of elements is grouped according to families or similarity of their more important properties.

c. Most elementary molecules consist of two identical atoms which are united chemically to form the molecule. Thus, most of the molecules of elements weigh twice as much, proportionately, as their respective atoms. A few monatomic elements are known and a few whose molecules contain more than one atom. In every elementary molecule, however, all of the molecules are alike.

44. Chemical formula.—*a.* A chemical formula is a collection of symbols and numbers showing the kinds and amounts of elements contained in a compound. An element has been defined as a substance whose molecules contain only one kind of atom; in contradistinction, a *compound* is a substance whose molecules contain more than one kind of atom and a compound, may be broken down chemically into two or more different kinds of atoms. Thus, salt or sodium chloride contains in each of its molecules—

1 atom of chlorine.
1 atom of sodium.

Calcium carbonate or chalk contains in each of its molecules—

1 atom of calcium.
1 atom of carbon.
3 atoms of oxygen.

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Pure sodium oleate, one of the common soaps, contains in each of its molecules—

18 atoms of carbon.
35 atoms of hydrogen.
2 atoms of oxygen.
1 atom of sodium.

There is no limit to the number of atoms which a molecule of a compound may contain except there cannot be less than two.

b. Formulas bear the same relationship to compounds that symbols bear to elements. They are the shorthand representations of what a compound contains and are concise statements of the number and kind of atoms in a molecule of the compound. Also, in an analogous manner to the writing and reading of symbols, the formula for a compound means 1 molecule of the compound weighing a certain definite relative amount. This molecular weight is the sum of the weights of the atoms which the molecule contains.

c. Formulas are written according to certain customs that are well understood by chemists everywhere. Some of these follow:

(1) Write formulas with the metallic elements on the left and other elements following.

(2) Formulas are read from left to right.

(3) The proper small numeral (subscript) is placed after and slightly below the symbol to indicate the number of atoms of each element in the compound if more than one atom is present in a molecule. Thus: C means an atom of carbon or 1 atomic weight; H_{35} means 35 atoms of hydrogen or 35 atomic portions of it by weight.

(4) Placing a large numeral (coefficient) before the whole formula or symbol and on a line with it multiplies everything following the numeral including the subscripts. Thus: 2NaCl means two molecules of sodium chloride and therefore, two atoms of sodium and two atoms of chlorine; $3CaCO_3$ means three molecules of calcium carbonate and therefore, 3 atoms of calcium, 3 atoms of carbon, and 9 atoms of oxygen.

45. Atomic weight.—*a.* Atomic weight of an element is the relation between the weight of 1 of its atoms and an atom of oxygen.

b. An atom of an element is by definition, "an inconceivably small" particle. If it is inconceivable, then it is certainly too small to weigh. It has been learned the number of atoms into which a certain weight of substance can be divided and it is possible to calculate the weight of an atom. Such a weight runs to upwards of 20 decimal places and is hard to apply to any practical use. Rather early in the study of

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chemistry it was learned that the relative weights of elements could be determined, that oxygen weighed 16 times as much as hydrogen per unit volume, and Avogadro early proved that, other things being equal, equal volumes of elementary gases contain the same number of molecules. From that, it was concluded that an atom of oxygen weighed 16 times as much as an atom of hydrogen and in a similar manner, these relative weights were obtained for other elements. Instead of using the long statement that "oxygen weighs 16 times as much per atom as hydrogen," the term, atomic weight of oxygen is 16, or simpler still, O=16, is used.

c. In the list of elements in paragraph 43*b*, the figures in the third column are the atomic weights corresponding to the elements whose names and symbols occupy the first two columns. It will be noted that no units of weight are given. This is because the weights shown are relative weights, or ratios between the elements named and a standard or reference element (oxygen).

d. Hydrogen, because it is the lightest known element, was, at first, chosen for the standard by which the weights of other elements were compared. The weights of other elements were determined by weighing the amount of another element which had combined with hydrogen. If it was found that, for instance, 35 parts by weight of chlorine had combined with 1 part by weight of hydrogen, then the atomic weight of chlorine was called 35. In similar manner, the weights of other elements were determined and in addition, other ways of comparing the weights were devised. With progress the atomic weights became more accurate, the elements under study became more and more numerous, and the number of known atomic weights increased. It was found that relatively few of the atoms combined directly with hydrogen, and that in a great many cases, awkward decimal fractions were obtained. Some investigators began to compare the other elements to oxygen because more elements combine directly with that element, and found that the weights so obtained were nearer to whole numbers. Gradually the use of oxygen as a standard became established and is universal today. So, the standard for atomic weights is the relation O=16, instead of the older H=1. It will be seen that for rough work there is very little difference (if O=16 then H=1.008); but for fine work the oxygen standard is preferred, and all tables of atomic weight are so made.

46. Molecular weight and percentage composition.—*a. Molecular weight.*—(1) The molecular weight of a substance is the sum

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of the atomic weights of its constituent atoms. Thus, the molecular weight of sodium chloride (NaCl) is—

Na, atomic weight	22.997	
Cl, atomic weight	35.457	
NaCl, molecular weight	58.454	

The molecular weight of calcium carbonate ($CaCO_3$) is—

Ca, atomic weight	40.08	
C, atomic weight	12.00	
O_3, atomic weight	48.00	(16×3)
$CaCO_3$, molecular weight	100.08	

(2) There are other means of determining molecular weight that are different from the process of finding the atomic weight of elements, and, as the molecular weights of elements found by such processes are almost always twice the atomic weight, it is believed that most elemental molecules in the gaseous form contain 2 atoms. Thus the molecular weight of oxygen is 32; the atomic weight is 16; therefore a molecule of oxygen must be O_2. However, while the atomic weight of mercury is 200, its molecular weight estimation gives the same figure, therefore, a molecule of mercury in the gaseous form evidently consists of 1 atom. Again, the atomic weight estimation of phosphorus is 31 as its relative combining weight, while its molecular weight has been experimentally proved to be 124; hence 1 molecule of phosphorus in the gaseous form must contain 4 atoms.

b. Percentage composition.—By means of atomic weight, the percentage of any element in a compound may be determined. Thus: Sodium chloride Na=22.997, Cl=35.457, NaCl=58.454.

$\frac{22.997}{58.454} \times 100$ percent=39.4 percent of sodium in sodium chloride.

$\frac{35.457}{58.455} \times 100$ percent=60.6 percent chlorine in sodium chloride.

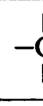
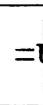
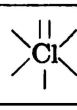
47. Valence.—*a. Definition.*—Valence is a measure of combining power; it shows how many atoms of one kind will combine with an atom of another kind. Since some unit of measure by which the amount of combining power may be expressed is necessary, hydrogen is taken as the basis. Thus, if any element combines with hydrogen in the proportion of 1 atom per atom of hydrogen it has a valence of one, and any element which combines with hydrogen in the proportion of 2 atoms of hydrogen to one atom of itself has a valence of 2; if an element has such combining power that it

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can unite with 4 atoms of hydrogen it has a valence of 4, etc. Elements which do not form compounds, such as inert gases, are said to have no valence. In some elements valence is comparative only, because they will not combine with hydrogen, as mercury, for instance. The valence of such an element is determined by comparison of the noncombining element with one which will combine with hydrogen. Therefore, as one atom of mercury will combine with one of oxygen, and it is known that one of oxygen will combine with two of hydrogen, the valence of mercury is said to be two.

b. Ways of showing valence.—(1) There are several ways in which it may be shown that an element has a certain valence and all reduce to the same meaning. The unit of valence is called a "valence bond" or simply a "bond." Thus, hydrogen has one bond, sulfur has two bonds, and nitrogen has three valence bonds; meaning that hydrogen has a valence of one, sulfur has a valence of two, or nitrogen has a valence of three. These bonds are often written as lines or dashes beside the symbol, thus H–, S=, N≡, or H–, –S–, –N–. Another system is the use of prefixes, thus: mono or uni meaning one, di or bi meaning two, tri meaning three, etc. Still another method of writing the valence of an element is as a small Roman numeral at the upper right hand corner of the symbol.

(2) The following tabulation is intended to combine all of the foregoing ways of showing valence of an element. Reading from left to right, all of the terms and signs are synonymous:

Na–	Na–	Na^{I}	Monovalent sodium or univalent sodium.	Sodium having a valence of 1.
O=	–O–	O^{II}	Divalent oxygen or bivalent oxygen.	Oxygen having a valence of 2.
Bi≡	–Bi–	Bi^{III}	Trivalent bismuth.	Bismuth having a valence of 3.
C≡		C^{IV}	Tetravalent carbon.	Carbon having a valence of 4.
As≡		As^{V}	Quinquivalent arsenic.	Arsenic having a valence of 5.
U≡		U^{VI}	Hexavalent uranium.	Uranium having a valence of 6.
Cl≡		Cl^{VII}	Heptavalent chlorine or septavalent chlorine.	Chlorine having a valence of 7.

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c. Valence of elements in compounds.—Many elements have the power to combine with other elements in more than one proportion. This is the reason that in the table of elements, series of valence figures are shown. This power to have more than one valence follows as a direct consequence of the law of multiple proportions and this condition is known as polyvalence. Thus, an atom of mercury will sometimes combine with one atom of chlorine, forming mercurous chloride, and under other conditions it will combine with two atoms of chlorine to form mercuric chloride. That these varying valences may be indicated, the terminations *ous* and *ic* are used, denoting the lower and higher valence, respectively, as mercur *ous* chloride and mercur *ic* chloride.

d. Nature of valence.—(1) Valence is thought to be of an electrical nature. It is a charge of electricity attached to an atom. This conception of valence explains a great deal about compound formation. Some elements have a positive charge, some have a negative charge. It is a well-known fact that in electricity, oppositely charged bodies attract each other, and the charge is neutralized when they are in contact. This is true, as well, in chemical compounds. In general, the metals and hydrogen are positively charged, or ELECTROPOSITIVE; the nonmetals and gases are negatively charged, or ELECTRONEGATIVE. Moreover, it is easy to determine whether an element is positive from a study of formulas of compounds containing the element. In nearly all formulas the electropositive element is written first or to the left while the electronegative element is written second or to the right. Thus in NaCl, sodium is positive, chlorine negative; in H_2O, hydrogen is positive, oxygen is negative.

(2) An element has as many charges as it has valence bonds. An element having a valence of two has two charges, positive if it is a metal, negative if it is a nonmetal. One of the best ways to study chemical reactions is to write compounds with all of these charges shown, thus:

$$\overset{+}{Na}\ \overset{-}{Cl},\quad \overset{++}{Fe}\ \overset{--}{Cl_2},\quad \overset{+++}{Fe}\ \overset{---}{Cl_3}.$$

It will be seen that the positive and negative signs are an indication of valence; they also show whether or not the compound is properly written, for in every case the positive signs must balance the negative.

48. Structural formulas.—By means of valence bonds it is possible to draw a diagram of a molecule of a compound instead of merely writing its formula. Such diagrams are called structural formulas. They are merely an indication of how it is believed the

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elements of a compound are united and are not to be thought of as actual pictures of compounds. Examples of some structural formulas:

Hydrochloric acid
HCl
H—Cl

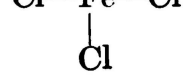
Potassium iodide
KI
K—I

Carbon monoxide
CO
C≡O

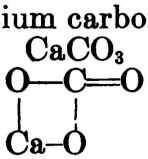
Carbon dioxide
CO_2
O=C=O

Ferrous chloride
$FeCl_2$
Cl—Fe—Cl

Ferric chloride
$FeCl_3$



Calcium carbonate
$CaCO_3$



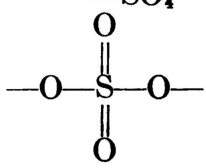
Water
H_2O
H—O—H

49. Radicals.—A great many chemical compounds contain groups of elements which have a character of their own and which, in reactions, move from compound to compound as a group, seemingly without internal change. Such groups of elements are called radicals. These radicals are well known in inorganic reaction, so well known that many of them have acquired names, thus: the hydroxyl radical, the nitrate radical, the sulfate radical, etc. Radicals act as though they were single elements in reactions, moving intact from salt to salt. Radicals also are said to have valence, which is probably a misnomer. However, in the structural formulas of various radicals it is evident that there must remain certain free bonds attached to some of the elements of the radical. It is these free bonds which give radicals their valence. Some typical radicals are—

Hydroxyl radical
—OH
—O—H

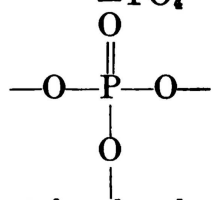
1 free bond
(valence 1)

Sulfate radical
$=SO_4$



2 free bonds
(valence 2)

Phosphate radical
$\equiv PO_4$



3 free bonds
(valence 3)

50. Chemical nomenclature.—*a.* Chemical nomenclature is the naming of chemicals. In addition to the formulas and symbols, there has grown up in chemistry a set of definite names referring to definite substances. Chemical nomenclature is systematic to some degree but there are a few terms which must be learned in specific instances. The nomenclature describing valence has been discussed and these prefixes are used a great deal and refer to a number in each case.

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(1) Other prefixes are also used at times; chief among these are—

Hypo	(meaning less or least)	Sodium hypochlorite Na ClO
Hyper or per	(meaning more or most)	Hydrogen peroxide $H_2 O_2$
Iso	(meaning equal)	Isomeric, isoalcoholic
Proto	(meaning less)	Mercury protoiodide Hg I
Sub	(meaning under or less)	Mercury subchloride Hg Cl
Sesqui	(meaning one and a half)	Iron sesquichloride $Fe Cl_3$

(2) These prefixes are not used so much as formerly, the more specific numerical prefixes being preferred in modern usage. The meaning of sesquichloride of iron does not explain itself whereas iron trichloride does.

b. Terms referring to valence.

Valence	Adjectives		Nouns
I	Univalent / Monovalent	Monatomic	Monad.
II	Bivalent / Divalent	Diatomic	Diatomic.
III	Trivalent	Triatomic	Triad.
IV	Tetravalent	Tetratomic	Tetrad.
V	Quinquivalent / Pentavalent	Pentatomic	Pentad.
VI	Hexavalent / Sexivalent	Hexatomic	Hexad.
VII	Heptavalent / Septavalent	Heptatomic	Heptad.

c. Terms used to indicate the number of elements in a compound are—

(1) *Binary* compounds are those composed of only two elements; e. g., H Cl, K I, $Ca Cl_2$, etc.

(2) *Ternary* compounds are those composed of three elements; e.g., $K NO_3$, Na OH, $H_2 SO_4$, etc.

(3) *Quaternary* compounds are those having four elements in the molecule; e.g., $Na_2 HPO_4$, etc.

d. Naming of acids and salts.—(1) *Binary acids and salts* are named uniformly, as follows: Acids contain the name of the characteristic element preceded by "hydro" and followed by "ic." In other words, the name of the element (or part of the name) is inserted into the dash in "hydro——ic." Examples are: hydrofluoric acid, hydrochloric acid, etc., the formulas of which are H F, and H Cl. The corresponding salts are named by adding as a suffix, the syllable "ide" to the name of the characteristic (electronegative) element. Thus the

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salts corresponding to the binary acids shown as examples are: fluorides, chlorides, etc.

(2) *Ternary acids and salts* are more difficult to name because there are more possibilities, and because of differences in valence, there is variation in the amount of oxygen (the usual third element) so that there is no uniformity in the nomenclature of ternary acids and salts. However, there does exist a certain amount of systematic naming within the acids and salts of any one element.

(*a*) "*Ous.*"—The suffix "ous" is added to names of compounds in which an element exists with its lower valence or valences; e. g., sulfur*ous* acid, nitr*ous* acid, etc.

(*b*) "*Ic.*"—The suffix "ic" is added to names of compounds in which an element exhibits its high or higher valence; e.g., sulfur*ic* acid, nitr*ic* acid, etc.

(*c*) "*Hypo——ous.*"—The prefix "hypo" is added before and the suffix "ous" after the name of an element in a compound in which the element exhibits a valence still lower than in the "ous" compound.

(*d*) "*Per——ic.*"—The prefix "per" added before, and the suffix "ic" added after the name of an element, indicates that in the compound so named the element exhibits a valence still higher than in the "ic" compound.

(3) Examples of naming of acids and salts of some elements:

HCl	Hydrochlor*ic* acid	KCl	Potassium chlor*ide*
$HClO$	*Hypo*chlor*ous* acid	$KClO$	Potassium *hypo*chlor*ite*
$(HClO_2)$	Chlor*ous* acid	$KClO_2$	Potassium chlor*ite*
$HClO_3$	Chlor*ic* acid	$KClO_3$	Potassium chlor*ate*
$HClO_4$	*Per*chlor*ic* acid	$KClO_4$	Potassium *per*chlor*ate*

"*Ite,*" "*ate,*" "*hypo——ite,*" and "*per——ate*" prefixes and suffixes should be self-apparent from the study of the acid which corresponds to them. Examples of the use of the terms are included in the preceding table. A salt of an "ous" acid has a name ending in "ite." A salt of "hypo——ous" acid is named "hypo——ite." In the same way, a salt of an "ic" acid ends in "ate"; and a salt of a "per——ic" acid has a name of the form "per——ate."

51. Acids.—*a.* Inorganic chemicals may be divided into several groups, each of which has characteristics common to all of the chemicals in the group. One of these groups is the one containing acids. The acids have certain properties in common which are called "acid properties." They are—

(1) *Structure.*—All acids are compounds of hydrogen with some other element, a nonmetal. They have the general formula, HR or

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H^+R^-, where H or H^+ represents hydrogen, and R or R^- represents another element or radical containing another element. The plus and minus signs are added to show that in the compound the hydrogen is electropositive, and the radical is electronegative.

(2) *Physical state of acids.*—Acids may be gases as HCl or H_2S, or liquids as H_2SO_4, or solids as H_3BO_3.

(3) *Chemical properties of acids.*—(*a*) All acids have a sour taste when in solution.

(*b*) The hydrogen of acids is liberated by treatment with a metal. (The symbol Me represents any metal. MeR means a salt of the acid with the same metal.)

$$HR+Me=MeR+H$$

(*c*) Acids react with bases characteristically. (The formula MeOH represents the hydroxide of any metal.)

$$HR+MeOH=MeR+H_2O$$

(*d*) Acids have characteristic reactions with indicators—they change blue litmus paper to red, and change methyl orange from yellow to pink, etc.

b. The H^+ of an acid is called a hydrogen ion; and it is the hydrogen ion that gives acids their chemical properties. It is seen from the symbol that a hydrogen ion is an atom of hydrogen carrying a positive charge of electricity. The "strength" of acids is measured by the amount of hydrogen ion they are able to produce in solution and any compound that is able to liberate hydrogen ion is acidic whether or not its actual formula conforms to the above general one.

52. Bases.—*a.* Another large group of chemicals is the one called "bases," and the properties which they possess in common are called basic properties. This group is the one commonly referred to as alkalies, or caustic alkalies, or simply hydroxides.

b. Common properties of bases are—

(1) *Structure.*—All bases are hydroxides of metals. They have the general formula MeOH in which "Me" represents any metal. To show the nature of the compounds the general formula is written Me^+OH^-, the Me^+ represents any metallic ion and OH^- represents hydroxyl ion. The group –O–H, commonly called hydroxyl ion, gives bases all of their properties. It is the exact complement of the hydrogen ion, and in many ways may be considered as its opposite. As in the case of the hydrogen ion, any substance which is capable of releasing hydroxyl ion when it is dissolved in water will have basic properties whether or not the substance actually is a base

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(2) *Chemical properties* of bases are—

(*a*) All bases have a bitter taste when dissolved.

(*b*) Bases react characteristically with acids.

$$MeOH + HR = MeR + H_2O$$

(*c*) Metals are generally unaffected by treatment with bases unless some other agent is present.

(*d*) Bases given characteristic reactions with indicators—they turn red litmus paper blue, methyl orange yellow, and phenolphthalein red.

53. Neutralization.—When substances having acidic properties are mixed with substances having basic properties in the proper proportion (molecule for molecule), both the acidic properties and basic properties disappear and the solution is no longer sour or bitter. If an indicator has been added to the solution it will have neither the color it has in acidic solutions nor that which it has in basic solutions.

a. Example of neutralization reaction with electrical charges shown for general and specific neutralization:

$$Me^+OH^- + H^+R^- = MeR + H_2O$$

$$Na^+OH^- + H^+I^- = NaI + H_2O$$

$$OH^- + H^+ = H_2O$$

b. It will be noticed that in every neutralization reaction water is formed and moreover, as the third reaction emphasizes, that the water is formed by the combination of hydrogen ion and hydroxyl ion. This shows the fact that water is neutral because every hydrogen ion in it is counterbalanced by a hydroxyl ion. Some of each in a free state exists in water, but as they are present in equal amounts, their presence is not shown by the appearance of either basic or acidic properties. Similarly any other substance is neutral which has every hydrogen ion counterbalanced by a hydroxyl ion and this balance of hydrogen ion and hydroxyl ion is neutrality.

c. In the second equation shown above, if molecular proportions of each chemical have been used, the solution will be neutral, all of the positive charges will have become balanced by negative charges. In addition, a new substance is formed, namely NaI, or sodium iodide. This is the other characteristic of neutralization reactions.

d. Thus, in neutralization, four things always happen:

(1) A substance having acidic properties reacts with one having basic properties.

(2) Both acidic and basic properties disappear.

(3) Water is formed.

(4) A salt is formed.

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54. Salts.—Salts are composed of one or more atoms of a metal combined with one or more atoms of nonmetals that have the general formula MeR. The properties of salts are too many and varied to describe except to state that they are neutral in comparison to acids and bases and do not react with as many other substances or as readily as acids or bases.

a. Normal salts are salts which are formed by the complete neutralization of acids and bases. They may be recognized at once from their formulas. If the formula contains neither hydrogen nor oxygen (apart from the oxygen of the electronegative radical) the salt is a normal one. Examples of normal salts are—

$NaCl$	Sodium chloride	$AgNO_3$	Silver nitrate
$BaSO_4$	Barium sulfate	KBr	Potassium bromide

b. Acid salts are formed by partial neutralization of bases and acids. Some acids have more than one hydrogen ion per molecule, e.g., sulfuric acid, H_2SO_4, and it is possible to replace only one of these hydrogen ions with a metal or, in other words, to only partially neutralize these acids. Any acid salt shows part of the hydrogen of the acid of its formula. The following equations show the formation of an acid salt and also the formation of a neutral salt of the same base and acid.

$$2NaOH + H_2SO_4 = Na_2SO_4 + 2H_2O$$
Normal salt

$$NaOH + H_2SO_4 = NaHSO_4 + H_2O$$
Acid salt

Acid salts are either so named or the prefix "bi" is inserted in the name to indicate that the salt is an acid one. Example: Sodium acid sulfate is a synonymous term of sodium bisulfate.

c. Solubility table.—The following solubility table is presented compositely in order to indicate chemical precipitations which may be anticipated by the technician. This table should be committed to memory. The formation of a less soluble compound or the lessening of the concentration of one pair of ions are the contributing factors to metathetical reactions in which a new salt is formed from the aqueous solutions of two other salts. Of these two factors, solubility is much the more important.

Since *water* is the most common solvent in use, these solubilities are intended to indicate solubility *in water*. Accurately speaking, no substance is *insoluble*, therefore, the term insoluble is used to designate substances which are so slightly soluble that their dissolved portion is not ordinarily appreciable. Under certain conditions and by use of certain methods, the solubility of insoluble substances may become no-

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ticeable and measured. Witness the use of potassium iodide used in rendering iodine soluble. This is the use of a so-called "compound solvent."

Acids.—All common acids are *soluble* in water with the exception of silicic (H_2SiO_3) and arsenious ($HAsO_2$) acids. Soluble acids have a sour taste and affect color indicators, such as litmus, etc.

Bases.—All common bases are *insoluble* with the exception of six:

Ammonium hydroxide, NH_4OH.
Potassium hydroxide, KOH.
Sodium hydroxide, NaOH.
Barium hydroxide, $Ba(OH)_2$.
Strontium hydroxide, $Sr(OH)_2$.
Calcium hydroxide, $Ca(OH)_2$.

Calcium hydroxide is only sparingly soluble. Only the soluble bases affect color indicators; these solutions usually have a bitter taste.

Salts.—All *common* salts of sodium, potassium, and ammonium are extensively soluble in water.

All *silver* salts are insoluble except silver fluoride, silver nitrate, silver chlorate, silver acetate, and silver sulfate. The last two are only sparingly soluble.

The *nitrates*, *acetates*, and *chlorates* of all metals are extensively soluble in water. Silver acetate is only moderately soluble.

The *sulfates* of lead, barium, and strontium are insoluble; calcium sulfate, mercurous sulfate, and silver sulfate are slightly soluble; and all other sulfates are extensively soluble.

The *chlorides* of silver and mercurous mercury are insoluble; lead chloride is very slightly soluble in cold water but extensively soluble in hot water; all other chlorides are moderately to extensively soluble.

The normal *carbonates*, *sulfites*, and *phosphates* of all metals are insoluble except those of sodium, potassium, and ammonium. The *acid* carbonates, sulfites, and phosphates, however, are soluble.

All *sulfides* and silicates are insoluble except those of sodium and potassium. Ammonium sulfide, too, is extensively soluble.

d. A *basic salt* is one containing more base than is necessary for the formation of normal salts. The base which remains in the salt is not so easily identified as the H^+ of an acid salt due chiefly to the tendency of two $-OH$ radicals to decompose to a molecule of H_2O and an $=O$ radical. Either the hydroxyl or oxygen from the base will be found in the formula of a basic salt. Examples of basic salts are—

Basic ferric chloride, Fe_2OCl_4.
Basic bismuth nitrate, $Bi(OH)(NO_3)_2$.

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e. Double salts are formed when two different bases neutralize a dibasic acid. Example: Potassium and sodium sulfate, $KNaSO_4$.

55. Chemical change.—*a.* Molecules are the smallest portions of a chemical compound that retain the properties of that compound and are composed of two or more atoms which are, in turn, the smallest possible divisions of the elementary substances. In chemical changes the atoms composing the original molecules dissociate, or combine with like and unlike atoms of other molecules, to form new substances possessing entirely different properties from the original. The six different ways in which chemical reactions may take place are—

(1) *Direct combination* or *addition reactions.*—In addition reactions two or more elements unite to form a compound without the formation of any byproduct. It may be illustrated by the following reaction:

$$Na+I=NaI$$

(2) *Simple decomposition* is that reaction in which one compound breaks down into two or more simpler compounds. It will be seen to be the exact opposite of addition reactions. The following examples illustrate various types of simple decomposition:

(*a*) Any oxide of a "noble metal" breaks down when heated, as follows:

$$2Ag_2O \overset{\triangle}{=} 4Ag+O_2^0$$

(*b*) Carbonyl chloride, when heated, decomposes into a simpler compound and the element chlorine:

$$COCl_2 \overset{\triangle}{=} CO+Cl_2^0$$

(*c*) Calcium carbonate when heated breaks down into two simpler compounds:

$$CaCO_3 \overset{\triangle}{=} CaO+CO_2$$

(*d*) The three reactions above are specific applications of the following three general reactions:

$$AB=A+B$$
$$ABC=AB+C$$
$$ABC=AB+BC$$

(3) *Displacement* is the kind of reaction in which an element replaces some other element in a compound. Certain active metals

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which react with monoxidizing acids displace hydrogen from the acid and take the place of the hydrogen in the compound.

$$Zn+2HCl=ZnCl_2+H_2°$$

The general formula for displacement reactions is AB+C=AC+B.

(4) *Double decomposition* (metathesis) is the type of reaction in which the elementary atoms "change partners." Example: $HgCl_2+2KI=HgI_2+2KCl$.

(*a*) The general reaction for double decomposition is AB+CD=AC+BD.

(*b*) Neutralization, which has been discussed, is a type of double decomposition.

(5) *Oxidation* means adding oxygen to a compound. Thus, the reaction $2Mg+O_2°=2MgO$ shown as an addition reaction is also an example of oxidation reaction. Any reaction in which the oxygen content of a compound is increased or in which the positive valence of an atom is increased is an oxidation reaction.

(6) *Reduction* is the opposite of oxidation. It is a type of reaction in which oxygen is abstracted from compounds or in which the positive valence of an atom is lowered by use of reducing agents. It should be noted that reduction reactions frequently involve hydrogen in a similar manner to the way oxidation reactions involve oxygen.

b. In conducting chemical reactions the chief considerations are—reagents, quantities of reagents, and physical conditions surrounding reactions.

(1) Reagents are substances which enter the reaction, and reagents must be used that will produce the change desired in carrying out the reaction. A further consideration is that reagents be chosen to produce the desired change in such a manner that the resultant product may be used or recovered. In the analysis of a substance the choice of a reagent that will cause a change which can be noted or measured is desired.

(2) The quantities of reagents to be used in a specific case may be calculated from an equation for the reaction. Thus, to prepare 100 grams of mercurous iodide from mercurous nitrate and potassium iodide it is possible to determine how much of the reagents must be used to produce the desired result—

$$HgNO_3+KI=HgI+KNO_3$$

Chemical equations represent relative weights of the substances involved, being composed of the formulas of the compounds involved. These relative weights total the same on each of the two sides of the equality sign in just the same way that the various atoms must reach

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the same total. In the following the equation is expanded by showing the relative weights involved:

$HgNO_3$	$+KI=$	$HgI+$	KNO_3
$Hg=1\times200.6=200.6$	$K=1\times39.1$	$Hg=200.6$	$K=39.1$
$N=1\times14.0=14.0$	$I=1\times126.92$	$I=126.92$	$N=14.0$
$O_3=3\times16=48.0$			
262.6	166.02	327.52	101.0

It may be seen that the equation is mathematically true, each side totals 428.62. Now, change the relative weights to actual weights which can be measured. This can be done by the use of proportion, for the actual weights involved are proportional to the relative weights. Then—

$$HgNO_3 : HgI : : 262.6 : 327.52$$

Since 100 grams of HgI is desired, substitute that figure and solve—

$$HgNO_3(X) : 100 \text{ gm} : : 262.6 : 327.52$$

$$HgNO_3(X)=\frac{262.6\times100}{327.52}=80.18 \text{ gm of } HgNO_3$$

Similarly for potassium iodide—

$$KI : HgI :: 166.02 : 327.52$$

$$KI : 100 \text{ gm} :: 166.02 : 327.52$$

$$KI=\frac{166.02\times100}{327.52}=50.69 \text{ gm of KI}$$

Thus, 80.18 grams of mercurous nitrate and 50.69 grams of potassium iodide are used to make 100 grams of mercurous iodide and a by-product $(80.18+50.69)-100$ grams or 30.87 grams of potassium nitrate in solution.

(3) Certain physical conditions surrounding reactions must take place in order for a reaction to occur. Reagents must be brought into intimate contact because chemical reactions take place between atoms, not between lumps or crystals. In the above reaction both the salts are soluble and they are dissolved, the solutions mixed and the mercurous iodide precipitates and may be washed until free from potassium nitrate. Some of the factors which are generally used to control or modify the speed of reaction or the degree of completeness to which a reaction will take place are as follows:

(*a*) *State of aggregation.*—Gases react most rapidly due to their molecules being in a state of rapid motion which results in intimacy of contact throughout the mass of gas. Liquids react less actively than gases but since they are readily mixed intimately, reactions

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between liquids take place fairly rapidly. Solids are rigid and react only at the surface, often very slowly and incompletely. Again, this is due to the fact that there is not intimate contact between the particles.

(*b*) *Temperature.*—Temperature has a large effect both on the speed of the reaction and upon the degree of completeness to which the reaction takes place. Both are generally increased by increasing the temperature. This follows from the kinetic theory that the heat increases the energy of the molecules.

(*c*) *Concentration.*—By concentration is meant the actual number of molecules in a definite amount of space or volume. Increased concentration increases the molecular contact and speeds up reaction. Concentration has another effect which is used in some reactions which do not ordinarily proceed to completion. In these cases a complete reaction is often obtained if one of the reagents is present in excess.

(*d*) *Removal of end products.*—Frequently the speed of reactions is increased if the products of the reaction are removed as they are formed.

(*e*) *Catalysts.*—These are substances which by their presence cause reactions to proceed at a greater speed or to a greater extent than they would if the catalyst were not present.

(*f*) *Pressure.*—The effect of pressure is similar to that of heat in that it increases the sphere of contact of the molecules. It has little effect on reactions between solids and liquids in which gases are not involved.

(*g*) Electricity may be used to begin speed, or to complete reactions, and as it acts quantitatively, a given amount of electricity will produce a given amount of chemical change.

c. Reactions which do not go to completion are known as reversible reactions and the point at which they seemingly stop is known as chemical equilibrium. An example of a reversible reaction: $2NaCl + H_2SO_4 \rightleftarrows 2HCl + Na_2SO_4$. If sulfuric acid is added to the salt, some of the salt is converted to hydrochloric acid but not all of it. If molecular quantities of the reagents were used, it would be expected to find only the two products, sodium sulfate and hydrochloric acid, in the solution. Instead, four products are found: sodium chloride, sodium sulfate, hydrochloric acid, and sulfuric acid. Moreover, if repeated analyses of this solution are made at various times but at the same temperature, they show that the four substances are present, each in the same concentration in each of the analyses. Therefore, a state of chemical equilibrium (balance) has been reached. As a re-

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sult of the kinetic theory it is known that the reaction is not just at a standstill but that it has reached a point at which just as many atoms are changing one way as there are changing back again, or the reaction is proceeding in both directions at the same time. That is the reason the reaction is called reversible, and also the reason that the equality sign is modified to become an arrow pointing in each direction. Also, if the reaction were started with the substances on the right of the equality sign, instead of those on the left, the same equilibrium mixture results if the temperature is the same.

SECTION IV

ORGANIC CHEMISTRY

	Paragraph
General	56
Structural formulas	57
Classification	58

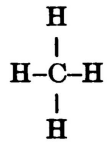
56. General.—*a.* Organic chemistry is the study of compounds of carbon. This field is so vast that it embraces every phase of our modern civilization, indeed, the very existence of life itself. The cell which is the unit of all living matter is made up of complex substances, all of which are compounds of carbon. The food we eat consists almost entirely of organic compounds. The textile fibers for our clothing, the wood for our furniture and buildings, the paper in our books and newspapers, the gasoline that runs automobiles are all carbon compounds as are thousands of other everyday materials such as medicines, dyes, perfumes, soaps, rubber, explosives, etc.

b. Various estimates place the number of organic compounds now known at anywhere from 225,000 to 500,000. As a striking contrast to these figures, all known compounds of all the elements other than carbon total up to no more than 26,000. Since carbon is not a very active element, it is surprising to find that it is present in so many compounds. The chief reason is that carbon atoms have the peculiar property of combining with each other, forming chains or rings which contain from two to as many as sixty atoms of carbon.

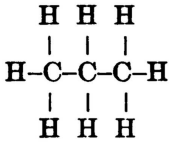
57. Structural formulas.—The study of organic compounds has been immeasurably simplified by representing their formulas in a graphic manner. A structural formula consists of symbols, to repre-

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sent atoms, and lines or bonds to represent valence. Thus, the structural formula of methane, the simplest organic compound, is—



This indicates that one atom of tetravalent carbon is combined with four atoms of univalent hydrogen. The structural formula of propane is written thus—



58. Classification.—Practically all organic compounds are grouped in the following classes:

Hydrocarbons	Ketones	Carbohydrates
Alcohols and phenols	Acids	Alkaloids
	Esters	Nitrogenous products
Aldehydes	Ethers	

a. Hydrocarbons.—A hydrocarbon is a compound containing only hydrogen and carbon. Hydrocarbons occur extensively in petroleum and fuel gases. Methane, acetylene, benzene, turpentine, and naphthalene are all important hydrocarbons. Methane is the simplest of all, its formula being CH_4. It is the initial compound of the paraffin series, the first five members of which are:

methane CH_4	propane C_3H_8	pentane C_5H_{12}
ethane C_2H_6	butane C_4H_{10}	

(1) *Homologous series.*—A study of the composition and structure of organic compounds reveals that they may be conveniently grouped in families. In the methane series above, it will be noted that the difference between any two successive members is CH_2. Such a group is called an homologous series. It should be further noted that the number of hydrogen atoms in a molecule of each of these compounds is twice the number of carbon atoms plus 2. The general formula for the members of the methane or paraffin series is therefore, $C_nH_{2n}+2$. In general, there is a graduation of properties such as physical state, boiling point, etc., as we pass from one member of the homologous series to the next.

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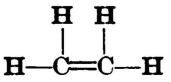
(2) *Methane.*—(*a*) Methane is a colorless, odorless gas which burns with a faintly luminous flame. It is formed by the decomposition of vegetable matter under water in marshy regions, hence its common name, marsh gas. Methane is frequently found in coal mines, where it is a great source of danger because it forms explosive mixtures with air. Miners call the gas fire damp. Methane is the principal constituent of natural gas and is one of the important ingredients present in most fuel gases.

(*b*) *Official hydrocarbons of the methane or paraffin series.*

1. *Benzinum Purificatum, U.S.P.*—Purified petroleum benzin, petroleum ether.
2. *Petrolatum Liquidum, U.S.P.*—Liquid petrolatum, liquid paraffin, white mineral oil.
3. *Petrolatum, U.S.P.*—Petrolatum, petroleum jelly (vaseline).
4. *Petrolatum album.*—White petrolatum, white petroleum jelly (white vaseline).
5. *Paraffinum.*—Paraffin.

(3) *Saturated and unsaturated compounds.*—In the members of the methane series, each carbon atom is joined to an adjacent carbon atom by a single valence bond. Such compounds are said to be *saturated.* There exist other carbon compounds where a carbon atom has one or more of its valence bonds unsatisfied. These unsatisfied carbon atoms form what is known as *unsaturated compounds.* Their structural formulas show neighboring carbon atoms joined by double bonds or triple bonds. Ethylene and acetylene are examples of unsaturated compounds.

(4) *Ethylene series.*—(*a*) In this series two adjacent carbon atoms are linked by a double bond. The general formula of a member of this series is C_nH_{2n}. The first compound of this group is ethylene (C_2H_4). Its structural formula is—



(*b*) *Official hydrocarbon of the ethylene series.*
Ethylenum, U.S.P.—Ethylene.

(5) *Acetylene series.*—In this series two adjacent carbon atoms are linked by a triple bond. The general formula is: C_nH_{2n-2}.
Its structural formula is: H—C≡C—H. It is made by the action of water on calcium carbide as follows:

$$CaC_2 + 2H_2O = Ca(OH)_2 + C_2H_2$$

It is a colorless gas and burns ordinarily with a very smoky flame.

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(6) *Substitution products of hydrocarbons.*—(*a*) Part or all of the hydrogen in methane (CH_4) may be replaced by chlorine, forming the following compounds: Monochlormethane or methyl chloride (CH_3Cl); Dichlormethane (CH_2Cl_2); Trichlormethane or chloroform ($CHCl_3$); Tetrachlormethane or carbon tetrachloride (CCl_4). Other elements or radicals such as Br, OH, NO_3, etc., can be used to replace the hydrogen in methane and other hydrocarbons, thus giving rise to an enormous number of compounds. Such derivatives are called *substitution products.*

(*b*) *Official substitution products of hydrocarbons.*

1. Chloroforum, U.S.P.—Chloroform (trichlormethane), methenyl trichloride. Prepared by the reaction between bleaching powder and ethyl alcohol. It is a heavy, volatile liquid with a pleasant sweetish odor. Chloroform is used as an anesthetic and as a solvent for fats.

2. Charbonei Tetrachloridum, U.S.P.—Carbon tetrachloride (tetrachlormethane). Prepared by the reaction between chlorine and carbon disulfide (CS_2). It is a heavy colorless liquid, having an odor resembling that of chloroform. It is a good solvent for grease and since it is noninflammable, it makes a safe fluid for dry cleaning. It neither burns nor supports combustion, hence it is useful for extinguishing fires. It has the further advantage of being a nonconductor of electricity and may therefore be employed to fight fires in the regions of electrical apparatus where it would be dangerous to use water.

3. Iodoformum, U.S.P.—Iodoform (triiodomethane, methenyl triiodide). Prepared by the reaction between iodine and ethyl alcohol in the presence of an alkali. It is a yellow crystalline solid with a penetrating odor. Iodoform is used as an antiseptic.

(7) *Aromatic hydrocarbons.*—This type of organic compound will be considered later in the section.

b. Alcohols.—(1) *General.*—(*a*) An alcohol is an organic compound containing one or more *hydroxyl* (OH) groups. Alcohols may be regarded as substitution products derived from hydrocarbons by replacing hydrogen atoms with hydroxyl groups.

(*b*) Methyl alcohol (CH_3OH) commonly called *wood alcohol* or methanol is related to methane because of the substitution of a hydrogen atom by an OH group. It is prepared commercially by the

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destructive distillation of wood. Wood alcohol is a colorless liquid having a characteristic odor. It is violently poisonous, and even small quantities have been known to cause blindness and death. Wood alcohol is used as a solvent in making varnish and shellac, as a fuel in alcohol lamps, and as a *denaturing agent*, by which ethyl alcohol is made unfit for beverage purposes.

(2) *Official alcohols.*—(*a*) *Alcohol, U.S.P.*—Alcohol (ethanol, ethyl alcohol, Spiritus Vini Rectificatus). Many alcohols are known but the term "alcohol" is most often applied to ethyl alcohol (ethanol, C_2H_5OH). It may be regarded as a substitution product of ethane, one hydrogen atom having been replaced by a hydroxyl group. Originally most of our ethyl alcohol was derived from corn, barley, and rye; hence the name *grain alcohol.* Practically all the alcohol now produced in this country is made by fermenting molasses obtained as a byproduct from the sugar refinery. Fermentation is a chemical change brought about by the action of microscopic plants such as bacteria, yeasts, and molds. These tiny organisms form complex organic catalysts called enzymes. The molasses solution containing principally glucose ($C_6H_{12}O_6$), is treated with yeast and undergoes alcoholic fermentation under the influence of *zymase*, an enzyme present in yeast. The products of the action are carbon dioxide and alcohol. Thus—

$$C_6H_{12}O_6 \xrightarrow{\text{(zymase)}} 2CO_2 + 2C_2H_5OH$$

Almost pure alcohol is obtained by fractional distillation of the resulting mixture.

Ethyl alcohol is a colorless liquid having an agreeable odor and a boiling point of 78° C. Like methyl alcohol it burns with a hot, colorless flame, forming water and carbon dioxide. It is miscible with water in all proportions. In its usefulness as a solvent, it is second only to water. It is employed in the manufacture of dyes, drugs, perfumes, varnishes, and a host of important organic products. Alcohol is intoxicating when taken internally, and, when used in excess, is definitely poisonous. It constitutes the important ingredient in a variety of fermented and distilled beverages, such as beer, wine, whisky, gin, brandy, etc. To prevent the illegal use of alcohol for beverage purposes, the Government requires that industrial alcohol be "denatured." This is accomplished by the addition of small amounts of other substances such as methanol, benzene, and pyridine, to render

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the alcohol poisonous or offensive in odor or taste. Industrial alcohol, completely denatured, is free from the restrictions and taxes imposed by the Government upon ethyl alcohol intended for use in beverages.

(*b*) *Alcohol Dehydratum, U.S.P.*—Dehydrated alcohol (absolute alcohol, dehydrated ethanol). Contains 99 percent by weight of C_2H_5OH.

(*c*) *Alcohol Dilutum, U.S.P.*—Diluted alcohol (diluted ethanol). A mixture of alcohol and water containing not less than 41 percent and not more than 42 percent by weight, corresponding to not less than 48.4 percent and not more than 49.5 percent by volume, at 15.56° C., of C_2H_5OH.

(*d*) *Glycerinum, U.S.P.*—Glycerine (glycerol). Glycerine is an alcohol with the formula $C_3H_5(OH)_3$. It may be regarded as a substitution product of propane in which three hydrogen atoms have been replaced by OH groups. Glycerine is obtained as a byproduct in the manufacture of soap. It is a thick, syrupy liquid having a sweetish taste. Glycerine finds it greatest use in the manufacture of high explosives, nitroglycerine, and dynamite.

(*e*) *Chlorobutanol, U.S.P.*—Chlorobutanol (chlorbutol, acetone-chloroform). CCl_3—C $(CH_3)_2$—OH.

c. Aldehydes.—(1) An aldehyde is an organic compound having the characteristic group—CHO. Aldehydes are formed from alcohols by partial oxidation. Formaldehyde (H–CHO) is the simplest and most important aldehyde. It is prepared by passing a mixture of methyl alcohol and air over hot copper gauze. Thus:

$$2\,CH_3OH + O_2 \text{———} 2\,H\text{–}CHO + 2\,H_2O$$

Formaldehyde is a colorless gas having a strong pungent odor.

(2) *Polymerization.*—Aldehydes are more reactive than most organic compounds and have the tendency to "polymerize." A polymer of any substance is a substance whose formula is a multiple of the one in question.

(3) *Official aldehydes.*—(*a*) *Liquor Formaldehyde, U.S.P.*—Solution of formaldehyde. This is an aqueous solution containing not less than 37 percent (H–CHO) with variable amounts of methyl alcohol to prevent polymerization.

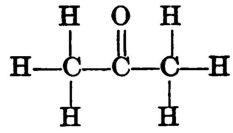
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(*b*) *Paraldehydum, U.S.P.*—Paraldehyde (paracetaldehyde). It can be seen from the formula of paraldehyde $(CH_3CHO)_3$ that it is a polymer of acetaldehyde which has the formula $(CH_3–CHO)$.

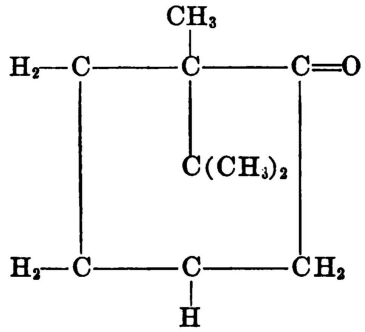
(*c*) *Chloralis Hydras, U.S.P.*—Chloral hydrate (chloral). An acetaldehyde derivative, $CCl_3–CH(OH)_2$.

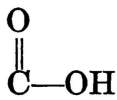
d. Ketones.—(1) A ketone is an organic compound having the characteristic C=O group. Although ketones are similar in structure to aldehydes, they are considerably more stable than the latter class of compounds.

(2) *Official ketones.*—(*a*) *Acetonum, U.S.P.*—Acetone (dimethyl ketone). Acetone, which is produced along with methanol in the destructive distillation of wood, has a very important use as a solvent, since it has the unique property of being able to dissolve a wide variety of substances. The formula of acetone is—



(*b*) *Camphora, U.S.P.*—Camphor.



e. Acids.—(1) An organic acid is a compound containing one or more carboxyl (–COOH) or  groups. Although the molecule of such an acid often contains many hydrogen atoms, only the hydrogen present in the carboxyl group becomes the hydrogen ion in dilute water solution, and may be replaced by a metal forming a salt. An organic acid may be prepared by careful oxidation of the corresponding alcohol. Formic acid (H—COOH), the simplest organic acid, is made by the oxidation of formaldehyde. It is a colorless liquid with

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a pungent odor. Formic acid is the irritating substance present in the sting of certain insects.

(2) *Official organic acids.*—(*a*) *Acidum Aceticum Glaciale, U.S.P.*—Glacial acetic acid. Acetic acid is the most important organic acid. It is obtained commercially by the destructive distillation of wood. It may also be prepared by the oxidation of ethyl alcohol in the "acetic acid fermentation." Thus—

$$C_2H_5OH + O_2 \qquad \begin{matrix} & H & O \\ & | & \| \\ H- & C & -C- & OH \\ & | & \\ & H & \end{matrix}$$

This action is caused by the enzymes in "mother of vinegar," present in the slimy substance often seen in a vinegar bottle. Acetic acid is a colorless liquid having a strong pungent odor. Since it does not readily ionize in water it is a weak acid. It is employed in the production of vinegar, white lead, and various other organic compounds such as cellulose acetate, used in making artificial silk and photographic film.

(*b*) *Acidum Aceticum, U.S.P.*—Acetic acid. Acetic acid is an aqueous solution containing not less than 36 percent and not more than 37 percent of $HC_2H_3O_2$.

(*c*) *Acidum Aceticum Dilutum, U.S.P.*—Diluted acetic acid. Diluted acetic acid is an aqueous solution containing in each 100 cc not less than 5.7 gm and not more than 6.3 gm of $HC_2H_3O_2$.

(*d*). *Acidum Trichloroaceticum, U.S.P.*—Trichloroacetic acid (CCl_3—COOH).

(*e*) *Acidum Stearicum, U.S.P.*—Stearic acid.

(*f*) *Acidum Oleicum, U.S.P.*—Oleic acid.

(*g*) *Oxalic Acid, U.S.P.*—Reagent. Oxalic acid (HOOC—COOH or $H_2C_2O_4$) is obtained by heating sawdust with caustic soda. Being a reducing agent, oxalic acid is useful for removing iron rust and ink spots from white cloth, for bleaching flax and straw, and for cleaning brass and copper.

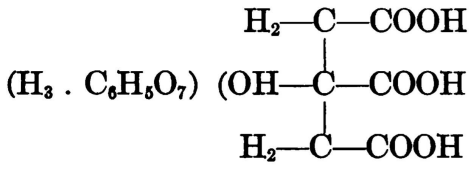
(*h*) *Acidum Lacticum, U.S.P.*—Lactic acid. Lactic acid ($HC_3H_5O_3$) is the acid present in sour milk. When sour milk is used as a leavening in baking, the acid reacts with baking soda ($NaHCO_3$), generating carbon dioxide.

(*i*) *Acidum Tartaricum, U.S.P.*—Tartaric acid. Tartaric ($H_2C_4H_4O_6$) $\begin{pmatrix} HO\cdot CH\cdot COOH \\ | \\ HO\cdot CH\cdot COOH \end{pmatrix}$ is present in grapes and other fruits

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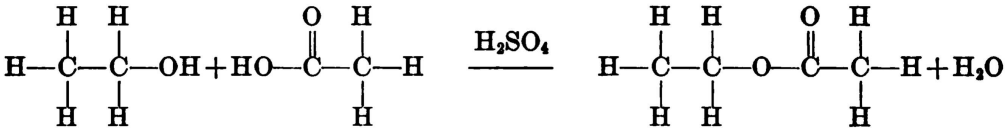
in the form of the salt, potassium acid tartrate (cream of tartar, $KHC_4H_4O_6$). The acid is a white crystalline solid, soluble in water. It is used in making soft drinks and Seidlitz powder and in dyeing. The salt is widely used as the acidic constituent in many baking powders.

(*j*) *Acidum Citricum, U.S.P.*—Citric acid (sour salt). Citric acid



$(H_3 . C_6H_5O_7)$ $(OH—C(CH_2—COOH)(COOH) . H_2O)$ is the acid to which the citrus fruits—lemons, oranges, grapefruit, and limes—owe their characteristic sour taste. It is used in making soft drinks and citrate of magnesia.

f. Esters.—(1) *Ethereal salt.*—The reaction between a base and an acid, called neutralization, produces water and a salt. In a like manner the reaction between an alcohol and an acid, called *esterification*, produces water and an ester or *ethereal salt.* Thus—



In the process of esterification, concentrated sulfuric acid is usually employed to absorb the water formed in the reaction.

(*a*) Nitroglycerine (glyceryl trinitrate) is made by the reaction between glycerine and nitric acid:

$$C_3H_5(OH)_3+3HNO_3 \longrightarrow 3H_2O+C_3H_5(NO_3)_3$$

(*b*) This is an oily liquid which explodes very easily and therefore must be handled with great caution. The liquid is usually soaked in some absorbent material such as sawdust, the resulting product being called "dynamite."

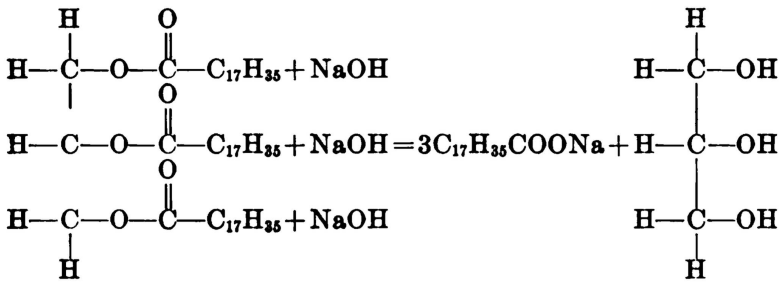
(2) *Official esters.*—(*a*) *Amylis Nitris, U.S.P.*—Amyl nitrite.

(*b*) *Aethylis Chaulmoogras, U.S.P.*—Ethyl chaulmoograte.

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(3) *Fats and oils.*—Fats and oils, from both vegetable and animal sources, are esters of glycerine and fatty acids. Beef fat is largely stearin or glyceryl stearate, with the formula $C_3H_9(C_{17}H_{35}COO)_3$. Vegetable oils, such as olive oil and cottonseed oil, are mainly olein. These oils are frequently converted into solid fats by addition of hydrogen (hydrogenation). "Crisco," a lard substitute, is made from cottonseed oil in this manner.

(4) *Soap.*—A soap is a metallic salt of a fatty acid. Ordinary soap is prepared by boiling fat with sodium hydroxide. The process is called *saponification.* The following is one of the main reactions involved:



Saponification is carried out in huge kettles about 50 feet high, each kettle holding enough material to make a million pounds of soap. When the chemical action is completed, salt is added to make a strong brine. The soap is thus rendered insoluble and floats to the top, where it is removed.

(*a*) *Kinds of soap.*—The soap manufacturer turns out a large assortment of cleansing products which are intended for various uses. *Hard soap* is the ordinary type of soap and is made with sodium hydroxide. *Soft soap* is made with potassium hydroxide. *Castile soap* is made from olive oil and consists largely of the sodium salt of oleic acid. So-called *floating soap* contains tiny bubbles of air which render it buoyant. *Laundry soap* usually contains a little free alkali to help it remove grease. *Soap powder* is finely ground soap mixed with washing soda (Na_2CO_3). *Scouring powder* is soap powder mixed with some gritty material, such as fine sand or pumice.

(*b*) *Cleansing action of soap.*—Soap in solution helps to remove dirt in two ways: The soap emulsifies the grease that is present with the dirt, thus making it possible for the water to wash away both the grease and the dirt; the particles of dirt are absorbed on the sur-

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face of the soap bubbles, and are thus removed. Both actions result from the fact that soap forms a colloidal suspension in water.

Soap does not lather in hard water, hence such water is not satisfactory for laundry purposes. Hard water usually contains dissolved salts of calcium and magnesium. These salts combine with ordinary soap, forming an insoluble scum which floats on the surface. For example, when calcium sulfate reacts with sodium stearate, insoluble calcium stearate is formed.

$$\underset{\text{Soluble soap}}{CaSO_4 + Na\ \text{Stearate}} = \underset{\text{Insoluble soap}}{Ca\ \text{Stearate}} + Na_2SO_4$$

An excessively large amount of soap must therefore be used in order first to precipitate all of the calcium and magnesium ions before any cleansing action can start.

(*c*) *Official soaps.*

1. Sapo Durus, U.S.P.—Hard soap (soap).

2. Sapo Mollis, U.S.P.—Soft soap (green soap).

g. Ethers.—(1) Ethers are organic compounds which contain this definite C–O–C grouping in the molecule, an oxygen atom being bound between two carbon atoms. Ethers are formed by the extraction of a molecule of water from two molecules of alcohol; this is usually done in the presence of sulfuric acid which aids in the extraction of the water molecule. Thus—

$$\underset{\text{ethyl alcohol}}{C_2H_5OH} + H_2SO_4 = \underset{\text{ethyl hydrogen sulfate}}{C_2H_5HSO_4} + H_2O$$

$$C_2H_5HSO_4 + C_2H_5OH = C_2H_5{-}O{-}C_2H_5 + H_2SO_4$$

(2) *Official ethers.*—(*a*) *Aether, U.S.P.*—Ether (ether for anesthesia).

(*b*) *Aethylis Oxidum, U.S.P.*—Ethyl oxide (solvent ether).

h. Carbohydrates.—(1) A *carbohydrate* is a compound containing carbon, hydrogen, and oxygen, the last two elements being present in the ratio of 2:1 just as in water. Starch, having the formula $(C_6H_{10}O_5)_x$, where the subscript x represents a number not yet determined, illustrates the relationship of the hydrogen to the carbon.

(2) *Starch* is found in the roots, seeds, and leaves of plants. In green plants, carbon dioxide combines with water, under the influence of sunlight and chlorophyll, forming starch (process of *photosynthesis*).

$$6CO_2 + 5H_2O \xrightarrow{\text{(Sunlight)}} C_6H_{10}O_5 + 6O_2$$

$$XC_6H_{10}O_5 \xrightarrow[\text{(Chlorophyll)}]{\text{(Starch)}} (C_6H_{10}O_5)_x$$

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Most starch is obtained from corn and potatoes. Starch is a white powder which does not dissolve in cold water, because each individual particle of it is surrounded by a thin coating of insoluble material. Boiling with water causes the starch grains to swell up and burst. The resulting mixture is a colloidal suspension known as "starch paste." A drop or two of iodine added to starch paste produces a deep blue color. This reaction constitutes a very delicate test for either starch or iodine. Starch is one of the most important food elements. It is used in the laundry for stiffening clothes; and is an essential raw material in the manufacture of *alcohol*, *glucose*, which is an important sugar, and *dextrin*, which is used in making adhesives.

(3) *Cellulose.*—Cellulose is a carbohydrate having the formula $(C_6H_{10}O_5)_y$, where the subscript y, although an unknown number, is necessarily different from the subscript x, which was previously used to represent the formula for starch. Plant stems, wood, and all vegetable fibers are mainly cellulose. Cotton and linen, which are nearly pure cellulose, are employed extensively in the textile industry. Paper, another important cellulose product, is manufactured from wood pulp or rags. A great variety of very valuable materials is produced as a result of the reaction of cellulose with certain chemicals.

(*a*) *Nitrocellulose* is made by the action of concentrated nitric acid on cellulose under the dehydrating influence of concentrated sulfuric acid. By altering the conditions of the reaction, it is possible to control the degree of nitration, thus yielding a number of different cellulose nitrates. Guncotton, a powerful explosive, is a highly nitrated cellulose.

1. *Pyroxylin, U.S.P.* (soluble guncotton $C_{12}H_{16}O_6(NO_3)_4$), is a less highly nitrated cellulose than guncotton, and finds extensive use in lacquers for automobiles, furniture, etc.
2. *Collodion, U.S.P.*, is made by dissolving pyroxylin in a mixture of alcohol and ether.
3. *Celluloid* is made by mixing pyroxylin with camphor and alcohol.

(*b*) *Cellulose acetate* is made by the action of acetic acid on cellulose. It is used extensively in making motion picture films, since it is not inflammable.

(*c*) *Artificial silk* is almost pure cellulose that has been precipitated from solutions of its compounds.

(*d*) *Cellophane* is a thin, highly transparent film that is made by regenerating cellulose in a manner similar to that used in the production of artificial silk.

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(4) *Sugars.*—The term "sugars" refers to a number of carbohydrates which have a sweet taste and are soluble in water. From a structural standpoint, sugars are the simplest of the carbohydrates.

(*a*) *Glucose, U.S.P.* (*liquid glucose*).—This sugar is also known as *dextrose* or *grape sugar* when solid. It occurs in grapes and in many other fruits and is made commercially by the hydrolysis of starch. In this process cornstarch is boiled in the presence of a small amount of hydrochloric acid which acts as a catalyst.

$$(C_6H_{10}O_5)_x + H_2O \xrightarrow{(HCl)} C_6H_{12}O_6$$

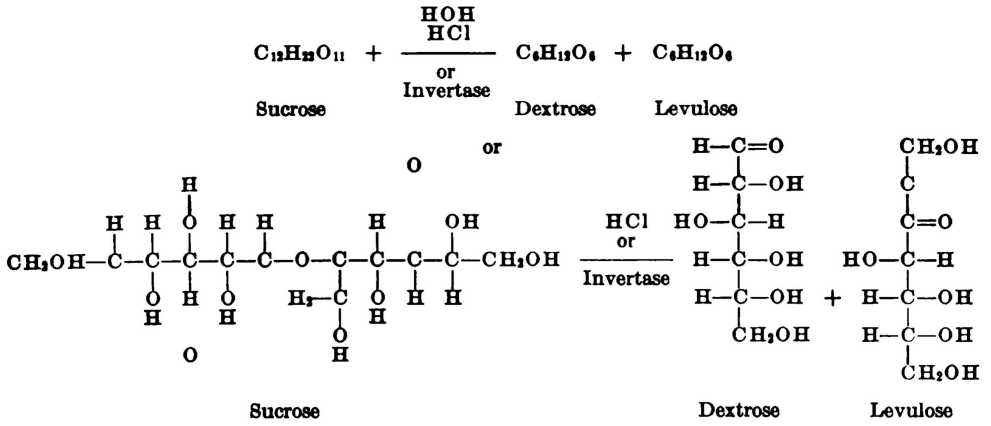
Starch may also be changed to glucose by the action of the enzyme called *diastase.* Glucose is used extensively in making candies, jams, table syrups, and other food products. In the process of digestion, starch is changed to glucose. As explained previously, the fermentation of glucose is an important source of both alcohol and carbon dioxide.

$$C_6H_{12}O_6 \xrightarrow{(Zymase)} 2C_2H_5OH + 2CO_2$$

(*b*) *Sucrose, U.S.P.* (*saccharum, sugar*).—Sucrose is ordinary cane sugar or beet sugar. It occurs in the sugar cane, in certain fruits and vegetables, and in maple sap. Most of our common sugar is obtained from sugar cane. The cane is first crushed to extract the juice, which is then treated with lime and then with carbon dioxide to remove albuminous impurities. The liquid is filtered and then evaporated, the latter process being carried on in vacuum pans to prevent scorching. The product obtained is raw sugar. In the refining process the sugar is redissolved, filtered through bone black to remove coloring matter, evaporated under reduced pressure, and then recrystallized. The resulting product is granulated sugar.

1. Sucrose is a white, sweet crystalline solid, which melts at about 160° C. When it is heated to 210° C., some water is driven off, leaving *caramel*, which is used as a coloring and flavoring agent.
2. When a solution of sucrose is boiled with a small amount of acid, the process of *inversion* takes place, in which the sugar combines with water, forming dextrose (glucose) and levulose (fructose). The mixture of the two simple sugars thus formed is called *invert sugar.* Inversion may also be brought about by an enzyme known as invertase, which is present in yeast.

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From the formulas shown in the above equation it can be seen that dextrose belongs both to that group of compounds classified as aldehydes and also the type of compounds called alcohols, since it contains both the hydroxyl (–OH) and the aldehyde (–CHO) grouping in its molecule. Likewise, levulose is a ketone alcohol, as is shown by the presence of the keto (C=O) and the hydroxyl (–OH) grouping in the molecule. In spite of these groups within the molecule, sugars do not possess the properties of either aldehydes, ketones, or alcohols.

(5) *Official carbohydrates.*—(*a*) *Amylum, U.S.P.*—Starch (cornstarch).

(*b*) *Mel, U.S.P.*—Honey (clarified honey).

(*c*) *Glucosum, U.S.P.*—Glucose (liquid glucose).

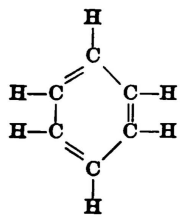
(*d*) *Sucrosum, U.S.P.*—Sucrose (saccharum, sugar).

(*e*) *Dextrosum, U.S.P.*—Dextrose (d-glucose).

(*f*) *Lactosum, U.S.P.*—Lactose (saccharum lactis, milk sugar).

i. Aromatic compounds.—(1) Many organic compounds are known in which the carbon atoms are united, not in a straight chain, as in the members of the aliphatic series thus far treated, but in a hexagonal ring formation. These compounds have alternate double bonds or bindings between the carbon atoms.

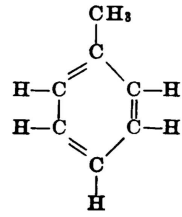
(2) The structural formula of the first hydrocarbon of the series is as follows:



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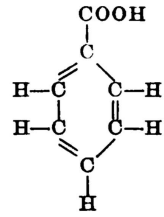
This compound is benzene, or coal tar benzene, sometimes called benzol in order to differentiate between it and petroleum benzin. It is a colorless, volatile liquid, having a characteristic odor. Benzene is a good solvent for fats, rubber, and resins. It is used in paint and varnish removers and in the manufacture of numerous dyes.

(3) Toluene is methyl benzene and has the following formula:



It is a colorless liquid made from coal tar. It is used in the preparation of drugs, dyes, perfumes, and saccharine. Trinitrotoluene (TNT) is a violent explosive made by treating toluene with nitric acid.

j. Aromatic acids.—(1) As was the case with the acids previously studied, the official aromatic acids are characterized by the carboxyl (–COOH) group. The simplest of the aromatic acids is benzoic acid, which has the following formula:

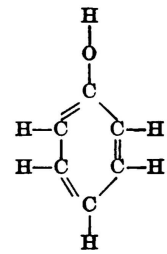


(2) *Official aromatic acids.*—(*a*) *Acidum Benzoicum, U.S.P.*—Benzoic acid.

(*b*) *Acidum Salicylicum, U.S.P.*—Salicylic acid. C_6H_4 . OH . COOH.

(*c*) *Acidum Acetylsalicylicum, U.S.P.*—Acetylsalicylic acid (aspirin). C_6H_4 . O . $COCH_3$ COOH 1:2 .

k. Phenols.—(1) Phenols are aromatic compounds which have one or more hydroxyl (–OH) groups attached directly to a carbon atom or atoms of the aromatic ring. The simplest of the phenols is phenol, often called carbolic acid because of its weakly acidic properties. It has the following formula:

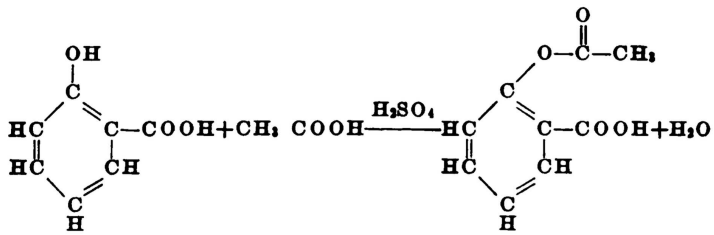


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Phenol is obtained principally from coal tar. It is a colorless crystalline solid with a characteristic odor and is extremely poisonous. The chief uses of phenol are in the manufacture of disinfectants, explosives, and synthetic plastics such as bakelite.

(2) *Official phenols.*—(*a*) *Phenol, U.S.P.*—Phenol (carbolic acid).
(*b*) *Thymol, U.S.P.*—Thymol.
(*c*) *Guaiacol, U.S.P.*—Guaiacol.
(*d*) *Betanaphthol, U.S.P.*—Betanaphthol.
(*e*) *Cresol, U.S.P.*—Cresol.
(*f*) *Pyrogallol, U.S.P.*—Pyrogallol (pyrogallic acid).
(*g*) *Eucalyptol, U.S.P.*—Eucalyptol (cineol).
(*h*) *Eugenol, U.S.P.*—Eugenol.
(*i*) *Menthol, U.S.P.*—Menthol.
(*j*) *Phenolphthalein, U.S.P.*—Phenolphthalein.
(*k*) *Resorcinol, U.S.P.*—Resorcinol (resorcin).
(*l*) *Terpini Hydras, U.S.P.*—Terpin hydrate.

l. Aromatic esters.—(1) Aromatic esters are produced by the reaction between a phenol and an acid. One of the most important of the aromatic esters is acetylsalicylic acid or aspirin which is easily prepared by the action of acetic acid on salicylic acid in the presence of concentrated sulfuric acid. Thus:



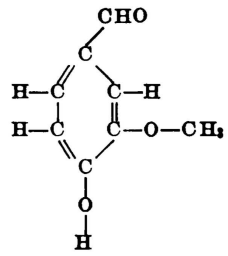
Salicylic acid Acetic acid Acetylsalicylic acid (Aspirin) Water

(2) *Official esters.*—(*a*) *Acidum Acetylsalicylicum, U.S.P.*—Acetylsalicylic acid (aspirin).
(*b*) *Methylis Salicylas, U.S.P.*—Methyl salicylate (oil of gaultheria, oil of wintergreen, oil of betula, oil of sweet birch).
(*c*) *Phenylis Salicylas, U.S.P.*—Phenyl salicylate (salol).

m. Aromatic ethers.—As would be expected, aromatic ethers contain the characteristic C–O–C grouping in the molecule, *Vanillin, U.S.P.*, the principal odorous constituent of vanilla, and is widely used as

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a flavoring agent. It is an aromatic ether and has the following structure:



Since vanillin contains an aldehyde (–CHO) and an hydroxyl (–OH) group attached to the aromatic ring it follows that it reacts like an aldehyde and a phenol as well as exhibiting the properties of an ether.

n. Alkaloids.—(1) An alkaloid may be thought of as an organic compound of plant origin containing carbon, hydrogen, nitrogen, and usually oxygen, some of which can be made synthetically. As a rule they are feebly basic compounds which form water soluble salts with acids and have marked physiological properties. Numerous attempts have been made to classify the nitrogen containing compounds into those which are definitely alkaloids and those which do not belong in this group. No classification, however, has been formulated upon which there is anything approaching universal agreement. Hence the following list of nitrogen compounds merely includes those which are *often thought of* as alkaloids.

(2) *Official nitrogen compounds* (other than alkaloids).—(*a*) *Acetanilidum, U.S.P.*—Acetanilid.

(*b*) *Acetophenetidinum, U.S.P.*—Acetophenetidin (acetphenetidinum, U.S.P., Phenacetin).

(*c*) *Aethylis Aminobenzoas, U.S.P.*—Ethyl aminobenzoate (benzocaine).

(*d*) *Aminopyrina, U.S.P.*—Aminopyrine (amidopyrina USPX).

(*e*) *Antipyrina, U.S.P.*—Antipyrine (phenazone).

(*f*) *Barbitalum, U.S.P.*—Barbital.

(*g*) *Methenamina, U.S.P.*—Methenamine (hexamethylenamine, hexamethylene-tetramine).

(*h*) *Methylthioninae Chloridum, U.S.P.*—Methylthionine chloride (methylene blue).

(*i*) *Neocincophenum, U.S.P.*—Neocincophen.

(*j*) *Phenobarbitalum, U.S.P.*—Phenobarbital (phenylethylmalonylurea, phenolbarbitone).

(3) *Official alkaloids.*—(*a*) *Aethylhydrocupreinae Hydrochloridum, U.S.P.*—Ethylhydrocupreine hydrochloride.

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(*b*) *Aethylmorphinae Hydrochloridum, U.S.P.*—Ethylmorphine hydrochloride.

(*c*) *Apomorphinae Hydrochloridum, U.S.P.*—Apomorphine hydrochloride.

(*d*) *Atropina, U.S.P.*—Atropine.

(*e*) *Caffeina, U.S.P.*—Caffeine.

(*f*) *Cocaina, U.S.P.*—Cocaine.

(*g*) *Codeina, U.S.P.*—Codeine.

(*h*) *Colchicina, U.S.P.*—Colchicine.

(*i*) *Emetinae Hydrochloridum, U.S.P.*—Emetine hydrochloride.

(*j*) *Ephedrina, U.S.P.*—Ephedrine.

(*k*) *Epinephrina, U.S.P.*—Epinephrine (animal origin).

(*l*) *Eucainae Hydrochloridum, U.S.P.*—Eucaine hydrochloride.

(*m*) *Histaminae Phosphas, U.S.P.*—Histamine phosphate (histamine acid phosphate).

(*n*) *Homatropinae Hydrobromidum, U.S.P.*—Homatropine hydrobromide.

(*o*) *Morphinae Sulfas, U.S.P.*—Morphine sulfate.

(*p*) *Phenacainae Hydrochloridum, U.S.P.*—Phenacaine hydrochloride.

(*q*) *Pilocarpinae Nitras, U.S.P.*—Pilocarpine nitrate.

(*r*) *Procainae Hydrochloridum, U.S.P.*—Procaine hydrochloride (procaine).

(*s*) *Quinidinae Sulfas, U.S.P.*—Quinidine sulfate.

(*t*) *Quinina, U.S.P.*—Quinine.

(*u*) *Scopolaminae Hydrobromidum, U.S.P.*—Scopolamine hydrobromide (hyoscine hydrobromide).

(*v*) *Strychninae Sulfas, U.S.P.*—Strychnine sulfate.

(*w*) *Theophyllina, U.S.P.*—Theophylline.

o. Miscellaneous compounds.—There are many important organic compounds containing elements in addition to carbon, hydrogen, oxygen, and nitrogen. In this synopsis of organic chemistry no attempt will be made to classify these compounds structurally, but they will be grouped according to the characteristic element which they contain.

(1) *Important sulfur containing compounds.*—(*a*) *Phenolsolfonphthalein, U.S.P.*—Phenolsulfonphthalein (phenol red).

(*b*) *Sulfonethylmethanum, U.S.P.*—Sulfonethylmethane.

(*c*) *Saccharinum, U.S.P.*—Saccharin (gluside, benzosulfinidum).

(*d*) *Sulfanilamidum, U.S.P.*—Sulfanilamide.

(2) *Important chlorine containing compounds.*—(*a*) *Chloramina-T, U.S.P.*—Chloramine-T (chloramine).

(*b*) *Dichloramina-T, U.S.P.*—Dichloramine-T (dichloramine).

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(3) *Important iodine containing compounds.*—(*a*) *Calcii Iodobehenas, U.S.P.*—Calcium iodobehenate (calcium monoiodobenhenate).

(*b*) *Iodophthaleinum Solubile, U.S.P.*—Soluble iodophthalein tetraiodophenolphthalein sodium, tetraiodophthalein sodium, tetiothalein sodium.

(*c*) *Thyroxinum, U.S.P.*—Thyroxin.

(4) *Important arsenic containing compounds.*—(*a*) *Arsphenamina, U.S.P.*—Arsphenamine (diaminodihydroxyarsenobenzine hydrochloride).

(*b*) *Neoarsphenamina, U.S.P.*—Neoarsphenamine.

(*c*) *Sodii Cacodylas, U.S.P.*—Sodium cacodylate.

(*d*) *Tryparsamidum, U.S.P.*—Tryparsamide.

(5) *Important bromine containing compounds.—Carbromalum, U.S.P.*—Carbromal (bromdiethylacetylurea).

(6) *Important mercury containing compounds.*—(*a*) *Merbaphenum, U.S.P.*—Merbaphen.

(*b*) *Hydrargyri Succinimidum, U.S.P.*—Mercuric succinimide.

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CHAPTER 4

PHARMACEUTICAL OPERATIONS AND APPARATUS

	Paragraph
Methods of heating	59
Practical applications of heat	60
Filtration	61
Straining or colation	62
Decantation	63
Precipitation	64
Comminution	65
Solutions	66
Extraction	67
Crystallization	68

59. Methods of heating.—A bath is a simple device for regulating or limiting the temperature applied to substances. Many valuable medicinals are injured when subjected to excessive heat. Baths serve to distribute the heat evenly to the container holding the substance to be heated, facilitating even heat to the contents, and avoid too sudden changes in temperature in the latter as well as to fragile containers.

a. Water baths are made of various materials and sizes, but the most common one is of copper with a top consisting of several rings of the same material so fashioned that when properly placed they form a plane surface and permit the technician to make adjustment for suitable evaporating dishes, flasks, etc., of various diameters. A tube is provided near the top for the escape of steam. The heat-transferring medium is water. Since both the water in the bath and the steam arising from it are under atmospheric pressure, the maximum temperature of the bath is 100° C., and any substance that is not injured at that temperature cannot suffer damage on such a bath as long as it contains water.

b. Sand baths are pans usually made of sheet iron and filled with a quantity of fine, clean sand to make a layer of about ½ inch. The heat must be regulated for each operation, as a very high temperature can be obtained with sand baths. This is usually done by adjusting the gas burner or by means of a thermostat.

c. Oil baths are shaped like water baths. Glycerine, mineral oil, or paraffin are usually used. These baths will attain a temperature of about 250° C.

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d. Salt solution baths are nearly or quite saturated solutions of salts in water. Temperatures up to about 180° C. can be obtained by selecting the proper salt.

60. Practical applications of heat.—*a. Evaporation* means to pass off in a vapor, escape in the air, and be dissipated. The primary purpose of this operation is to remove water, alcohol, or other solvent from nonvolatile substances in order that the solute may be prepared in greater concentration or in dry form. Factors that hasten evaporation are—the use of a shallow evaporating dish which exposes a larger surface of the substance to be evaporated; constant stirring which brings fresh material to the surface; and the use of sufficient heat.

b. Distillation is the separation of a volatile liquid from one or more associated liquids by vaporization and condensation by virtue of their different boiling points. The equipment usually used in the process of distillation is a flask, a condenser, and a receiver. The *flask* contains the substance and is heated to vaporize the liquid, the vapors rise to the neck of the flask, and pass through the side tube and into a *condenser* which condenses the vapor into liquid form; the *receiver* collects the distillate (condensate). Bumping of a liquid during distillation may be so severe as to carry some of the liquid over into the condenser and receiver, which condition can generally be avoided by placing a few small pieces of porcelain, broken glass, or other unobjectionable solid in the flask before it is charged with the liquid.

(1) *Steam distillation.*—Many volatile organic substances require such a high temperature when distilled in the ordinary way that they may be injured, but can readily be volatilized with steam. For this purpose live steam may be conducted into a flask containing the substance to be distilled.

(2) *Fractional distillation.*—In analytical and other work it is frequently necessary to separate a composite liquid into its several components. This is accomplished by fractional distillation. The distilling flask is provided with a thermometer whose bulb is on a level with the side tube. Heat is applied to the flask, the temperature noted as the vapor enters the side tube, and the distillation continued as long as the temperature of the vapor remains approximately constant. As soon as the latter rises, an empty receiver is substituted for the first one. This procedure is continued until practically the entire liquid has been distilled.

(3) *Destructive distillation* is applied to organic substances; it is incomplete combustion and is carried on in an oven or other en-

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closure to which but little air is admitted, causing decomposition of the substance heated. Provision is made for the condensation of any volatile substances.

(4) *Rectification* is the purification of volatile substances by distillation. Is is used frequently in pharmacy for the purification of alcohol.

c. Sublimation is the volatilization of a solid and subsequent condensation of the vapor. Sublimation on a small scale can be carried out with very simple equipment. The material is ground or mixed with sand, placed in a small flask with a short neck which is passed through a hole in a box. The flask is carefully heated to volatilize the material, and the vapors pass into the box whose temperature is much lower than that of the flask, and the material condenses. Iodine may be sublimed by heating in a small evaporating dish over which a funnel is inverted. The latter being cooler than the dish, serves as a condenser.

d. Fusion is the melting of a solid by the application of heat which converts it into a fluid and is applied to solid fats, waxes, etc., for the purpose of mixing them intimately with other substances.

e. Desiccation is the removal of moisture of water not chemically combined with a substance by exposing the substance to a dry atmosphere at ordinary temperature or by placing it in a drying oven which is maintained at a temperature high enough to remove the moisture rapidly but not so high as to injure it.

f. Exsiccation is the removal of "water of crystallization" from chemicals that contain it. Exsiccation is applied in the same manner as desiccation.

g. Torrefaction is the roasting of substances. The heat must not be so intense as to char the substance; generally, however, there is a darkening.

h. Carbonization is the heating of a substance to incomplete combustion in a chamber to which but little air is admitted until it is completely charred; only carbon plus inorganic constituents (charcoal) is left.

i. Calcination is the application of a rather high degree of heat to inorganic chemical substances to drive out some volatile component.

j. Ignition or *incineration* is the application of a temperature high enough to burn all combustible matter.

61. Filtration.—Filtration is the process of separating solid materials from a liquid by the intervention of a porous medium known as a filter. Modern filters are made of paper, asbestos, glass wool, sand, charcoal, stoneware, and other insoluble material. Paper filters

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are most commonly used in pharmaceutical work. For most operations the plain filter is used. To fold this type of filter, lay the filter on the desk and fold it through the center so as to form a half circle. Turn it one-fourth way around and fold it again through the center so as to form a quarter circle. Then open it to a cone shape and place in the funnel. One thickness of the paper rests upon one side of the funnel and three thicknesses upon the other side.

62. Straining or colation.—Straining or colation is the process of separating solid material from a liquid by the intervention of a porous medium such as a cloth or screen. The operation is practically identical with filtration except that the medium has larger meshes and is employed if the solid material exists in the form of coarse particles.

63. Decantation.—Decantation is the process of pouring off a liquid for the purpose of separating it from some underlying substance such as a precipitate, or a heavier immiscible liquid.

64. Precipitation.—Precipitation is the process in which substances in solution are thrown out in an insoluble form. It is employed extensively in qualitative and quantitative analysis as well as in the manufacture of many substances. Precipitation can be caused by numerous agencies, but the most common one is the addition of a chemical in solution, known as the *precipitant*, the one that causes the change, to the solution of another, the object being to produce a third chemical substance which is insoluble in the mixed liquids, now known as the *supernatant* liquid. The insoluble substance which results is known as the *precipitate*. Such a reaction is known as double decomposition because neither of the original chemicals retains its original identity. An example of this type of precipitation is the addition of silver nitrate solution to a solution of hydrochloric acid, resulting in the precipitation of silver chloride.

65. Comminution.—Comminution is the process of reduction of a substance to a smaller or finer state of subdivision, as to a powder, irrespective of the particular method employed. Processes of comminution are—

a. Contusion or breaking and crushing a drug by beating or pounding it with the use of a heavy mortar and a heavy pestle.

b. Trituration or the rubbing or grinding of a substance to a very fine powder. Trituration is generally done in a mortar with the aid of a pestle.

c. Pulverization by intervention is employed with some substances which are difficult to reduce to powder form when triturated alone, as camphor, iodine, etc. Camphor yields rapidly to trituration when a few drops of alcohol or ether are added. Iodine crystals

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can be reduced in size by grinding with a little dry, clean sand, which remains behind when the iodine is dissolved. Such processes are pulverization by intervention.

d. Levigation is the process of reducing an inorganic substance to an impalpable powder by rubbing it while moist with a liquid in which it is not soluble. This is generally done in a mortar.

e. Elutriation is carried out by mixing an insoluble powder with water, allowing the coarser and heavier particles to subside, and decanting a part of the water carrying the fine material in suspension into another vessel. The latter is then dried and sifted.

66. Solutions.—*a.* A *solution* may be defined as a homogeneous mixture (usually liquid) of two or more substances, one dissolved in the other. It is composed of a solvent and a solute and is said to be *saturated* when a solvent has dissolved as much of any solute as it can retain in solution under normal conditions of temperature and pressure.

(1) A *solvent* is a substance capable of, or used in, dissolving another substance.

(2) A *solute* is a dissolved substance.

(3) A *supersaturated solution* occurs if a temperature change occurs influencing the capacity of the solvent to hold more of the solute in solution than in a saturated solution.

b. Two kinds of solutions are generally recognized. They are—

(1) *Simple solution.*—One in which the solute dissolves without undergoing chemical change; if the solvent is evaporated off the solute is recovered in the original state.

(2) *Chemical solution.*—One in which the solute undergoes chemical change and cannot, therefore, be recovered in its original state upon evaporation of the solvent.

c. Conditions which influence the rate and extent of solubility.—

(1) *Temperature.*—Heat usually aids solution in speed and concentration.

(2) *Particle size.*—Subdividing the solid into finer particles presents greatly increased surface area to the solvent and hastens the process of solution.

(3) *Agitation.*—If the mixture is agitated the less saturated portions of solvent are constantly brought in contact with the solid and the solution is effected more rapidly.

(4) *Selection of solvent.*—If it becomes permissible to choose among two or more solvents, the one in which the solute dissolves most readily should be selected.

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d. Classification of solvents.—(1) *Water.*—Water is the most generally used solvent. The majority of the inorganic salts as well as sugar, glucosides, alkaloidal salts, etc., are water-soluble.

(2) *Alcohol.*—Alcohol dissolves resins, volatile oils, alkaloids, and many other plant products. In addition to its solvent powers, alcohol is used as a preservative.

(3) *Glycerine.*—Glycerine is a very useful solvent and is a preservative in solutions containing 25 percent or more of it in solution. It dissolves tannin, pepsin, etc.

(4) *Oils.*—Fixed oils are used as solvents in liniments and other preparations.

(5) *Acids.*—Acids are employed in dilute solutions as solvents for alkaloids and usually convert them to readily soluble salts of the alkaloids.

(6) *Miscible solvents.*—Miscible solvents are liquids that mix with each other in all proportions.

(7) *Immiscible solvents.*—Immiscible solvents are those that will not mix one with another.

(8) *Solutions of gases in liquids.*—The solubility of gases in liquids *decreases* proportionally with increase in temperature. The solubility of gases in liquids *increases* proportionally with increase in pressure.

67. Extraction.—Extraction may be defined as the process of separating mixtures of soluble and insoluble substances by partial solution, with the object of obtaining the soluble portion, or of purifying the insoluble portion, or of doing both. Processes of extraction are—maceration, digestion, infusion, decoction, and percolation.

a. Maceration is the process of soaking a drug in a liquid at ordinary temperature. The liquid penetrates the drug, causes it to swell, and aids in the solution of desired constitutents.

b. Digestion is maceration at a temperature of from 30° to 40° C. unless otherwise specified.

c. Infusion is made by pouring boiling water on the drug, allowing it to stand for a specified time, and separating the liquid extract from the drug.

d. Decoction is prepared by pouring cold water upon the drug, then gradually bringing it to the boiling point and separating the liquid extract from the drug.

e. Percolation is the process of depriving a drug of its soluble constituents by passage of a solvent through the powder contained in a suitable vessel. The solvent in this case is called the *menstruum*,

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the vessel is called the *percolator*, and the solution of active principles emerging from the percolator is called the *percolate*.

(1) *Apparatus.*—(*a*) The utensil in which the drug is introduced is called a percolator and consists of a suitable cylindric vessel of metal or glass, provided with an orifice at the bottom.

(*b*) A receiver for the percolate may be a wide-mouthed bottle placed at the orifice of the percolator.

(*c*) In order to regulate the flow of percolation the following arrangement may be made: A perforated cork, carrying a glass tube about 2 inches long, is inserted into the lower orifice of the percolator. The glass should be flush with the upper end of the cork. A tightly fitting rubber tube, about one-quarter longer than the percolator, is slipped over the protruding end of the glass tube. A bent glass tube is attached to the other end of the rubber tube which can be attached to the upper end of the percolator during maceration, and during the latter process can be lowered or raised to regulate the flow of the percolate.

(2) *Operation.*—The process of percolation may be considered under the following headings:

(*a*) *Comminution.*—Before percolating the drug it is essential that it be reduced to particles of more or less fineness, for the same reason the drugs are comminuted before solution.

(*b*) *Maceration.*—Before packing the drug in the percolator it is directed to be moistened with menstruum, this being done because, when the drug comes in contact with the menstruum, the compressed dried cells are swollen to their normal size; if this swelling occurred within the percolator it would cause sufficient expansion to cause a stoppage of the operation. This moistening is accomplished by placing the drug in a suitable container and adding the required quantity of menstruum, mixing it thoroughly with the drug by stirring. After being moistened it should be allowed to remain for about half an hour in order to complete the swelling.

(*c*) *Packing of the drug.*—Place a thin layer of absorbent cotton over the outlet of the percolator. Transfer about one-quarter of the moistened drug to the percolator at one time. When the first portions are being added the percolator is tapped or rotated until the drug presents an even surface. It is now packed with a large cork or piece of towel; the first portion should be packed somewhat lightly and each succeeding portion a little more firmly, the last, quite firmly. A piece of filter paper is placed upon the surface of the drug and held in place by means of glass stoppers or pieces of broken glass. Menstruum is poured on the drug from time to time, care

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being exercised to keep the surface continually covered. A piece of glass is placed on the top of the percolator. As soon as the menstruum has permeated the entire column the lower orifice is closed and the drug is now allowed to macerate for the prescribed length of time. Percolation may now proceed.

(*d*) *Percolation—rate of flow.*—The proper menstruum is poured upon the filter paper above the powdered drug in the percolator, care being taken to pour it so as not to cause the floating of the paper. As the menstruum passes down through the drug, more is added to take its place, it being an unvaried rule that there should always be maintained a layer of menstruum above the surface of the drug, for, if the drug is exposed to the air, evaporation takes place from its surface, and fissures occur through which the menstruum added afterwards will run, instead of through the entire surface of the drug. The U.S.P. directs the rate of flow of percolate in each case in these terms: "percolate slowly" means not more than 1 cc per minute, "percolate at a moderate rate" means a rate of 1 to 3 cc per minute, and "percolate rapidly" means at a rate of 3 to 5 cc per minute. These terms are defined on the basis of 1,000 grams of drug. The rate of flow is regulated as explained in *e*(1) (*c*) above.

(*e*) *Finishing the process.*—The official directions are frequently definite in fixing the quantity of percolate to be received from a given quantity of powder, but the often repeated direction to "percolate to exhaustion" at once raises the question of when a drug is exhausted of its activity. This question can be properly answered only by knowing beforehand the active principles of the drug. For example: If the drug's activity resides in its bitter principles, the absence of bitterness in the percolate in such cases indicates exhaustion; if the drug is used for its coloring matter, the absence of coloring in the percolate indicates exhaustion, etc.

68. Crystallization.—*a.* Crystallization is the process of separating substances in which the atoms and molecules arrange themselves into definite geometrical patterns possessing plane faces and definite angles. Such substances are called *crystalline* while substances which cannot be made to form definite geometric angles are said to be *amorphous.* The object of the pharmacist in producing substances in crystalline form is to obtain them in a higher degree of purity.

b. The several ways in which crystals are produced are as follows:

(1) *Cooling a liquid.*—The most common example of this is the cooling of water to form ice. When cooling a hot saturated solution of a substance, the excess will separate out in the form of crystals.

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(2) *By evaporation of the solvent.*—This process is especially useful where the liquid is more volatile than water, as alcohol, ether, chloroform, etc. In such cases the chemical is dissolved in the smallest quantity of the liquid, the solution filtered into an evaporating dish and allowed to stand, when, due to the gradual vaporization of the solvent, the crystals slowly form in the bottom of the dish.

(3) *Sublimation.*—Some chemicals, on subliming, solidify in the form of crystals. An example of this process is the sublimation of benzoic acid in its manufacture from its natural source, the official benzoin.

(4) *Fusion and partial cooling.*—An application of heating sulfur to a state of fusion, as the pellicle forms on the surface of the cooling mass, a hole is punched through, and the remaining liquid poured out. On removing the pellicle it will be found that the sulfur has deposited in the form of crystals.

(5) *Effecting a change in the character of the solvent.*—Some substances are soluble in one solvent and insoluble in another. Thus, if another solvent is added to a saturated solution of a substance, the latter will separate out in the form of crystals.

(6) *Electrolytic deposition.*—This method is commonly known as electro-plating and the deposited metal consists of extremely small crystals.

(7) *Chemical action.*—The interaction of two solutions to form a new substance which separates out as a precipitate; the action of a gas on a solution such as hydrogen sulfide on solutions of metals; and the reaction of a solid on a solution as metallic iron on cupric sulfate precipitating metallic copper.

c. Water of crystallization.—Water of crystallization is the water that unites with the substance in the formation of the crystal.

(1) *Interstitial water* is *not* water of crystallization but is the water which is held mechanically in the interstices of crystals.

(2) *Efflorescence* is the process whereby crystals containing water of crystallization usually lose part or all of this water upon exposure to the atmosphere, resulting in crumbling and loss of original crystaline form.

(3) *Hygroscopic* substances slowly absorb moisture from the atmosphere.

(4) *Deliquescent* substances take up moisture rapidly from the atmosphere and in sufficient quantity to cause them to liquefy.

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CHAPTER 5

PHARMACEUTICAL PREPARATIONS

		Paragraphs
SECTION I.	Aquae or waters	69–85
II.	Liquors (solutions)	86–116
III.	Emulsions	117–123
IV.	Syrups	124–139
V.	Mucilages	140–142
VI.	Mixtures	143–146
VII.	Magmas	147–148
VIII.	Lotions	149–151
IX.	Glycerites	152–155
X.	Spirits	156–171
XI.	Elixirs	172–185
XII.	Collodions	186–189
XIII.	Liniments	190–195
XIV.	Oleates	196–197
XV.	Infusions	198–200
XVI.	Tinctures	201–228
XVII.	Fluidextracts	229–241
XVIII.	Oleoresins	242–244
XIX.	Extracts	245–258
XX.	Powders	259–262
XXI.	Pills	263–266
XXII.	Tablets	267–270
XXIII.	Ointments	271–293
XXIV.	Pastes	294–296
XXV.	Suppositories	297–301

SECTION I

AQUAE OR WATERS

	Paragraph
Definition	69
Methods of preparation	70
Official processes for aromatic waters	71
Aqua Ammoniae	72
Aqua Ammoniae Fortior	73
Aqua Anisi	74

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	Paragraph
Aqua Aurantii Florum	75
Aqua Camphorae	76
Aqua Chloroformi	77
Aqua Cinnamomi	78
Aqua Destillata	79
Aqua Destillata Sterilisata	80
Aqua Foeniculi	81
Aqua Menthae Piperitae	82
Aqua Menthae Viridis	83
Aqua Rosae	84
Aqua Rosae Fortior	85

69. Definition.—Aquae (waters) are aqueous solutions of volatile substances, and are also known as medicated, aromatic, or distilled waters. Aromatic waters are defined as being saturated solutions (unless otherwise specified) of volatile oils or other aromatic volatile substances in distilled water.

70. Methods of preparation.—*a. Simple solution in cold water.*—This method is followed when the proportion of the volatile substance is small enough to dissolve easily in the quantity of water required or when an excess of volatile oil is added, and after repeated agitation and standing for about 12 hours, the product is filtered through a paper filter which has been thoroughly washed with distilled water.

b. Filtration with the aid of an absorbent powder.—The volatile substance is thoroughly incorporated with talc which exposes a greater surface of the volatile substance so that the water in filtering through it may become completely saturated.

c. Filtration with the aid of shredded filter paper.—This process consists in dropping the volatile oil upon white filter paper, tearing this into shreds, transferring it to a flask, adding distilled water in portions, and shaking it thoroughly with subsequent filtering.

d. Distillation.—This process is used for some aromatic waters and for the distilled waters.

71. Official processes for aromatic waters.—Aromatic waters are prepared by the following U.S.P. general processes:

a. Distillation.—Place the odoriferous portion of the plant or drug from which the aromatic water is to be prepared in a suitable still with sufficient distilled water, and distill most of the water, carefully avoiding the development of empyreumatic odors through the charring or scorching of the substances. Separate the excess of oil and preserve or use the clear aqueous portion, filtered if necessary.

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b. Solution.

The volatile oil or other specified volatile substance	2 cc or 2 gm
Distilled water, a sufficient quantity	
To make	1,000 cc

Shake the volatile substance (suitably comminuted if a solid) with 1,000 cc of distilled water in a capacious bottle, and repeat the shaking several times during a period of about 15 minutes. Set the mixture aside for 12 hours or overnight, filter through wetted filter paper, and pass enough distilled water through the filter to make the product measure 1,000 cc.

c. Alternative solution method.—The following method for preparing aromatic waters by solution is alternative with the method just prescribed. Thoroughly incorporate the volatile oil (or the suitably comminuted volatile solid) with 15 gm of purified talc or with a sufficient quantity of purified soliceous earth or pulped filter paper. Add 1,000 cc of distilled water and thoroughly agitate the mixture several times during 10 minutes. Then filter the mixture, returning the first portions if necessary, to obtain a clear filtrate and add enough distilled water through the filter to make the product measure 1,000 cc.

72. Aqua Ammoniae—ammonia water, U.S.P.XI.—An aqueous solution of ammonia containing in each 100 cc not less than 9 gm and not more than 10 gm of NH_3.

a. Prepared as follows.—Stronger ammonia water, 398 cc; distilled water, a sufficient quantity to make 1,000 cc. Mix them.

b. Use.—Rarely used in medicine, the aromatic spirit being preferred for internal use.

c. Average dose.—1 cc, well diluted.

d. Storage.—Preserve in a cool place, in glass-stoppered bottles made of hard glass, free from lead.

73. Aqua Ammoniae Fortior—stronger ammonia water, U.S.P. XI.—An aqueous solution of ammonia containing not less than 27 percent and not more than 29 percent by weight of NH_3. This solution deteriorates rapidly in open containers.

a. Use.—In preparing ammonia water.

b. Storage.—Same as ammonia water.

c. Caution.—Great care should be used in handling the liquid because of its caustic and irritating properties.

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74. Aqua Anisi—anise water, U.S.P. XI.—A saturated solution of oil of anise in distilled water, prepared by one of the processes described in paragraph 71.

a. Use.—Flavored vehicle.

b. Average dose.—15 cc.

75. Aqua Aurantii Florum—orange flower water, U.S.P. XI.—A saturated solution of the odoriferous principles of the flowers of citrus aurantium linné (Fam. Rutaceae) prepared by distillation, as described in paragraph 71.

a. Use.—Flavored vehicle.

b. Storage.—Allow a limited access of fresh air to the container.

76. Aqua Camphorae—camphor water, U.S.P. XI—A saturated solution of camphor in distilled water prepared by a process as described in paragraph 71.

a. Use.—Vehicle.

b. Dose.—10 cc.

77. Aqua Chloroformi—chloroform water, U.S.P. XI.—*a. Prepared as follows.*—Chloroform, distilled water; of each a sufficient quantity. To a convenient quantity of distilled water contained in an amber-colored bottle, add enough chloroform to maintain a slight excess after the mixture has been repeatedly and thoroughly shaken. When chloroform water is to be dispensed, decant the quantity required, refill the bottle with distilled water, and saturate it by thorough agitation, taking care that there is always an excess of chloroform present.

b. Use.—Sedative in cough mixtures and as a vehicle.

c. *Average dose.*—15 cc.

d. Storage.—Preserve in well-closed containers and protected from light.

78. Aqua Cinnamomi—cinnamon water, U.S.P. XI.—A saturated solution of oil of cinnamon in distilled water prepared by one of the processes described in paragraph 71.

a. Use.—Flavored vehicle.

b. Average dose.—15 cc.

79. Aqua Destillata—distilled water, U.S.P. XI.—Water (H_2O) purified by distillation. The Pharmacopoeia recognizes no official process for its preparation, however, all contact with lead and iron should be avoided and it must be carefully preserved.

80. Aqua Destillata Sterilisata—sterilized distilled water, U.S.P. XI.—*a. Preparation.*—(1) Place freshly distilled water, neutral

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to litmus paper, in sterilized containers of insoluble glass having a capacity of not over 1,000 cc each. Stopper the containers with plugs of purified nonabsorbent cotton wrapped in gauze. Fasten stout, nonabsorbent paper or tinfoil over the top of the plug and the lip of the flask, and sterilize in an autoclave, under steam pressure, giving a temperature of not less than 115° C., for 30 minutes.

(2) If an autoclave is not available, close the mouth of the flask containing the freshly distilled water with a plug of purified nonabsorbent cotton wrapped in gauze, boil the contents actively for not less than 1 hour, and allow the water to cool without removing the cotton plug. Until ready for use, protect the mouth of the flask and the plug from contamination through dust by wrapping the top of the flask tightly with paper.

b. Storage.—When stored in a stoppered container, should be used within 24 hours after its distillation.

81. Aqua Foeniculi—fennel water, U.S.P. XI.—A saturated solution of oil of fennel in distilled water prepared by one of the processes described in paragraph 71.

a. Uses.—A flavored vehicle.

b. Average dose.—15 cc.

82. Aqua Menthae Piperitae—peppermint water, U.S.P. XI.—A saturated solution of oil of peppermint in distilled water, prepared by one of the processes described under paragraph 71.

a. Uses.—A flavored vehicle.

b. Average dose.—15 cc.

83. Aqua Menthae Viridis—spearmint water, U.S.P. XI.—A saturated solution of oil of spearmint in distilled water, prepared by one of the processes described under paragraph 71.

a. Uses.—A flavored vehicle.

b. Average dose.—15 cc.

84. Aqua Rosae—rose water, U.S.P. XI.—*a. Prepared as follows.*—Stronger rose water, distilled water; of each, one volume. Mix them immediately before use.

b. Use.—Vehicle-in-eye preparations and lotions.

85. Aqua Rosae Fortior—stronger rose water, U.S.P. XI.—A saturated solution of the odoriferous principles of the flowers of rosa centifolia linne' (Fam. Rosaceae), prepared by distillation, as described in paragraph 71. It is used for perfume in cold creams and lotions.

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SECTION II

LIQUORS (SOLUTIONS)

	Paragraph
Definition	86
Types of solutions	87
Liquor Acidi Arsenosi	88
Liquor Acidi Borici	89
Liquor Alumini Acetatis	90
Liquor Amaranthi	91
Liquor Antisepticus	92
Liquor Aromaticus Alkalinus	93
Liquor Calcii Hydroxidi	94
Liquor Cresolis Saponatus	95
Liquor Ephedrinae Sulfatis	96
Liquor Epinephrinae Hydrochloridi	97
Liquor Ergosterolis Irradiati	98
Liquor Formaldehydi	99
Liquor Hepatis	100
Liquor Hepatis Purificatus	101
Liquor Histaminae Phosphatis	102
Liquor Hydrogenii Peroxidi	103
Liquor Iodi Compositus	104
Liquor Magnesii Citratis	105
Liquor Parathyroidei	106
Liquor Picis Carbonis	107
Liquor Pituitarii Posterii	108
Liquor Potassii Arsenitis	109
Liquor Potassii Hydroxidi	110
Liquor Potassii Iodidi	111
Liquor Sodae et Menthae	112
Liquor Sodii Boratis Compositus	113
Liquor Sodii Chloridi Physiologicus	114
Liquor Sodii Hypochloritis	115
Liquor Sodii Hypochloritis Dilutus	116

86. Definition.—The term liquors (solutions) as used in the U.S.P. is generally applied to aqueous solutions of nonvolatile substances. There are, however, exceptions to this definition in that some few contain volatile substances and one is an oily solution.

87. Types of solutions.—*a. Simple solution.*—This is one in which the active ingredient or ingredients are added directly to the solvent.

b. Chemical solution.—In this type of solution the active ingredient is formed in the process of manufacture, as the result of chemical action.

88. Liquor Acidi Arsenosi—solution of arsenous acid, U.S.P. XI (solution of arsenic chloride).—Contains in each 100 cc the equivalent of not less than 0.975 gm and not more than 1.025 gm of As_2O_3.

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a. Prepared as follows.—Arsenic trioxide, 10 gm; diluted hydrochloric acid, 50 cc; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the acid in 250 cc of water; boil the arsenic trioxide therein until it is dissolved. After cooling, add enough distilled water to make 1,000 cc.

b. Use.—Alterative.

c. Average dose.—0.2 cc.

89. Liquor Acidi Borici—solution of boric acid, N.F. VI (saturated solution of boric acid).—Contains in each 100 cc not less than 4.25 gm of H_3BO_2.

a. Prepared as follows.—Boric acid, 50 gm; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the boric acid, with the aid of heat, in enough distilled water to make 1,000 cc. Filter until clear upon cooling.

b. Use.—Antiseptic, used for the eyes and as wet compress. If diluted for use in the eye, sterile distilled water should be used.

c. Storage.—Store in well-closed containers, in a moderately warm place.

90. Liquor Alumini Acetatis—solution of aluminum acetate, N.F. VI (Burow's solution).—An aqueous solution containing in each 100 cc not less than 4.8 gm and not more than 5.8 gm of $Al(C_2H_3O_2)_3$.

a. Prepared as follows.—Lead acetate, 150 gm; aluminum sulfate, 87 gm; water, a sufficient quantity to make 1,000 cc. Dissolve each salt separately in 525 cc of water, and mix the cold solutions by pouring the lead acetate solution in a thin stream, with constant stirring, into the aluminum sulfate solution. Set the mixture aside in a cold place (about 10° C.) for 24 hours. Syphon off 1,000 cc of the clear liquid, or, if necessary, transfer the magma to a filter and add sufficient water through the magma to make the product measure 1,000 cc.

NOTE.—This solution should only be dispensed when clear.

b. Use.—Externally as an astringent.

c. Average dilution.—For external use, 1 volume with 9 volumes of water.

d. Storage.—Preserve in well-filled, tightly stoppered bottles.

e. Caution.—Do not confuse this preparation with liquor alumini subacetatis which is a stronger preparation.

91. Liquor Amaranthi—solution of amaranth, N.F. VI.—*a. Prepared as follows.*—Amaranth, 1 gm; distilled water, a sufficient quantity to make 100 cc. Dissolve the amaranth in the distilled water.

b. Use.—Coloring agent.

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92. Liquor Antisepticus—N. F. antiseptic solution, N.F. VI.—*a. Prepared as follows.*—Boric acid, 25 gm; thymol, 1 gm; chlorthymol, 1 gm; menthol, 1 gm; eucalyptol, 2 cc; methyl salicylate, 1.2 cc; oil of thyme, 0.3 cc; alcohol, 50 cc; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the boric acid in 650 cc of distilled water and the other ingredients in 250 cc of alcohol. Mix the two solutions, and allow the mixture to stand in a warm place, with occasional agitation, during 24 hours; then filter, using 10 gm of purified talc, if necessary, to clarify the product; add 50 cc of alcohol to the filtrate and enough distilled water to make 1,000 cc.

b. Use.—Antiseptic mouthwash and gargle.

93. Liquor Aromaticus Alkalinus—alkaline aromatic solution, N.F. VI.—*a. Prepared as follows.*—Potassium bicarbonate, 20 gm; sodium borate, 20 gm; thymol, 0.5 gm; eucalyptol, 1 cc; methyl salicylate, 0.5 cc; tincture of cudbear, 20 cc; alcohol, 50 cc; glycerine, 100 cc; distilled water, a sufficient quantity to make 1,000 cc. Mix the potassium bicarbonate and the sodium borate with 100 cc of distilled water, and add the glycerine; when the effervescence has ceased, add the mixture to 500 cc of distilled water. Dissolve the thymol, eucalyptol, methyl salicylate, and the tincture of cudbear in the alcohol; then add the solution of the salts to the alcoholic solution, with constant agitation; finally add sufficient distilled water to make 1,000 cc. Allow to stand, with occasional shaking, for 24 hours; then filter, using 10 gm of purified talc, if necessary, to clarify the product.

b. Use.—Antiseptic mouthwash and gargle.

94. Liquor Calcii Hydroxidi—solution of calcium hydroxide, U.S.P. XI (lime water).—An aqueous solution containing in each 100 cc at 25° C. not less than 0.14 gm of $Ca(OH)_2$. The content of calcium hydroxide varies with the temperature at which the solution is stored, being about 0.17 gm per 100 cc at 15° C., and less at a higher temperature.

a. Prepared as follows.—Calcium hydroxide, 3 gm; cool distilled water, 1,000 cc. Mix them and agitate the mixture repeatedly during one hour. Allow the excess to settle and dispense only the clear, supernatant liquid. The undissolved portion of the mixture is not suitable for preparing additional quantities of the liquor.

b. Use.—Antacid.

c. Average dose.—15 cc.

d. Storage.—Preserve in well-filled, tightly stoppered bottles, in a cool place.

95. Liquor Cresolis Saponatus—saponated solution of cresol, U.S.P. XI (compound solution of cresol).—*a. Prepared as follows.*—Cresol, 500 cc; linseed oil, 350 cc; potassium hydroxide, 14.52 gm; so-

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dium hydroxide, 37.05 gm; distilled water, a sufficient quantity to make 1,000 cc. Mix the cresol and linseed oil, add the potassium hydroxide and sodium hydroxide, dissolve in 50 cc of distilled water, and mix well. Heat the mixture to about 70° C. and maintain that temperature until a portion of it makes a clear solution with nine volumes of cold distilled water. Then cool the liquid and add sufficient distilled water to make 1,000 cc.

b. Use.—Disinfectant.

96. Liquor Ephedrinae Sulfatis—solution of ephedrine sulfate, N.F. VI.—Contains in each 100 cc not less than 2.8 gm and not more than 3.2 gm of ephedrine sulfate.

a. Prepared as follows.—Ephedrine sulfate, 30 gm; chlorobutanol, 5 gm; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the ephedrine sulfate and chlorobutanol in enough distilled water to make 1,000 cc. Filter, if necessary.

b. Use.—Vasoconstrictor, on mucous membranes, usually diluted with an equal volume of water.

97. Liquor Epinephrinae Hydrochloridi—solution of epinephrine hydrochloride, U.S.P. XI.—A solution of epinephrine in distilled water and hydrochloric acid, containing in each 100 cc not less than 0.095 gm and not more than 0.105 gm $C_9H_{13}O_3N$.

a. Use.—Vasoconstrictor.

b. Average dose.—By parenteral injection, 0.5 cc.

c. Storage.—Preserve in small, well-filled, amber-colored bottles or in ampules.

98. Liquor Ergosterolis Irradiati—solution of irradiated ergosterol, U.S.P. XI.—A solution of ergosterol in an edible vegetable oil, activated by irradiation with ultraviolet rays. It contains in each gram not less than 10,000 U.S.P. units of vitamin D.

a. Use.—Antirachitic.

b. Average dose.—0.3 cc.

c. Storage.—Preserve in small, well-stoppered bottles, in a cool place.

99. Liquor Formaldehydi—solution of formaldehyde, U.S.P. XI.—An aqueous solution containing not less than 37 percent of CH_2O, with variable amounts of menthanol to prevent polymerization. It is used as a strong disinfectant.

100. Liquor Hepatis—solution of liver, U.S.P. XI (liquid extract of liver).—Contains that soluble fraction of mammalian livers which increases the number of red corpuscles in the blood of persons suffering from pernicious anemia, and conforms with outlined specifications.

a. Use.—In pernicious anemia treatment.

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b. Average dose.—To be stated on label of container.

c. Storage.—Preserve in well-closed containers, and preferably in a cool place.

101. Liquor Hepatis Purificatus—purified solution of liver, U.S.P. XI (parenteral solution of liver).—Extracted in the same manner as the previous preparation. This solution is intended for parenteral injection and must be highly purified and sterile.

a. Use.—In pernicious anemia treatment.

b. Average dose.—To be stated on label of container.

c. Storage.—Preserve in well-closed containers, and preferably in a cool place.

102. Liquor Histaminae Phosphatis—solution of histamine phosphate, U.S.P. XI (solution of histamine acid phosphate).—*a. Prepared as follows.*—Histamine phosphate, 1 gm; distilled water, a sufficient quantity to make 1,000 cc. Prepare a solution, filtering it, if necessary, until clear. A preservative may be added provided it conforms with the requirements set forth in the U.S.P.

b. Use.—As a diagnostic agent.

c. Average dose.—By parenteral injection, 0.3 cc.

d. Storage.—Preserve in small, well-filled bottles or in ampules.

103. Liquor Hydrogenii Peroxidi—solution of hydrogen peroxide, U.S.P. XI.—An aqueous solution containing in each 100 cc not less than 2.5 gm and not more than 3.5 gm of H_2O_2.

a. Use.—Antiseptic.

b. Average dose.—4 cc.

c. Storage.—Preserve in a cool place protected from light and dust.

104. Liquor Iodi Compositus—compound solution of iodine, U.S.P. XI (Lugol's solution).—A solution containing in each 100 cc not less than 4.5 gm and not more than 5.5 gm of I, and not less than 9.5 gm and not more than 10.5 gm of KI.

a. Prepared as follows.—Iodine, 5 gm; potassium iodide, 10 gm; distilled water, a sufficient quantity to make 100 cc. Dissolve the iodine and the potassium iodide in 10 cc of distilled water, then add enough distilled water to make 100 cc.

b. Use.—For internal administration of iodine in the treatment of goiter, etc.

c. Average dose.—0.2 cc.

105. Liquor Magnesii Citratis—solution of magnesium citrate, U.S.P. XI.—Contains in each 100 cc an amount of magnesium citrate corresponding to not less than 1.6 gm and not more than 1.9 gm of MgO.

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a. Prepared as follows.—Magnesium carbonate, 15 gm; citric acid, 33 gm; syrup, 60 cc; purified talc, 5 gm; oil of lemon, 0.1 cc; potassium bicarbonate, 2.5 gm; distilled water, a sufficient quantity to make 350 cc. Dissolve the citric acid in 150 cc of hot distilled water in a suitable dish, and, having added the magnesium carbonate, previously mixed with 100 cc of distilled water, stir until dissolved. Then add the syrup; heat the mixed liquids to the boiling point; immediately add the oil of lemon, previously triturated with the purified talc, and filter the mixture, while hot, into a strong sterile bottle of suitable capacity. Add enough boiled distilled water to make 350 cc. Stopper the bottle with purified cotton and allow to cool. Then drop in the potassium bicarbonate and stopper the bottle securely.

b. Use.—Saline cathartic.

c. Average dose.—200 cc.

d. Storage.—Keep the bottle on its side in a cool place, preferably in a refrigerator.

106. Liquor Parathyroidei—solution of parathyroid, U.S.P. XI (parathyroid extract).—A sterile solution of the principles that are soluble in water and which are capable of raising the calcium content of blood serum.

a. Use.—Treatment of parathyroid deficiency.

b. Average dose.—By hypodermic injection, 25 units.

c. Storage.—Preserve in airtight containers, preferably in a cool place.

107. Liquor Picis Carbonis—solution of coal tar, N.F. VI (liquor carbonis detergens).—*a. Prepared as follows.*—Coal tar, 200 gm; quillaja (in moderately coarse powder), 100 gm; alcohol, a sufficient quantity to make 1,000 cc. Mix the coal tar with 700 cc of alcohol, add the quillaja, and macerate the mixture during seven days, in a closed vessel, with occasional agitation. Then filter and wash the contents of the filter with enough alcohol to make 1,000 cc.

b. Use.—External application in dermatitis.

c. Average dilution.—With 9 volumes of water or alcohol.

108. Liquor Pituitarii Posterii—solution of posterior pituitary, U.S.P. XI (solution of pituitary).—A sterile solution of the water-soluble principle or principles from the fresh posterior lobe of the pituitary body of healthy domesticated animals used for food by man. It is assayed for activity upon the isolated uterus of the virgin guinea pig.

a. Use.—Uterine stimulant.

b. Average dose.—By hypodermic injection, 1 cc.

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c. Storage.—Preserve in small, well-filled, amber-colored containers or ampules.

109. Liquor Potassii Arsenitis—solution of potassium arsenite, U.S.P. XI (Fowler's solution).—Contains in each 100 cc the equivalent of not less than 0.950 gm and not more than 1.050 gm of As_2O_3.

a. Prepared as follows.—Arsenic trioxide, 10 gm; potassium bicarbonate, 7.6 gm; alcohol, 30 cc; distilled water, a sufficient quantity to make 1,000 cc. Boil the potassium bicarbonate and the arsenic trioxide with 100 cc of distilled water until dissolved. Cool the solution and add enough distilled water to make 950 cc, add the alcohol, and enough distilled water to make 1,000 cc.

b. Use.—Alterative.

c. Average dose.—0.2 cc.

110. Liquor Potassii Hydroxidi—solution of potassium hydroxide, N.F. VI.—Contains in each 100 cc not less than 4.5 gm and not more than 5.5 gm of total alkali, calculated as KOH, of which not more than 0.35 gm is K_2CO_3.

a. Prepared as follows.—Potassium hydroxide, 60 gm; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the potassium hydroxide in enough water to make 1,000 cc.

b. Use.—Alkalizer, usually in genito-urinary infections.

c. Average dose.—1 cc.

d. Storage.—Preserve in well-filled bottles of hard glass, with tight rubber or glass stoppers well-coated with petrolatum.

e. Caution.—This solution should be freely diluted with water before being taken into the mouth.

111. Liquor Potassii Iodidi—solution of potassium iodide, N.F. VI (saturated solution of potassium iodide).—An aqueous solution containing, in each 100 cc, not less than 97 gm and not more than 103 gm of KI.

a. Prepared as follows.—Potassium iodide, 100 gm; distilled water, a sufficient quantity to make 100 cc. Dissolve the salt in 68 cc of hot water, cool, and add enough distilled water to make 100 cc. Filter if necessary.

b. Use.—Alterative.

c. Average dose.—0.3 cc.

NOTE.—If the solution is not to be used extemporaneously, 0.05 gm of sodium thiosulfate should be added.

112. Liquor Sodae et Menthae—solution of soda and mint, N.F. VI (soda mint).—*a. Prepared as follows.*—Sodium bicarbonate, 50 gm; aromatic spirit of ammonia, 20 cc; spearmint water, a sufficient quantity to make 1,000 cc. Dissolve the sodium bicarbonate in 950

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cc of spearmint water, add the aromatic spirit of ammonia, and shake the mixture intermittently during 30 minutes. Filter, using 10 gm of purified talc, and add enough spearmint water, through the filter, to make 1,000 cc. When preferred, peppermint water may be used in place of the spearmint water.

b. Use.—Alkalizer-carminative.

c. Average dose.—8 cc.

113. Liquor Sodii Boratis Compositus—compound solution of sodium borate, N.F. VI (Dobell's solution).—*a. Prepared as follows.*—Sodium borate, 15 gm; sodium bicarbonate, 15 gm; liquefied phenol, 3 cc; glycerine, 35 cc; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the sodium borate and the sodium bicarbonate in about 500 cc of the water; add the glycerine and liquefied phenol, and allow the mixture to stand half an hour, or until the effervescence has ceased; then add sufficient distilled water to make the product measure 1,000 cc and filter.

b. Use.—Mouthwash and gargle.

c. Average dilution.—Undiluted or for the dental spray bottle dilute with 5 volumes of water.

114. Liquor Sodii Chloridi Physiologicus—physiological solution of sodium chloride, U.S.P. XI (physiological salt solution, normal saline solution).—*a. Prepared as follows.*—Sodium chloride, 8.5 gm; distilled water, freshly distilled, a sufficient quantity to make 1,000 cc. Dissolve the sodium chloride in enough distilled water, neutral to litmus paper, to measure 1,000 cc, and filter until free from foreign particles. Sterilize the solution, contained in a flask of insoluble glass, in an autoclave under steam pressure maintaining a temperature of not less than 115° for 30 minutes.

b. Caution.—This solution must be protected from contamination and should be used within 24 hours after its sterilization if not stored in hermetically-sealed containers.

115. Liquor Sodii Hypochloritis—solution of sodium hypochlorite, U.S.P. XI. Contains not less than 4 percent and not more than 6 percent of NaOCl.

a. Use.—Disinfectant and deodorant. Also as a bleaching agent.

b. Storage.—Preserve in well-stoppered bottles, in a cool place, and protected from light.

c. Caution.—This solution is not suitable for application to wounds.

116. Liquor Sodii Hypochloritis Dilutus—diluted solution of sodium hypochlorite, U.S.P. XI (modified Dakin's solution).—An aqueous solution of chlorine compounds of sodium containing in each 100 cc not less than 0.45 gm and not more than 0.50 gm of NaOCl,

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equivalent to not less than 0.43 gm and not more than 0.48 gm of available Cl.

a. Prepared as follows.—Solution of sodium hypochlorite, 1,000 cc; sodium bicarbonate and distilled water, of each, a sufficient quantity. Dilute the solution of sodium hypochlorite with 5,000 cc of distilled water and add 40 cc of a 5 percent solution of sodium bicarbonate in cold distilled water and mix well. Remove about 20 cc of the mixture, add to it about 0.02 gm of powdered phenolphthalein, and shake it gently for 2 minutes. If a red color appears, add more of the bicarbonate solution, and test with powdered phenolphthalein as just described, repeating the procedure as often as necessary until no red color is produced. Assay the liquid and dilute it with sufficient distilled water to make the final solution contain in each 100 cc, 0.48 gm of NaOCl.

b. Use.—Antiseptic and disinfectant for wounds.

c. Storage.—Preserve in well-stoppered bottles, in a cool place and protect from light.

SECTION III

EMULSIONS

	Paragraph
Definitions	117
Emulsifying agents	118
Methods of preparing emulsions	119
Emulsum Asafoetidae	120
Emulsum Olei Morrhuae	121
Emulsum Olei Terebinthinae	122
Emulsum Petrolati Liquidi	123

117. Definitions.—*a. General.*—An emulsion is a heterogeneous system consisting of two liquid phases, one of which is dispersed as minute droplets in the other. The liquid which is broken up into minute droplets is known as the dispersed phase or the internal phase, while the liquid surrounding the droplets is known as the continuous or external phase.

b. Natural emulsions.—Examples of natural emulsions are yolk of egg and milk. Milk contains in true solution mineral salts, soluble albumin and lactose, and, in less complete solution, the casein, while the finely divided fat globules are held in suspension in the milk serum, forming an emulsion.

c. Artificial emulsions.—(1) Oil-in-water or O/W emulsions are those in which the emulsifying agent is soluble in water, or if it is an insoluble substance it is more easily wetted by water than by oil.

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(2) A water-in-oil or W/O emulsion is one in which the emulsifying agent is soluble in oil, or is more easily wetted by oil.

d. Cracking.—This is a term applied to deemulsification. The globules of the dispersed phase coalesce to form a continuous layer and no amount of shaking will bring about reemulsification. Cracking may be caused by any one of the following conditions: Too prolonged trituration of the oil with acacia in the continental method; heat; freezing; incorporation of an electrolyte; coagulation of the emulsifying agent; or addition to a liquid in which both phases are soluble.

118. Emulsifying agents.—*a. Acacia* is the most commonly used emulsifying agent for oil-in-water emulsions. Acacia and other gums should not be used in emulsions intended for external application, as they leave a sticky layer on the surface of the body.

b. Tragacanth is next in importance to acacia but is not so soluble in cold water. If used in conjunction with other good emulsifiers, it produces the necessary viscosity to assist in stabilizing the emulsion.

c. Agar absorbs considerable quantities of water and in this respect is similar to tragacanth. It is useful when combined with acacia and must be used in the form of its solution and this must be kept warm until the emulsion is completed as the agar gels at about 40° C.

d. Gelatin should not be combined with other emulsifying agents. Gelatin solutions are used to some extent for making liquid petrolatum emulsions.

e. Chondrus mucilage prepared from chondrus is seldom used except in large-scale operations because of the time required for preparing it.

f. Egg yolk is a natural emulsion and may be used in preparing artificial emulsions.

g. Soap is an excellent emulsifying agent but is not, in general, used for preparing emulsions for internal use on account of its laxative action and unpleasant taste. Lime liniment (carron oil) is a water-in-oil emulsion in which the soap formed by the action of the lime water on linseed oil, is the emulsifying agent.

h. Alkalies are frequently listed as emulsifying agents but they act by saponifying fats and oils, producing soaps which are the actual emulsifiers.

119. Methods of preparing emulsions.—*a. General.*—(1) A mortar and pestle are ordinarily used for the extemporaneous preparation of emulsions. The mortar should be broad and shallow and the pestle should have a large end adapted to the purpose of causing

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rapid and thorough disintegration of the liquid being emulsified. The ordinary household egg beater is a very efficient emulsifier, as is also the more elaborate type of electrically driven kitchen mixer.

(2) The mixing of oil, gum, and water should not be effected by the usual method of trituration, which involves pressure on the pestle against the material on the bottom and sides of the mortar, and consequent development of heat, but should be brought about by a rapid, light rotary movement of the wrist, communicated to the pestle held loosely in the hand. If the emulsion is made in a bottle, it should be shaken with a whipping motion as much as possible. The oil and water should not be measured in the same graduate, as oil particles may thus be carried into the emulsion without being emulsified and afterwards rise to the surface of the emulsion.

b. English method.—In the English method a mucilage is prepared by adding the water to the granulated acacia in a mortar, triturating until the acacia is dissolved. The oil is then added in divided portions, each such portion being completely emulsified before more oil is added. After all the oil has been added and emulsified, the emulsion nucleus is flavored and diluted with water to the required volume.

c. Continental method.—In the continental method 1 gram of finely powdered acacia is incorporated with each 4 cc of oil by trituration or agitation in a thoroughly dry mortar or bottle, after which 2 cc of water are added all at once and the whole triturated or shaken promptly and rapidly until the primary emulsion is formed, which may then be diluted if desired. Only finely powdered acacia can be used in this method as it is necessary that it dissolve in the water almost at once, and the smaller quantity of acacia is sufficient because the oil is dispersed much more promptly and completely than when added gradually to a solution of the acacia as in the English method. Success of the continental method is dependent upon promptness and rapidity of trituration or agitation after the water is added and upon the use of a dry mortar or bottle. The error of stopping the trituration too soon is very common.

d. Flask method.—This method is usually employed for the volatile oils, the gum and oil being put into a *dry* bottle and shaken. Then the water is added and the bottle is shaken thoroughly. Interrupted shaking appears to produce a better emulsion than continuous shaking.

120. Emulsum Asafoetidae—emulsion of asafetida, U.S.P. XI.—*a. Prepared as follows.*—Asafetida, in tears or selected masses, 40 gm; distilled water, a sufficient quantity to make 1,000 cc. Rub

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the asafetida in a mortar with 900 cc of distilled water, at first very gradually added until a uniform emulsion results. Then strain the mixture into a graduated vessel, and rinse the mortar and strainer with enough distilled water to make the product measure 1,000 cc. Mix thoroughly.

b. Use.—Carminative.

c. Average dose.—15 cc.

121. Emulsum Olei Morrhuae—emulsion of cod liver oil, U.S.P. XI.—*a. Prepared as follows.*—(1) The method directed is the continental method and while the Pharmacopoeia permits the replacement, in part or in whole, of the acacia by agar, gelatin, tragacanth, or mixtures of these, best results are obtained by adhering strictly to the prescribed formula.

(2) Cod liver oil, 500 cc; acacia, in very fine powder, 125 gm; syrup, 100 cc; methyl salicylate, 4 cc; distilled water, a sufficient quantity, to make 1,000 cc. Quickly and thoroughly mix the acacia with the cod liver oil in a dry mortar or other suitable vessel, then add at once 250 cc of distilled water, and complete the emulsification by trituration or by the aid of a suitable mechanical device. When a thick, white, homogeneous emulsion is obtained, add the methyl salicylate and the syrup with sufficient distilled water to make the product measure 1,000 cc, and mix thoroughly. The methyl salicylate may be replaced with not more than 1 percent of any other flavoring substance or by any mixture of flavoring substances recognized in the Pharmacopoeia. If it is to be kept for any length of time, 70 cc of alcohol should be added, replacing a corresponding volume of distilled water. The alcohol should be added last and in small portions, shaking after each addition.

b. Use.—This is simply a more palatable form of cod liver oil and possesses identical therapeutic action.

c. Average dose.—Adults, 15 cc. Infants, 8 cc. (Administer three times daily.)

122. Emulsum Olei Terebinthinae—emulsion of oil of turpentine, U.S.P. XI.—*a. Prepared as follows.*—Rectified oil of turpentine, 15 cc; acacia, in a very fine powder, 5 gm; distilled water, a sufficient quantity to make 100 cc. Place the powdered acacia in a dry bottle, add the oil of turpentine, mix thoroughly, add exactly 10 cc of distilled water, and agitate briskly until an emulsion forms, then gradually add sufficient distilled water to make the product measure 100 cc, and mix thoroughly.

b. Use.—Carminative.

c. Average dose.—2 cc.

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123. Emulsum Petrolati Liquidi—emulsion of liquid petrolatum, U.S.P. XI.—*a. Prepared as follows.*—Heavy liquid petrolatum should be used in preparing this emulsion. Liquid petrolatum, 500 cc; acacia, in very fine powder, 125 gm; syrup, 100 cc; vanillin, 0.04 gm; alcohol, 6 cc; distilled water, a sufficient quantity, to make 1,000 cc. Mix the liquid petrolatum with the powdered acacia in a dry mortar, add 250 cc of distilled water all at once, and emulsify the mixture. Then add, in divided portions and triturating after each addition, a mixture of the syrup, 50 cc distilled water and the vanillin, dissolved in the alcohol. Finally add sufficient distilled water to make 1,000 cc.

b. Use.—Laxative.

c. Average dose.—30 cc.

SECTION IV

SYRUPS

	Paragraph
Definition	124
Types of syrups	125
Methods of preparation	126
Preservation	127
Syrupus	128
Syrupus Acidi Citrici	129
Syrupus Acidi Hydriodici	130
Syrupus Aurantii	131
Syrupus Aurantii Florum	132
Syrupus Balsami Tolutani	133
Syrupus Glycyrrhizae	134
Syrupus Ipecacuanhae	135
Syrupus Picis Pini	136
Syrupus Pruni Virginianae	137
Syrupus Rhei Aromaticus	138
Syrupus Sarsaparillae Compositus	139

124. Definition.—Syrups are concentrated solutions of sucrose in water or aqueous liquids. They may be vehicles or medicinal syrups.

125. Types of syrups.—*a. Simple syrup.*—This is a concentrated solution of sucrose in distilled water. It is official in the Pharmacopoeia.

b. Flavored syrup.—This type syrup is not medicinal in action, but contains various aromatic or pleasantly flavored substances. It is used to disguise the taste of unpleasant medicaments.

c. Medicated syrup.—In this type syrup a medicinal substance has been added.

126. Methods of preparation.—*a. By solution with heat.*—(1) This method consists of adding the sucrose to the distilled water or

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aqueous solution and heating until the solution is affected. The resulting syrup is then strained and sufficient distilled water added to make the desired measure.

(2) There are several disadvantages to using this method. It cannot be used if any of the constituents are volatile or injured by heat. In the presence of an acid or mineral salt, or even by prolonged heating at high temperatures, the sucrose may be inverted into simple sugars, thus making the syrup more liable to ferment. If an excess of sucrose is used in making a solution by this method, a supersaturated solution will result, and on cooling the crystallization may go beyond the point of saturation, making an undersaturated solution. Undersaturated solutions of sucrose, containing no preservative, are liable to rapid fermentation. The heating of a syrup to high temperatures will cause darkening due to caramelization of the sucrose.

b. By agitation without heat.—This process is directed by the Pharmacopoeia in those cases where heat would cause the loss of valuable volatile constituents. Sucrose is added to the aqueous solution in a bottle of twice the size required for the syrup. This permits active agitation and rapid solution. The bottle should be left on its side when not being agitated.

c. By the simple addition of a medicating liquid to syrup.—This method is resorted to in those cases in which medicinal liquids are added to syrup to form a medicated syrup. If this medicinal liquid is of high alcoholic content, precipitation may occur on mixing, due to the insolubility of the active ingredient in the syrup.

d. By percolation.—In this method a large pledget of absorbent cotton is placed in the neck of the percolator, the granulated sucrose poured on and packed down. Upon this is poured the requisite amount of the liquid. The liquid is attracted downward by gravitation, and in traversing through the sucrose dissolves enough of it to make a saturated solution. This method makes a clear and brilliant syrup.

127. Preservation.—Syrups should be preserved in well-dried, dark bottles, preferably those which have been sterilized, and in a moderately cool place.

128. Syrupus—syrup, U.S.P. XI (simple syrup).—A concentrated solution of sucrose in distilled water. It contains 64.7 percent of sucrose W/W.

a. Prepared as follows.—Sucrose, 850 gm; distilled water, a sufficient quantity to make 1,000 cc. Prepared by the percolation method, using 450 cc of distilled water. If necessary, repass portions through the percolator until all of the sucrose has been dissolved.

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Then pass enough distilled water through the cotton to make 1,000 cc, and mix thoroughly. This preparation may also be prepared by the solution with heat method, using 450 cc of distilled water as the solvent and making up to 1,000 cc with distilled water. The temperature at no time should exceed 100° C.

b. Use.—Sweetening agent and vehicle.

129. Syrupus Acidi Citrici—syrup of citric acid, U.S.P. XI.—A pleasant flavoring agent and is used when syrup of lemon is called for.

a. Prepared as follows.—Tincture of lemon, 10 cc; citric acid, 10 gm; distilled water, 10 cc; syrup, a sufficient quantity to make 1,000 cc. Dissolve the citric acid in the distilled water and mix the solution with 950 cc of syrup. Add the tincture and enough syrup to make the product measure 1,000 cc.

b. Use.—Flavoring agent and vehicle.

c. Caution.—This preparation must not be dispensed if it has a terebinthinate odor or taste or shows any other indications of deterioration.

130. Syrupus Acidi Hydriodici—syrup of hydriodic acid, U.S.P. XI.—A syrup containing in each 100 cc not less than 1.3 gm and not more than 1.5 gm of hydriodic acid (HI). Darkening of this syrup may be caused by caramelization of the sugar or liberation of iodine.

a. Prepared as follows.—Diluted hydriodic acid, 130 cc; sucrose, 450 gm; distilled water, a sufficient quantity to make 1,000 cc. Mix the diluted hydriodic acid with 550 cc of distilled water and dissolve the sucrose in this mixture by agitation. Add sufficient distilled water to make the product 1,000 cc, and filter.

b. Use.—Alterative.

c. Average dose.—4 cc.

d. Caution.—This preparation should not be dispensed if it is darker than straw color.

131. Syrupus Aurantii—syrup of orange, U.S.P. XI.—*a. Prepared as follows.*—Tincture of sweet orange peel, 50 cc; citric acid, 5 gm; purified talc, 15 gm; sucrose, 820 gm; distilled water, a sufficient quantity to make 1,000 cc. Triturate the talc with the tincture and the acid and add 400 cc of water, filter, dissolve the sucrose in the filtrate, without heat, and finally add enough water to make 1,000 cc.

b. Use.—Flavoring agent and vehicle.

c. Caution.—This preparation must not be dispensed if it has a terebinthinate odor or taste or shows any other indications of deterioration.

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132. Syrupus Aurantii Florum—syrup of orange flowers, U.S.P. XI.—*a. Prepared as follows.*—Orange flower water, 225 cc; sucrose, 850 gm; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the sucrose in the orange flower water and an equal amount of water by agitation or percolation, without heating, and add sufficient distilled water to make 1,000 cc, and strain.

b. Use.—Flavoring agent and vehicle.

133. Syrupus Balsami Tolutani—syrup of tolu balsam, U.S.P. XI (syrup of tolu).—*a. Prepared as follows.*—Tincture of tolu balsam, 50 cc; magnesium carbonate, 10 gm; sucrose, 820 gm; distilled water, a sufficient quantity to make 1,000 cc. Mix the tincture intimately with the magnesium carbonate and 60 gm of sucrose in a mortar. Gradually add 430 cc of distilled water with trituration, and filter. Dissolve the remainder of the sucrose in the clear filtrate with gentle heating, strain the syrup while warm, and add sufficient distilled water through the strainer to make the product measure 1,000 cc. This syrup may also be prepared by percolation.

b. Use.—Vehicle for cough syrups.

c. Average dose.—10 cc.

134. Syrupus Glycyrrhizae—syrup of glycyrrhiza, N.F. VI (syrup of licorice).—*a. Prepared as follows.*—Oil of fennel, 0.05 cc; anethol, 0.50 cc; benzaldehyde, 0.02 cc; fluidextract of glycyrrhiza, 250 cc; syrup, a sufficient quantity to make 1,000 cc. Add the oil, the anethol, and the benzaldehyde to the fluidextract of glycyrrhiza, and agitate until thoroughly mixed. Then add sufficient syrup to make the product measure 1,000 cc, and mix well.

b. Use.—Flavoring agent and vehicle.

135. Syrupus Ipecacuanhae—syrup of ipecac, U.S.P. XI.—*a. Prepared as follows.*—Fluidextract of ipecac, 70 cc; glycerine, 100 cc; syrup, a sufficient quantity to make 1,000 cc. Mix the fluidextract with the glycerine and add a sufficient quantity of syrup to make 1,000 cc.

b. Uses and doses.—Expectorant, 0.75 cc; emetic, 15 cc.

136. Syrupus Picis Pini—syrup of pine tar, U.S.P. XI (syrup of tar).—*a. Prepared as follows.*—Rectified oil of tar, 1 cc; sucrose, 850 gm; distilled water, a sufficient quantity to make 1,000 cc. Shake and macerate the oil with 450 cc of distilled water during 24 hours. Filter, and dissolve the sucrose in the filtrate without heating. Add sufficient distilled water to make 1,000 cc. Mix and strain.

b. Use.—Stimulating expectorant.

c. Average dose.—10 cc.

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137. Syrupus Pruni Virginianae—syrup of wild cherry, U.S.P. XI.—*a. Prepared as follows.*—Wild cherry bark (coarse powder), 150 gm; sucrose, 800 gm; glycerine, 50 cc; alcohol, 20 cc; distilled water, a sufficient quantity to make 1,000 cc. Moisten the drug with a mixture of the glycerine and 200 cc of distilled water. Pack in a percolator and add 200 cc of distilled water. Macerate for 1 hour and then start percolation, collecting the percolate in a bottle containing the sucrose. Add the alcohol to the percolate and dissolve the sucrose by agitation. Pass enough distilled water through the drug in the percolator to make 1,000 cc of syrup. Avoid heat in the manufacture of this preparation.

b. Use.—Vehicle in cough mixtures.

c. Average dose.—10 cc.

138. Syrupus Rhei Aromaticus—aromatic syrup of rhubarb, U.S.P. XI.—*a. Prepared as follows.*—Aromatic tincture of rhubarb, 150 cc; potassium carbonate, 1 gm; syrup, a sufficient quantity to make 1,000 cc. Dissolve the potassium carbonate in the tincture and add enough syrup to make 1,000 cc.

b. Use.—Laxative syrup for children.

c. Average dose.—10 cc.

139. Syrupus Sarsaparillae Compositus—compound syrup of sarsaparilla, U.S.P. XI.—*a. Prepared as follows.*—Fluidextract of sarsaparilla, 200 cc; fluidextract of glycyrrhiza, 15 cc; oil of sassafras, 0.2 cc; oil of anise, 0.2 cc; methyl salicylate, 0.2 cc; alcohol, 19.4 cc; syrup, 765 cc. Dissolve the oils in the alcohol, add the fluidextracts, and then mix with the syrup.

b. Use.—Flavoring agent and vehicle.

c. Average dose.—15 cc.

Section V

MUCILAGES

Paragraph
Definition 140
Mucilago Acaciae 141
Mucilago Tragacanthae 142

140. Definition.—Mucilages are thick, viscid, adhesive liquids or semi-solids, produced by dissolving gum in water, or by extracting with water the mucilaginous principles from vegetable substances. The mucilages are all prone to decomposition and should never be made in larger quantities than can be used immediately, unless a preservative is added.

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141. Mucilago Acaciae—mucilage of acacia, U.S.P. XI (mucilage of gum arabic).—*a. Prepared as follows.*—Acacia (in small fragments), 350 gm; sodium benzoate, 1 gm; distilled water, a sufficient quantity to make 1,000 cc. Wash the acacia with cold water and dissolve it in sufficient distilled water, in which the sodium benzoate has been dissolved, to make 1,000 cc. Strain. This preparation may also be made by dissolving 350 gm of granular acacia in 400 cc of distilled water by trituration in a mortar and adding the sodium benzoate and enough distilled water to make 1,000 cc.

b. Uses.—Demulcent, excipient, emulsifying agent.

c. Average dose.—15 cc.

d. Storage.—This preparation should be stored in a refrigerator.

e. Caution.—Do not dispense if sour or moldy.

142. Mucilago Tragacanthae—mucilage of tragacanth, U.S.P. XI.—*Prepared as follows.*—Tragacanth, 6 gm; glycerine, 18 gm; distilled water, a sufficient quantity to make 100 gm. Mix the glycerine with 75 cc of distilled water, heat to boiling, add the tragacanth, and macerate 24 hours. Add enough distilled water to make 100 gm; mix thoroughly and strain through muslin by expression.

Section VI

MIXTURES

	Paragraph
Definition	143
Mistura Cretae	144
Mistura Opii et Glycyrrhizae Composita	145
Mistura Rhei Composita	146

143. Definition.—Mixtures are aqueous preparations intended for internal use containing insoluble nonfatty substances. Since they contain insoluble matter, they must be dispensed with a "Shake Well" label.

144. Mistura Cretae—chalk mixture, U.S.P. XI.—*a. Prepared as follows.*—Compound chalk powder, 20 gm; cinnamon water, 40 cc; distilled water, a sufficient quantity to make 100 cc. Triturate the powder with the cinnamon water and about 20 cc of distilled water. Transfer to a graduated vessel and rinse the mortar with enough distilled water to make 100 cc. Mix thoroughly.

b. Use.—Antacid and alimentary canal protective.

c. Average dose.—15 cc.

d. Caution.—This preparation must not be dispensed unless it has been recently prepared.

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145. Mistura Opii et Glycyrrhizae Composita—compound mixtures of opium and gylcyrrhiza, U.S.P. XI (brown mixture).—*a. Prepared as follows.*—Fluidextract of glycyrrhiza, 120 cc; antimony and potassium tartrate, 0.24 gm; camphorated tincture of opium, 120 cc; spirit of ethyl nitrite, 30 cc; glycerine, 120 cc; distilled water, a sufficient quantity to make 1,000 cc. Dilute the fluidextract with the glycerine and 500 cc of distilled water, add the antimony and potassium tartrate dissolved in 12 cc of hot distilled water, then add the other ingredients and enough distilled water to make the product measure 1,000 cc.

b. Use.—Expectorant.

c. Average dose.—4 cc.

146. Mistura Rhei Composita—compound mixture of rhubarb, N.F. VI (mixture of rhubarb and soda).—*a. Prepared as follows.*—Fluidextract of rhubarb, 15 cc; fluidextract of ipecac, 3 cc; sodium bicarbonate, 35 gm; spirit of peppermint, 35 cc; glycerine, 200 cc; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the sodium bicarbonate in about 500 cc of water; add the fluidextracts, the glycerine, the spirit of peppermint, and sufficient distilled water to make 1,000 cc; mix thoroughly.

b. Use.—Antacid and carminative.

c. Average dose.—4 cc.

Section VII

MAGMAS

Paragraph
Definition 147
Magma Magnesiae 148

147. Definition.—*a.* Magmas (milks) are aqueous preparations containing inorganic constituents, largely a suspension in a milky or colloidal state.

b. This class of preparations is closely related to mixtures, the chief difference being that magmas contain bulky precipitates of inorganic matter, whereas mixtures contain insoluble organic substances.

148. Magma Magnesiae—magnesia magma, U.S.P. XI (milk of magnesia).—An aqueous suspension of magnesium hydroxide containing not less than 7 percent and not more than 8.5 percent of $Mg(OH)_2$. For purposes of minimizing the action of the glass container on magnesia magma, 0.1 percent of citric acid may be added. One-half cc of a volatile oil or blend of volatile oils, suitable for flavoring purposes, may be added to each 1,000 cc of magnesia magma.

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a. Discussion.—No formula is now included in the U.S.P. as there are various satisfactory methods of preparation and any one of these may be used if the finished product conforms in physical appearance and other characteristics to the finished official specifications.

b. Uses and doses.—Antacid, 4 cc; laxative, 15 cc.

SECTION VIII

LOTIONS

Paragraph
Definition ---- 149
Lotio Calaminae ---- 150
Lotio Calaminae Phenolata ---- 151

149. Definition.—Lotions are liquid preparations, usually containing suspended insoluble matter and applied externally. They differ from mixtures in being designed for external use and from liniments in being aqueous, rather than oleaginous or alcoholic. Lotions containing insoluble material must be dispensed with a "Shake Well" label.

150. Lotio Calaminae—calamine lotion, N.F. VI.—*a. Prepared as follows.*—Prepared calamine, 80 gm; zinc oxide, 80 gm; glycerine, 20 cc; solution of calcium hydroxide (lime water), a sufficient quantity to make 1,000 cc. Triturate the prepared calamine and the zinc oxide with the glycerine and about 100 cc of the lime water until a smooth paste is formed, gradually add, with agitation, enough lime water to make the product measure 1,000 cc.

b. Use.—Externally, in skin diseases.

151. Lotio Calaminae Phenolata—phenolated lotion of calamine, N.F. VI (compound lotion of calamine).—A 1 percent solution of liquefied phenol in calamine lotion.

a. Prepared as follows.—Liquefied phenol, 10 cc; calamine lotion, 990 cc. Mix them.

b. Use.—Externally, in skin diseases.

SECTION IX

GLYCERITES

Paragraph
Definition ---- 152
Glyceritum Acidi Tannici ---- 153
Glyceritum Amyli ---- 154
Glyceritum Phenolis ---- 155

152. Definition.—Glycerites are solutions or partial solutions of medicinal agents in glycerine. Glycerine is very hygroscopic, and all

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these preparations absorb moisture on exposure to air, therefore, they should be preserved in tightly closed containers.

153. Glyceritum Acidi Tannici—glycerite of tannic acid, U.S.P. XI (glycerite of tannin).—*a. Prepared as follows.*—Tannic acid, 20 gm; sodium citrate, 1 gm; glycerine, 79 gm. Dissolve the tannic acid and sodium citrate in the glycerine by rubbing in a porcelain dish and heating to 115° to 120° C. on a sand bath until dissolved.

b. Use.—Astringent, throat swab.

154. Glyceritum Amyli—glycerite of starch, U.S.P. XI.—*a. Prepared as follows.*—Starch, 10 gm; distilled water, 20cc; glycerine, 70 cc. Triturate the starch with the distilled water and add to the glycerine, previously heated to 140° C. Continue heating between 140° and 144° C. until a jelly forms, then strain through muslin. A temperature of 140° to 144° C. is necessary to rupture the starch granules, however, higher temperatures will cause charring.

b. Use.—Pill excipient, basis of enemas.

155. Glyceritum Phenolis—glycerite of phenol, N.F. VI (glycerite of carbolic acid).—*a. Prepared as follows.*—Liquefied phenol, 20 cc; sodium citrate, 1 gm; distilled water, 1 cc; glycerine, 79 cc. Dissolve the sodium citrate in the hot distilled water, and incorporate this solution with the mixture of liquefied phenol and glycerine.

b. Use.—For preparing antiseptic dilutions of phenol.

c. Average dose.—0.3 cc.

Section X

SPIRITS

	Paragraph
Definition	156
Methods of preparation	157
Spiritus Aethylis Nitritis	158
Spiritus Ammoniae Aromaticus	159
Spiritus Anisi	160
Spiritus Aurantii Compositus	161
Spiritus Camphorae	162
Spiritus Chloroformi	163
Spiritus Cinnamomi	164
Spiritus Frumenti	165
Spiritus Glycerylis Trinitratis	166
Spiritus Lavandulae	167
Spiritus Menthae Piperitae	168
Spiritus Menthae Viridis	169
Spiritus Oleorum Volatilium	170
Spiritus Vini Vitis	171

156. Definition.—Spirits are alcoholic solutions of volatile substances. They differ from waters only in the solvent employed.

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Spirits are more concentrated than waters because the substances are more soluble in alcohol than water.

157. Methods of preparation.—*a. Simple solution.*—This process is simply adding and dissolving the medicated substance in alcohol.

b. Solution by maceration.—This method is employed when it is desirable to introduce the coloring matter of the drug into the preparation. The active constituent is a volatile oil and the coloring of the preparation is accomplished by macerating the drug in alcohol.

c. Distillation.—This method is used when the desirable volatile principles which are present in the finished preparation can be vaporized at the temperature of boiling alcohol or diluted alcohol.

d. Chemical reaction.—In this method chemicals are brought together and allowed to react to form the spirit. The U.S.P. XI has omitted the method of preparation of these spirits, so they may be considered as simple solutions.

158. Spiritus Aethylis Nitritis—spirit of ethyl nitrite, U.S.P. XI (sweet spirit of nitre).—An alcoholic solution of ethyl nitrite containing not less than 3.5 percent and not more than 4.5 percent of C_2H_5ONO.

a. Use.—Diaphoretic, diuretic.

b. Average dose.—2 cc.

c. Storage.—Preserve spirit of ethyl nitrite in small, well-filled and tightly stoppered bottles, in a cool, dark place, remote from fire. This product will lose strength very rapidly at room temperature.

159. Spiritus Ammoniae Aromaticus—aromatic spirit of ammonia, U.S.P. XI.—Contains in each 100 cc not less than 1.7 gm and not more than 2.1 gm of total NH_3; and ammonium carbonate, corresponding to not less than 3.5 gm and not more than 4.5 gm, as $(NH_4)_2CO_3$.

a. Prepared as follows.—Ammonium carbonate, in translucent pieces, 34 gm; ammonia water, 90 cc; oil of lemon, 10 cc; oil of lavender, 1 cc; oil of myristica, 1 cc; alcohol, 700 cc; distilled water, a sufficient quantity to make 1,000 cc. Dilute the ammonia water with 140 cc of water, dissolve therein the ammonium carbonate, and let stand 12 hours. Dissolve the oils in the alcohol, then add the carbonate solution and enough water to make 1,000 cc. Let stand 24 hours and filter.

b. Use.—Hyperacidity, stimulant.

c. Average dose.—2 cc.

160. Spiritus Anisi—spirit of anise, U.S.P. XI.—Contains in each 100 cc not less than 9 cc and not more than 11 cc of oil of anise.

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a. Prepared as follows.—Oil of anise, 100 cc; alcohol, a sufficient quantity to make 1,000 cc. Mix them.

b. Use.—Carminative.

c. Average dose.—1 cc.

161. Spiritus Aurantii Compositus—compound spirit of orange, U.S.P. XI.—Contains in each 100 cc not less than 25 cc and not more than 30 cc of the mixed oils.

a. Prepared as follows.—Oil of orange, 200 cc; oil of lemon, 50 cc; oil of coriander, 20 cc; oil of anise, 5 cc; alcohol, a sufficient quantity to make 1,000 cc. Mix them.

b. Use.—Flavoring agent.

162. Spiritus Camphorae—spirit of camphor, U.S.P. XI.—An alcoholic solution containing in each 100 cc not less than 9.2 gm and not more than 10.4 gm of camphor at 25° C.

a. Prepared as follows.—Camphor, 100 gm; alcohol, a sufficient quantity to make 1,000 cc. Dissolve the camphor in about 800 cc of alcohol, and then add enough additional alcohol to make the product measure 1,000 cc. Filter, if necessary.

b. Use.—Sedative, antispasmodic.

c. Average dose.—1 cc.

163. Spiritus Chloroformi—spirit of chloroform. U.S.P. XI.—Contains in each 100 cc not less than 8.5 gm and not more than 9.25 gm of $CHCl_3$ at 25° C.

a. Prepared as follows.—Chloroform, 60 cc; alcohol, a sufficient quantity to make 1,000 cc. Mix them.

b. Use.—Sedative, antiflatulant.

c. Average dose.—2 cc.

d. Storage.—Preserve in well-closed containers, protected from light.

164. Spiritus Cinnamomi—spirit of cinnamon, U.S.P. XI.—Contains in each 100 cc not less than 9 cc and not more than 11 cc of oil of cinnamon.

a. Prepared as follows.—Oil of cinnamon, 100 cc; alcohol, a sufficient quantity to make 1,000 cc. Mix them.

b. Use.—Flavored cordial.

c. Average dose.—1 cc.

165. Spiritus Frumenti—whisky, U.S.P. XI.—An alcoholic liquid obtained by the distillation of the fermented mash of wholly or partly malted cereal grains and containing at 15.56° C. not less than 47 percent and not more than 53 percent, by volume, of C_2H_5OH. It must have been stored in charred wood containers for a period of not less than 4 years. It is used as a stimulant.

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166. Spiritus Glycerylis Trinitratis—spirit of glyceryl trinitrate, U.S.P. XI (spirit of nitroglycerine; spirit of glonoin).—An alcoholic solution containing not less than 1 percent and not more than 1.1 percent of $C_3H_5(NO_3)_3$.

a. Use.—In circulatory disorders.

b. Average dose.—0.06 cc.

c. Caution.—Great care must be exercised in dispensing, handling, packing, transporting, and storing this spirit, since a dangerous explosion may result if any considerable quantity of it is spilled, and the alcohol wholly or partially lost by evaporation. If, through accident, it is spilled, a solution of potassium or sodium hydroxide must be poured over it at once to effect decomposition of the glyceryl trinitrate.

167. Spiritus Lavandulae—spirit of lavender, U.S.P. XI.—Contains in each 100 cc not less than 4 cc and not more than 6 cc of oil of lavender.

a. Prepared as follows.—Oil of lavender, 50 cc; alcohol, a sufficient quantity to make 1,000 cc. Mix them.

b. Use.—Carminative.

c. Average dose.—2 cc.

168. Spiritus Menthae Piperitae—spirit of peppermint, U.S.P. XI (essence of peppermint).—Contains in each 100 cc not less than 9 cc and not more than 11 cc of oil of peppermint.

a. Prepared as follows.—Oil of peppermint, 100 cc; peppermint, in coarse powder, 10 gm; alcohol, a sufficient quantity to make 1,000 cc. Macerate the peppermint leaves with water during 1 hour and then strongly express them. Add the peppermint leaves to 900 cc of alcohol and macerate 6 hours. After filtration add the oil and run through the filter enough alcohol to make 1,000 cc.

b. Use.—Carminative.

c. Average dose.—1 cc.

169. Spiritus Menthae Viridis—spirit of spearmint, U.S.P. XI.—Contains in each 100 cc not less than 9 cc and not more than 11 cc of oil of spearmint.

a. Prepared as follows.—Oil of spearmint, 100 cc; spearmint, in coarse powder, 10 gm; alcohol, a sufficient quantity to make 1,000 cc. The method of manufacture of this preparation is the same as described under spirit of peppermint, using the above ingredients.

b. Use.—Carminative.

c. Average dose.—1 cc.

170. Spiritus Oleorum Volatilium—spirits of volatile oils, N.F. VI.—Spirits of volatile oils for which only the general formula is

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provided. Prepared as follows: The volatile oil, 65 cc; alcohol, a sufficient quantity to make 1,000 cc. Mix them.

171. Spiritus Vini Vitis—brandy, U.S.P. XI.—An alcoholic liquid obtained by the distillation of the fermented juice of sound ripe grapes and containing 15.56° C., not less than 48 percent and not more than 54 percent, by volume, of C_2H_5OH. It must have been stored in wood containers for a period of not less than 4 years. It is used as a stimulant.

SECTION XI

ELIXIRS

	Paragraph
Definition	172
Elixir Amygdalae Compositum	173
Elixir Aromaticum	174
Elixir Bromidorum Trium	175
Elixir Cardamomi Compositum	176
Elixir Ferri, Quininae et Strychninae	177
Elixir Glycyrrhizae	178
Elixir Iso-alcoholicum	179
Elixir Pepsini Compositum	180
Elixir Pepsini et Rennini	181
Elixir Phenobarbitali	182
Elixir Sodii Bromidi	183
Elixir Terpini Hydratis	184
Elixir Terpini Hydratis et Codeinae	185

172. Definition.—Elixirs are aromatic, sweetened, hydroalcoholic liquid preparations, for internal use, sometimes containing active medicinal ingredients. Some elixirs contain no active medicinal ingredient, but are intended for vehicles for the administration of active remedies. Purified talc will assist in clarifying these preparations if added before filtration.

173. Elixir Amygdalae Compositum—compound elixir of almond, N.F. VI.—*a. Prepared as follows.*—Vanillin, 1 gm; oil of bitter almond, 0.5 cc; orange flower water, 150 cc; alcohol, 50 cc; syrup, 400 cc; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the oil of bitter almond and the vanillin in the alcohol; add the syrup, the orange flower water, and sufficient distilled water, in several fractions, shaking the mixture thoroughly after each addition to make the product measure 1,000 cc; then filter until clear.

b. Use.—Flavoring agent and vehicle.

174. Elixir Aromaticum—aromatic elixir, U.S.P. XI (simple elixir).—*a. Prepared as follows.*—Compound spirit of orange, 12 cc; syrup, 375 cc; purified talc, 30 gm; alcohol and distilled water, of each a sufficient quantity to make 1,000 cc. Dissolve the compound spirit of

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orange in 238 cc of alcohol, add the syrup in several portions, agitating after each addition, and in like manner, enough distilled water to make 1,000 cc. Add the talc, and filter until clear.

b. Use.—Flavoring agent and vehicle.

175. Elixir Bromidorum Trium—elixir of three bromides, N.F. VI.—Contains in each 100 cc not less than 23 gm and not more than 25 gm of total bromides.

a. Prepared as follows.—Ammonium bromide, 80 gm; potassium bromide, 80 gm; sodium bromide, 80 gm; solution of amaranth, 3 cc; compound elixir of almond, a sufficient quantity to make 1,000 cc. Dissolve the bromides in 800 cc of compound elixir of almond, add the solution of amaranth and enough compound elixir of almond to make 1,000 cc. Filter until clear.

b. Use.—Nerve sedative.

c. Average dose.—4 cc.

176. Elixir Cardamomi Compositum—compound elixir of cardamom, N.F. VI.—*a Prepared as follows.*—Compound spirit of cardamom, 10 cc; alcohol, 90 cc; syrup, 400 cc; distilled water, a sufficient quantity to make 1,000 cc. Mix the compound spirit of cardamom with the alcohol; add the syrup and enough distilled water, in several portions, shaking after each addition, to make 1,000 cc, allow to stand 24 hours, with occasional shaking, and filter, using talc, if necessary, for clarification.

b. Use.—Flavoring agent and vehicle.

177. Elixir Ferri, Quininae et Strychninae—elixir of iron, quinine and strychnine, N.F. VI (elixir I. Q. & S.).—*a. Prepared as follows.*—Tincture of ferric citrochloride, 125 cc; quinine hydrochloride, 8 gm; strychnine sulfate, 175 mg; compound spirit of orange, 10 cc; alcohol, 240 cc; glycerine, 300 cc; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the quinine hydrochloride in the alcohol, add the compound spirit of orange, then the strychnine sulfate previously dissolved in 10 cc of distilled water. Then add successively the glycerine, the tincture of ferric citrochloride, and enough distilled water to make 1,000 cc; mix well and filter, using 10 gm of talc, if necessary, to clarify the product.

b. Use.—General tonic.

c. Average dose.—4 cc.

d. Caution.—This elixir should not be dispensed if markedly darkened in color.

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178. Elixir Glycyrrhizae—elixir of glycyrrhiza, U.S.P. XI (elixir of licorice; elixir adjuvans).—*a. Prepared as follows.*—Fluidextract of glycyrrhiza, 125 cc; aromatic elixir, 875 cc. Mix and filter.

b. Use.—Flavoring agent and vehicle.

179. Elixir Iso-alcoholicum—iso-alcoholic elixir, N.F. VI (iso-elixir).—Intended to serve as a general vehicle for various medicaments that require solvents of different alcoholic strengths. When, therefore, iso-alcoholic elixir is specified in a prescription, that proportion of its two ingredients is to be used that will produce a perfect solution, "low-alcoholic elixir," and "high-alcoholic elixir," as described below. The alcoholic strength of the iso-alcoholic elixir to be used with a single liquid galenical in a prescription is approximately the same as that of the galenical. When galenicals of different alcoholic strengths are used in the same prescription, the iso-alcoholic elixir to be used will generally be found to be the average of the alcoholic strengths of the several ingredients. For nonextractive substances, the lowest alcoholic strength of the alcoholic elixir that will yield a perfect solution should be chosen.

a. Prepared as follows.—(1) *Iso-alcoholic elixir.*—Low-alcoholic elixir, a certain volume; high-alcoholic elixir, a certain volume; mix them.

(2) *Low-alcoholic elixir.*—Compound spirit of orange, 10 cc; alcohol, 100 cc; glycerine, 200 cc; sucrose, 320 gm; distilled water, a sufficient quantity to make 1,000 cc. Mix the alcohol, glycerine, and 500 cc of distilled water, add the compound spirit of orange, agitate thoroughly from time to time, and let stand 24 hours. Filter, through paper, until clear. Dissolve the sucrose in the filtrate and add enough of the solvent mixture to make 1,000 cc.

(3) *High-alcoholic elixir.*—Compound spirit of orange, 4 cc; saccharin, 3 gm; glycerine, 200 cc; alcohol, a sufficient quantity to make 1,000 cc. Dissolve the compound spirit of orange and the saccharin in 700 cc of alcohol, add the glycerine and sufficient alcohol to make 1,000 cc. Mix and filter.

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b. Table for adjustment of iso-alcoholic elixir.

Low-alcoholic elixir	High-alcoholic elixir	Suitable as vehicle for preparations of the following alcoholic strengths
Volume	*Volume*	*Percent*
1	None	0–10
4	1	10–20
3	1	20–30
2	1	30–40
1	1	40–50
1	2	50–60
1	3	60–70
1	4	70–80
None	1	80–95

c. Use.—Vehicle.

180. Elixir Pepsini Compositum—compound elixir of pepsin, N.F. VI (elixir of lactated pepsin; compound digestive elixir).—Possesses in each 100 cc a proteolytic activity equal to not less than 1.75 gm of reference pepsin.

a. Prepared as follows.—Pepsin, 35 gm; lactic acid, 1 cc; glycerine, 250 cc; alcohol, 200 cc; oil of orange, 2 cc; tincture of cudbear, 10 cc; distilled water, a sufficient quantity to make 1,000 cc. Add the pepsin to 500 cc of cold distilled water containing the lactic acid, and allow to stand in a cool place until the pepsin is thoroughly softened; then stir gently until dissolved, and add the glycerine. Dissolve the oil of orange and the tincture of cudbear in the alcohol and gradually add this solution to the pepsin solution with gentle stirring. Add enough distilled water to make 1,000 cc and filter until clear.

b. Use.—Vehicle.

c. Average dose.—8 cc.

181. Elixir Pepsini et Rennini—elixir of pepsin and rennin, N.F. VI (essence of pepsin).—Possesses in each 100 cc a proteolytic activity equal to not less than 2.25 gm of reference pepsin and a coagulative activity equal to not less than 1.75 gm of reference rennin.

a. Prepared as follows.—Pepsin, 45 gm; rennin, 18 gm; glycerine, 150 cc; alcohol, 165 cc; tincture of sweet orange peel, 50 cc; oil of myristica, 0.1 cc; distilled water, a sufficient quantity to make 1,000 cc. Add the pepsin and the rennin to 500 cc of cold distilled water and allow to stand in a cool place until the pepsin is thoroughly softened; then stir gently until the solids are dissolved and add the glycerine. Dissolve the tincture of sweet orange peel and the oil of myristica in the alcohol, and gradually add to the aqueous solution

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with gentle stirring. Then add enough distilled water to make 1,000 cc. Mix and filter until clear.

b. Use.—Vehicle.

c. Average dose.—8 cc.

182. Elixir Phenobarbitali—elixir of phenobarbital, N.F. VI.—Contains in each 100 cc not less than 0.37 gm and not more than 0.43 gm of phenobarbital.

a. Prepared as follows.—Phenobarbital, 4 gm; tincture of sweet orange peel, 30 cc; tincture of cudbear, 7 cc; alcohol, 175 cc; glycerine, 235 cc; soluble saccharin, 0.6 gm; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the phenobarbital in the alcohol; add the tinctures, the glycerine, the soluble saccharin dissolved in a little distilled water, and enough distilled water to make 1,000 cc. Mix and filter until clear.

b. Use.—Hypnotic and sedative.

c. Average dose.—4 cc.

183. Elixir Sodii Bromidi—elixir of sodium bromide, N.F. VI.—Contains in each 100 cc not less than 17 gm and not more than 18 gm of sodium bromide.

a. Prepared as follows.—Sodium bromide, 175 gm; syrup, 200 cc; distilled water, 460 cc; aromatic elixir, a sufficient quantity to make 1,000 cc. Dissolve the sodium bromide in the distilled water, add the syrup and enough aromatic elixir to make 1,000 cc. Mix and filter until clear.

b. Use.—Nerve sedative.

c. Average dose.—4 cc.

184. Elixir Terpini Hydratis—elixir of terpin hydrate, N.F. VI.—*a. Prepared as follows.*—Terpin hydrate, 17 gm; tincture of sweet orange peel, 20 cc; spirit of bitter almond, 5 cc; alcohol, 425 cc; glycerine, 400 cc; syrup 100 cc; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the terpin hydrate in the alcohol; add successively the tincture, the spirit, the glycerine, the syrup, and sufficient distilled water to make 1,000 cc; mix well and filter until clear.

b. Use.—Expectorant.

c. Average dose.—4 cc.

185. Elixir Terpini Hydratis et Codeinae—elixir terpin hydrate and codeine, NF. V.—*a. Prepared as follows.*—Codeine, 2 gm; elixir terpin hydrate, a sufficient quantity to make 1,000 cc. Dissolve the codeine in the elixir.

b. Use.—Expectorant, cough sedative.

c. Average dose.—4 cc.

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SECTION XII

COLLODIONS

Paragraph
Definition ---- 186
Storage ---- 187
Collodium ---- 188
Collodium Flexile ---- 189

186. Definition.—Collodions are liquid preparations intended for external use, having for their base a solution of pyroxylin in a mixture of ether and alcohol. Collodions are applied to the skin by means of a soft brush, and when the ether and alcohol evaporate, a film is left on the surface which either acts simply as a protection or, in some instances, brings a medicinal agent in contact with the skin.

187. Storage.—Collodions should be stored in tightly closed containers, in a cool place, remote from fire.

188. Collodium—collodion, U.S.P. XI.—*a. Prepared as follows.*—Pyroxylin, 40 gm; ethyl oxide, 750 cc; alcohol, 250 cc. Add the pyroxylin to the alcohol and then add the ether, shake until the pyroxylin is dissolved, allow to stand until clear, and decant the clear liquid.

b. Use.—Protection for small wounds.

189. Collodium Flexile—flexible collodion, U.S.P. XI.—*a. Prepared as follows.*—Camphor, 20 gm; castor oil, 30 gm; collodion, a sufficient quantity to make 1,000 gm. Mix the ingredients and agitate until dissolved.

b. Use.—A flexible protection for small wounds.

SECTION XIII

LINIMENTS

Paragraph
Definition ---- 190
Linimentum Calcis ---- 191
Linimentum Camphorae ---- 192
Linimentum Camphorae et Saponis ---- 193
Linimentum Chloroformi ---- 194
Linimentum Saponis Mollis ---- 195

190. Definition.—Liniments are solutions or mixtures of various substances in oily or alcoholic liquids, intended for external application, usually being applied with friction. As liniments are

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intended for external use, they should be dispensed with a "For External Use" label.

191. Linimentum Calcis—lime liniment, N.F. VI (carron oil).—*a. Prepared as follows.*—Solution of calcium hydroxide, 500 cc; linseed oil, 500 cc. Mix them by agitation.

b. Use.—External application for burns.

192. Linimentum Camphorae—camphor liniment, U.S.P. XI (camphorated oil).—Contains not less than 19 percent and not more than 21 percent of camphor.

a. Prepared as follows.—Camphor (in coarse powder), 200 gm; cottonseed oil, 800 gm. Dissolve the camphor in the cotton seed oil, using heat.

b. Use.—Mild counterirritant.

c. Caution.—This preparation is not intended for hypodermic use.

193. Linimentum Camphorae et Saponis—camphor and soap liniment, U.S.P. XI (soap liniment).—*a. Prepared as follows.*—Hard soap (dried and granulated or powdered), 60 gm; camphor (in small pieces), 45 gm; oil of rosemary, 10 cc; alcohol, 700 cc; distilled water, a sufficient quantity to make 1,000 cc. Dissolve the camphor and the oil of rosemary in the alcohol, add the soap, then enough distilled water to make 1,000 cc. Agitate the mixture until dissolved. Allow to stand for 24 hours and filter. If a soap made from animal oils is used, gelatinization will result.

b. Use.—Mild anodyne and rubefacient.

194. Linimentum Chloroformi—chloroform liniment, U.S.P. XI.—Contains at 25° C. in each 100 cc not less than 40 gm and not more than 45 gm of $CHCl_3$.

a. Prepared as follows.—Chloroform, 300 cc; camphor and soap liniment, 700 cc. Mix them.

b. Use.—Stimulating liniment, local anesthetic in neuralgia.

Caution.—This preparation deteriorates with age.

195. Linimentum Saponis Mollis—liniment of soft soap, U.S.P. XI (tincture of green soap).—*a. Prepared as follows.*—Soft soap, 650 gm; oil of lavender, 20 cc; alcohol, a sufficient quantity to make 1,000 cc. Mix the oil of lavender with 300 cc of alcohol, dissolve in this the soft soap by stirring or by agitation, and set aside for 24 hours. Filter, and add enough alcohol to make 1,000 cc.

b. Use.—Detergent.

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SECTION XIV

OLEATES

Paragraph
Definition 196
Oleatum Hydrargyri 197

196. Definition.—Oleates are liquid preparations of metallic oxides or alkaloids in oleic acid. They produce the physiologic effect of the active ingredient through absorption on application to the skin by inunction.

197. Oleatum Hydrargyri—oleate of mercury, U.S.P. XI.—A solution of mercuric oleate in oleic acid corresponding to not less than 24 percent and not more than 26 percent of HgO.

a. Prepared as follows.—Yellow mercuric oxide, 25 gm; oleic acid, a sufficient quantity to make 100 gm. Mix the yellow mercuric oxide with 75 gm of oleic acid, warm the mixture to a temperature not exceeding 50° C., stir constantly for 5 minutes, and then continue the heat, stirring frequently, until the mercuric oxide is dissolved. Add sufficient oleic acid to make 100 gm and mix thoroughly. Avoid contact with metallic utensils.

b. Use.—Parasiticide.

c. Storage.—Preserve in tightly closed containers, protected from strong light.

SECTION XV

INFUSIONS

Paragraph
Definition 198
Infusa 199
Infusum Digitalis 200

198. Definition.—Infusions are aqueous preparations containing the water soluble principles of vegetable drugs, extracted by the use of hot or cold water. Although the official formulae call for the use of hot water, cold water should be selected as the menstruum when the drug contains a valuable volatile principle, when the active ingredient is injured by heat, or when the desirable principles are readily soluble in water at ordinary temperature. An infusion must never be made from a tincture or fluidextract and should be dispensed only after recent preparation.

199. Infusa—infusions, U.S.P. XI.—A general formula for infusions in which the drug concentration is not otherwise specified.

a. Prepared as follows.—The drug, coarsely comminuted, 50 gm; distilled water, a sufficient quantity to make 1,000 cc. Moisten the

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drug in a suitable vessel, preferably of earthenware and provided with a cover, with 50 cc of cold distilled water and allow it to stand for 15 minutes. Then add 900 cc of boiling distilled water, cover the vessel tightly, and allow it to stand for half an hour. Then strain the mixture and pass enough distilled water through the strainer to make 1,000 cc.

b. Caution.—The drug concentration of an infusion representing a potent drug should be specified by the physician.

200. Infusum Digitalis—infusion of digitalis, N.F. VI.—*a. Prepared as follows.*—Powdered digitalis, 15 gm; alcohol, 100 cc; spirit of cinnamon, 5 cc; distilled water, a sufficient quantity to make 1,000 cc. Pour 900 cc of boiling distilled water upon the powdered digitalis contained in a suitable vessel; cover tightly, and infuse 1 hour in a warm place. Then add the alcohol, in which the spirit of cinnamon has been dissolved; filter, and pass enough distilled water through the residue on the filter to make the product measure, 1,000 cc.

b. Uses.—In various heart and kidney diseases.

c. Average dose.—6 cc.

d. Caution.—Only U.S.P. XI biologically standardized "powdered digitalis" is to be used in this preparation, and the infusion must not be dispensed unless freshly prepared.

SECTION XVI

TINCTURES

	Paragraph
Definition	201
Strength of tinctures	202
Methods of preparation	203
Storage	204
Tinctura Aconiti	205
Tinctura Aurantii Amari	206
Tinctura Aurantii Dulcis	207
Tinctura Balsami Tolutani	208
Tinctura Belladonnae	209
Tinctura Benzoini	210
Tinctura Benzoini Composita	211
Tinctura Cardamomi Composita	212
Tinctura Digitalis	213
Tinctura Gentianae Composita	214
Tinctura Hyoscyami	215
Tinctura Iodi	216
Tinctura Iodi Fortior	217
Tinctura Iodi Mitis	218
Tinctura Lavandulae Composita	219
Tinctura Limonis	220

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	Paragraph
Tinctura Myrrhae	221
Tinctura Nucis Vomicae	222
Tinctura Opii	223
Tinctura Opii Camphorata	224
Tinctura Persionis	225
Tinctura Rhei Aromatica	226
Tinctura Stramonii	227
Tinctura Valerianae	228

201. Definition.—Tinctures are alcoholic or hydro-alcoholic liquid preparations of vegetable or animal drugs or, in a few instances, of chemicals, and so prepared that each tincture contains the therapeutic constituents from a definite quantity of the drug or chemical. Other agents, such as glycerine or hydrochloric acid, may be used in the menstruum to aid in dissolving the active ingredient or to make the tincture stable on standing.

202. Strength of tinctures.—Tinctures of potent drugs are usually made so that each 100 cc of the tincture represents 10 gm of the drug; or the tincture is so adjusted in volume that it contains in each 100 cc the same amount of assayable constituent or constituents as is required in 10 gm of the standard drug. Less potent tinctures are usually made so that 100 cc of the incture represents 20 gm of the drug. Tinctures of fresh drugs are made so that 100 cc of the tincture represents 50 gm of the fresh drug. Compound tinctures are made according to long established formulas.

203. Methods of preparation.—The official processes for the manufacture of tinctures are described below.

a. Process P, by percolation.—(1) Mix the ground drug (or mixed drugs) with a sufficient quantity of the prescribed menstruum to render it evenly and distinctly damp; this usually requires 60 to 80 cc of the menstruum for each 100 gm of the drug. Transfer the dampened drug to a suitable percolator and allow it to stand 15 minutes; then pack it firmly, pour on a sufficient quantity of the menstruum to saturate the drug, and cover the top of the percolator. When the liquid is about to drip from the percolator, close the lower orifice and allow the drug to macerate for about the prescribed period of time. Then, if no assay is directed, proceed with the percolation at the specified rate (for description of rates of flow, see paragraph 67*e*(2)(*d*)) adding fresh menstruum as needed, until a sufficient quantity of the percolate is obtained to make the required amount of tincture, and mix thoroughly.

(2) If the tincture is to be adjusted to a prescribed standard, collect about 95 percent of the percolate that is required for the tincture,

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mix the percolate thoroughly, assay it, and dilute it, if necessary, to the proper volume, as determined by calculation from the assay, using a sufficient quantity of the prescribed menstruum for dilution. Methods of assay for U.S.P. and N.F. tinctures are not included in the scope of this manual. They may be obtained by reference to the respective books.

b. Process M, by maceration.—Macerate the drug (or mixed drugs) in a tightly closed container, in a moderately warm place, with about 75 percent of the prescribed menstruum, agitating frequently for 3 days, or until the soluble matter is dissolved. Transfer the mixture in portions to a filter, and when the liquid has passed through the filter, wash the residue on the filter with enough of the menstruum until a sufficient quantity of the filtrate is obtained to make the required amount of tincture, and mix thoroughly.

c. By solution or dilution.—A few tinctures are made in this way, such as tincture of iodine. It is a simple solution of the substance in the prescribed diluent. The U.S.P. also states that tinctures may be made from official fluidextracts, provided that the tincture, so prepared, corresponds in drug strength, in alcohol content, and in content of other menstruum ingredients, as one prepared directly from the drug by the official process.

204. Storage.—Tinctures should be stored in tightly closed containers at a temperature not exceeding that of normal room conditions, and should not be exposed during storage to direct sunlight.

205. Tinctura Aconiti—tincture of aconite, U.S.P. XI.—When assayed possesses a potency, per cubic centimeter, equivalent to not less than 0.140 mg and not more than 0.160 mg of reference aconitine.

a. Prepared as follows.—Aconite, 100 gm; to make about 1,000 cc of the tincture. Prepare a tincture by process P, as modified for assayed tinctures (par. 203), using a mixture of 3 volumes of alcohol and 1 volume of distilled water. Macerate the drug during 24 hours and then percolate at a moderate rate.

b. Use.—Cardiac sedative.

c. Average dose.—0.6 cc.

206. Tinctura Aurantii Amari—tincture of bitter orange peel, U.S.P. XI.—*a. Prepared as follows.*—Bitter orange peel, 200 gm; to make 1,000 cc of the tincture. Prepare a tincture by process P (par. 203), using a mixture of 2 volumes of alcohol and 1 volume of distilled water as the menstruum. Macerate the drug from 12 to 16 hours, and percolate at a moderate rate.

b. Use.—Adjuvant.

c. Average dose.—4 cc.

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207. Tinctura Aurantii Dulcis—tincture of sweet orange peel, U.S.P. XI.—*a. Prepared as follows.*—Sweet orange peel, the outer yellow rind grated from the fresh fruit, 500 gm; to make 1,000 cc of the tincture. Prepare a tincture by process M (par. 203), macerating the drug in 1,000 cc of alcohol and completing the preparation with alcohol. Use purified cotton as the filtering medium.

b. Use.—Flavoring agent.

c. Average dose.—4 cc.

208. Tinctura Balsami Tolutani—tincture of tolu balsam, U.S.P. XI (tincture of tolu).—*a. Prepared as follows.*—Tolu balsam, 200 gm; to make 1,000 cc of the tincture. Prepare a tincture by process M (par. 203), using alcohol as solvent.

b. Use.—Coating for pills, a balsamic preparation employed as an addition to expectorant mixtures.

c. Average dose.—2 cc.

209. Tinctura Belladonnae—tincture of belladonna, U.S.P. XI.—Yields from each 100 cc not less than 0.027 gm and not more than 0.033 gm of the alkaloids of belladonna leaf.

a. Prepared as follows.—Belladonna leaf, in moderately coarse powder, 100 gm; to make about 1,000 cc of the tincture. Prepare a tincture by process P as modified for assayed tinctures (par. 203), using a mixture of 3 volumes of alcohol and 1 volume of distilled water as the menstruum. Finally adjust the tincture to contain, in each 100 cc, 0.03 gm of the alkaloids of belladonna leaf.

b. Use.—Antispasmodic for the intestinal tract.

c. Average dose.—0.6 cc.

210. Tinctura Benzoini—tincture of benzoin, U.S.P. XI.—*a. Prepared as follows.*—Benzoin, in moderately coarse powder, 200 gm; to make 1,000 cc of the tincture. Prepare a tincture by process M (par. 203), using alcohol as a solvent.

b. Use.—Pill coating, also used in lotions.

c. Average dose.—1 cc.

211. Tinctura Benzoini Composita—compound tincture of benzoin, U.S.P. XI.—*a. Prepared as follows.*—Benzoin, in moderately coarse powder, 100 gm; aloe in moderately coarse powder, 20 gm; storax, 80 gm; tolu balsam, 40 gm; to make 1,000 cc of the tincture. Prepare a tincture by process M (par. 203), using alcohol as a solvent.

b. Use.—In acute laryngitis, by adding to boiling water and inhaling vapors. Also taken on sugar for croup.

c. Average dose.—2 cc.

212. Tinctura Cardamomi Composita—compound tincture of cardamom, U.S.P. XI.—*a. Prepared as follows.*—Cardamom seed,

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in moderately coarse powder 20 gm; cinnamon, in fine powder, 25 gm; caraway in moderately coarse powder, 12 gm; cochineal, in fine powder, 5 gm. Prepare a tincture by process M (par. 203), macerating the mixed powders in 750 cc of a mixture of 50 cc of glycerine and 950 cc of diluted alcohol, and completing the preparation by using first the remainder of the mixture prepared as directed above, and then diluted alcohol.

b. Use.—Carminative, vehicle.

c. Average dose.—4 cc.

213. Tinctura Digitalis—tincture of digitalis, U.S.P. XI.—The potency of tincture of digitalis should be such that 1 cc of the tincture, when assayed, as directed in the U.S.P., will possess an activity equivalent to not less than 1 and not more than 1.1 U.S.P. digitalis units.

a. Prepared as follows.—Digitalis, in fine powder 100 gm; to make about 1,000 cc of the tincture. Prepare a tincture by process P, as modified for assayed tinctures (par. 203), using a mixture of 4 volumes of alcohol and 1 volume of distilled water as the menstruum. Adjust the volume of the finished tincture to conform to the required biological standard.

b. Use.—Stimulant in acute circulatory failure, cardiac tonic in heart disease.

c. Average dose.—1 cc.

214. Tinctura Gentianae Composita—compound tincture of gentian, U.S.P. XI.—*a. Prepared as follows.*—Gentian, in moderately coarse powder, 100 gm; bitter orange peel, in moderately coarse powder, 40 gm; cardamon seed, in moderately coarse powder, 10 gm; to make 1,000 cc of the tincture. Prepare a tincture by process P (par. 203), packing the mixed drugs lightly and using a mixture of 100 cc of glycerine, 500 cc of alcohol, and 400 cc of distilled water as the first menstruum, and completing the percolation with diluted alcohol. Macerate the drugs from 12 to 16 hours and then percolate at a moderate rate.

b. Use.—Bitter tonic.

c. Average dose.—4 cc.

215. Tinctura Hyoscyami—tincture of hyoscyamus, U.S.P. XI (tincture of henbane).—Yields from each 100 cc not less than 0.0034 gm and not more than 0.0046 gm of the alkaloids of hyoscyamus.

a. Prepared as follows.—Hyoscyamus, in moderately coarse powder, 100 gm; to make about 1,000 cc of the tincture. Prepare a tincture by process P as modified for assayed tinctures (par. 203), using a mixture of 3 volumes of alcohol and 1 volume of distilled water as the men-

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struum. Finally adjust the tincture to contain in each 100 cc, 0.0040 gm of the alkaloids of hyoscyamus.

b. Use.—Urinary sedative.

c. Average dose.—2 cc.

216. Tinctura Iodi—tincture of iodine, U.S.P. XI.—An alcoholic solution of iodine and potassium iodide containing in each 100 cc not less than 6.5 gm and not more than 7.5 gm of I, and not less than 4.5 gm and not more than 5.5 gm of KI.

a. Prepared as follows.—Iodine, 70 gm; potassium iodide, 50 gm; distilled water, 50 cc; alcohol, a sufficient quantity to make 1,000 cc. Dissolve the potassium iodide in the distilled water, add the iodine, and agitate until solution is effected. Then add sufficient alcohol to make 1,000 cc and mix thoroughly.

b. Use.—Externally as a germicide; internally for the therapeutic effect of iodine.

c. Average dose.—0.1 cc.

217. Tinctura Iodi Fortior—stronger tincture of iodine, N.F. VI (Churchill's tincture of iodine).—An alcoholic solution of iodine and potassium iodide, and yields from each 100 cc not less than 16 gm and not more than 17 gm of I, and not less than 3 gm and not more than 4 gm of KI.

a. Prepared as follows.—Iodine, 165 gm; potassium iodide, 35 gm; water, 250 cc; alcohol, a sufficient quantity to make 1,000 cc. Dissolve the potassium iodide in the water, add the iodine and 600 cc of alcohol, and agitate the mixture frequently until the iodine is completely dissolved. Then add enough alcohol to make 1,000 cc and mix well.

b. Use.—Externally as a strong germicide.

218. Tinctura Iodi Mitis—mild tincture of iodine, U.S.P. XI.—Contains in each 100 cc not less than 1.8 gm and not more than 2.2 gm of I, and not less than 2.1 gm and not more than 2.5 gm of NaI.

a. Prepared as follows.—Iodine, 20 gm; sodium iodide, 23 gm; diluted alcohol, a sufficient quantity to make 1,000 cc. Dissolve the iodine and sodium iodide in enough diluted alcohol to make 1,000 cc.

b. Use.—Externally as an antiseptic and germicide. This preparation is not as irritating as tincture of iodine.

219. Tinctura Lavandulae Composita—compound tincture of lavender, U.S.P. XI (compound spirit of lavender).—*a. Prepared as follows.*—Oil of lavender, 8 cc; oil of rosemary, 2 cc; cinnamon, in moderately coarse powder, 20 gm; clove, in moderately coarse powder, 5 gm; myristica, in moderately coarse powder, 10 gm; red saunders, in moderately coarse powder, 10 gm; to make 1,000 cc of the tincture. Prepare a tincture by process M (par. 203), macerating the mixed pow-

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ders in a mixture of 750 cc of alcohol, in which the oils have been dissolved, and 250 cc of distilled water. Complete the preparation with a menstruum of 3 volumes of alcohol and 1 volume of distilled water.

b. Use.—Antiflatulent.

c. Average dose.—2 cc.

220. Tinctura Limonis—tincture of lemon, U.S.P. XI.—*a. Prepared as follows.*—Lemon peel, the outer yellow rind grated from the fresh fruit, 500 gm; to make 1,000 cc of the tincture. Prepare a tincture by process M (par. 203), macerating the drug in 1,000 cc of alcohol, and completing the preparation with alcohol. Use purified cotton as the filtering medium.

b. Use.—Flavoring agent.

221. Tinctura Myrrhae—tincture of myrrh, U.S.P. XI.—*a. Prepared as follows.*—Myrrh, in moderately coarse powder, 200 gm; to make 1,000 cc of the tincture. Prepare a tincture by process M (par. 203), using alcohol as the solvent.

b. Use.—Astringent, largely in mouthwashes.

c. Average dose.—2 cc.

222. Tinctura Nucis Vomicae—tincture of nux vomica, U.S.P. XI.—Yields from each 100 cc not less than 0.108 gm and not more than 0.120 gm of strychnine.

a. Prepared as follows.—Nux vomica, in moderately coarse powder, 100 gm; to make about 1,000 cc of the tincture. Prepare a tincture by process P, as modified for assayed tinctures (par. 203). Macerate the drug during 24 hours in a mixture of 7.5 cc of hydrochloric acid, 150 cc of alcohol, and 42.5 cc of distilled water; then percolate slowly, using a mixture of 3 volumes of alcohol and 1 volume of distilled water as the menstruum. Adjust the volume of the finished tincture by the addition of enough of a mixture of 0.75 cc of hydrochloric acid, 75 cc of alcohol, and 24.25 cc of distilled water to make each 100 cc contain 0.114 gm of strychnine. Cool to a temperature of 5° C. for half an hour and filter.

b. Use.—Stimulant, bitter tonic.

c. Average dose.—1 cc.

223. Tinctura Opii—tincture of opium, U.S.P. XI (laudanum, tincture of deodorized opium).—Yields from each 100 cc not less than 0.95 gm and not more than 1.05 gm of anhydrous morphine.

a. Prepared as follows.—Granulated opium, 100 gm; to make about 1,000 cc of the tincture. Pour 500 cc of boiling water upon the opium and stir frequently during 24 hours; percolate slowly with water to exhaustion; concentrate the percolate, on a water bath, to 400 cc;

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then boil the percolate for 15 minutes and allow to stand overnight. Heat to 80°C. and add 50 gm of paraffin, warming the mixture until the paraffin melts. Beat the mixture and, after cooling, remove the paraffin cake and filter, adding sufficient distilled water to make 750 cc. Add 188 cc of alcohol and assay. Dilute the liquid with a mixture of 1 volume of alcohol and 4 volumes of water, as required to produce a tincture containing 1 gm of anhydrous morphine in each 100 cc.

b. Use.—Somnifacient, anodyne.

c. Average dose.—0.6 cc.

224. Tinctura Opii Camphorata—camphorated tincture of opium, U.S.P. XI (paregoric).—Yields from each 100 cc not less than 0.035 gm and not more than 0.045 gm of anhydrous morphine.

a. Prepared as follows.—Tincture of opium, 40 cc; oil of anise, 4 cc; benzoic acid, 4 gm; camphor, 4 gm; to make 1,000 cc of the tincture. Dissolve the ingredients in 900 cc of diluted alcohol, add 40 cc of glycerine, and then enough diluted alcohol to make 1,000 cc. Agitate and filter.

b. Use.—Mild anodyne and sedative.

c. Average dose.—4 cc.

225. Tinctura Persionis—tincture of cudbear, N.F. VI.—*a. Prepared as follows.*—Cudbear, in fine powder, 100 gm; to make 1,000 cc of the tincture. Mix the cudbear with about twice its weight of clean sand and prepare a tincture by process P (par. 203), using as a menstruum, a mixture of 3 volumes of alcohol and 1 volume of water. Macerate 24 hours and percolate slowly. Adjust the tincture so that its color equals the standard color solution.

b. Use.—Coloring agent.

226. Tinctura Rhei Aromatica—aromatic tincture of rhubarb, U.S.P. XI.—*a. Prepared as follows.*—Rhubarb, in moderately coarse powder, 200 gm; cinnamon, in moderately coarse powder, 40 gm; clove, in moderately coarse powder, 40 gm; myristica, in moderately coarse powder, 20 gm; to make 1,000 cc of the tincture. Prepare a tincture by process P (par. 203), using a mixture of 100 cc of glycerine, 500 cc of alcohol, and 400 cc of distilled water as the first menstruum, and completing the percolation with diluted alcohol. Macerate the drug during 4 hours and then percolate it rapidly.

b. Use.—In preparing compound syrup of rhubarb.

c. Average dose.—4 cc.

227. Tinctura Stramonii—tincture of stramonium, U.S.P. XI.—Yields from each 100 cc not less than 0.022 gm and not more than 0.028 gm of the alkaloids of stramonium.

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a. Prepared as follows.—Stramonium, in moderately coarse powder, 100 gm, to make about 100 cc of the tincture. Prepare a tincture by process P, as modified for assayed tinctures (par. 203), using a mixture of 3 volumes of alcohol and 1 volume of distilled water as the menstruum. Percolate at a moderate rate. Finally, adjust the tincture to contain in each 100 cc, 0.025 gm of the alkaloids of stramonium.

b. Use.—Antispasmodic.

c. Average dose.—0.75 cc.

228. Tinctura Valerianae—tincture of valerian, U.S.P. XI.—*a. Prepared as follows.*—Valerian, in moderately coarse powder, 200 gm; to make 1,000 cc of the tincture. Prepare a tincture by process P (par. 203), using a mixture of 3 volumes of alcohol and 1 volume of distilled water as the menstruum. Percolate at a moderate rate.

b. Use.—Nerve sedative.

c. Average dose.—4 cc.

SECTION XVII

FLUIDEXTRACTS

	Paragraph
Definition	229
Methods of preparation	230
Storage	231
Fluidextractum Cascarae Sagradae	232
Fluidextractum Cascarae Sagradae Aromaticum	233
Fluidextractum Ergotae	234
Fluidextractum Eriodictyi	235
Fluidextractum Glycyrrhizae	236
Fluidextractum Ipecacuanhae	237
Fluidextractum Rhei	238
Fluidextractum Sarsaparillae	239
Fluidextractum Sennae	240
Fluidextractum Zingiberis	241

229. Definition.—Fluidextracts are liquid preparations of vegetable drugs, containing alcohol as a solvent or preservative, and so prepared that each 1 cc of the fluidextract contains the therapeutic constituents of 1 gm of the drug; if the drug is an assayed one, the fluidextract made from it is so adjusted in volume that it contains in each 100 cc the same quantity of assayable constituent or constituents as is required in each 100 gm of the drug. Methods of assay for U.S.P. and N.F. fluidextracts are not included in the scope of this manual. They may be obtained by reference to the respective books.

230. Methods of preparation.—The official fluidextracts are made by the process of percolation, the menstruum and the rate of flow (par. 67*e*(2)(*d*)) to be used being specified in each case. The

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manufacture by the usual process calls for a concentration of the weaker percolate by distillation in a vacuum distillation apparatus, the temperature of the still being kept below 60° C. The four official processes for the manufacture of fluidextracts are described below.

a. Process A.—(1) This process is used for preparing fluidextracts which are made with menstrua of alcohol or mixtures of alcohol and water by ordinary percolation.

(2) Carefully mix 1,000 gm of ground drug with a sufficient quantity of the prescribed menstruum to render it evenly and distinctly damp. This usually requires from 600 cc to 800 cc of menstruum. Allow the dampened drug to stand for about 15 minutes, then pack it firmly in a suitable percolator, and pour on sufficient menstruum to saturate the drug and leave a stratum above. When the liquid is about to drop from the percolator, close the lower orifice, cover the percolator, and allow the drug to macerate for about the prescribed period of time. Then proceed with the percolation at the specified rate, adding fresh menstruum as needed until the drug is exhausted of its active principles. Reserve the first 850 cc of percolate (unless otherwise directed in the formula), recover the alcohol from the percolate subsequently collected, and concentrate the residue to a soft extract at a temperature not exceeding 60° C. Dissolve this extract in the reserved percolate, and, if no assay is directed, add enough of the menstruum to make the fluidextract measure 1,000 cc, and mix thoroughly. In case the fluidextract being prepared is to be adjusted to a standard, assay a portion of the reserved percolate in which the soft extract has been dissolved, and dilute the remainder to the volume determined as necessary by calculation from the assay, using a sufficient quantity of the prescribed menstruum as the diluent. Mix the product well.

b. Process B.—(1) This process is used in preparing fluidextracts, the menstrua for which contain, in addition to alcohol, or a mixture of alcohol and distilled water, definite quantities of other components such as an acid or glycerine, the two menstrua being successively employed.

(2) Prepare 1,000 cc of menstruum I, containing the special ingredient, and mix 1,000 gm of the ground drug with a sufficient quantity of this menstruum to render it evenly and distinctly damp. From 600 cc to 800 cc of menstruum is usually required. Allow the dampened drug to stand for about 15 minutes, then pack it firmly in a suitable percolator, and pour on the remainder of menstruum I. When the liquid is about to drop from the percolator, close the lower orifice, cover the percolator, and allow the drug to macerate for

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about the prescribed period of time. Then proceed with the percolation at the specified rate and, when the first menstruum has disappeared from the surface of the drug, use menstruum II, as needed, until the drug is exhausted of its active principles. Reserve the first 850 cc of percolate, recover the alcohol from the percolate subsequently collected, and evaporate the residue to a soft extract at a temperature not exceeding 60° C. Dissolve this extract in the reserved percolate, and, if no assay is directed, add enough of menstruum II to make the fluidextract measure 1,000 cc, and mix thoroughly. In case the fluidextract being prepared is to be adjusted to a standard, assay a portion of the reserved percolate in which the soft extract has been dissolved, and dilute the remainder to the volume determined as necessary by calculation from the assay, using a sufficient quantity of menstruum I as the diluent. Mix the product well.

(3) The precipitation experienced heretofore when the evaporated weak percolate was added to the reserved portion is considerably diminished by causing the former to be evaporated to a soft extract. This precipitation, formerly noticed more particularly in alcoholic fluidextracts, was due to the volatility of the alcohol in the weak percolates, which, when evaporated, left the residue to a great extent aqueous; when this residue was added to the strongly alcoholic reserved portion, a precipitation of resinous and frequently of active matter took place, which necessitated the storing of the fluidextract until precipitation ceased, and subsequent filtration. This is almost altogether avoided by evaporating to a soft extract, and the loss of activity through precipitation is thus greatly diminished.

(4) The argument is frequently advanced that the application of heat is detrimental to solutions of organic principles, that it dissociates some, and always proves injurious to the desirable constituents, *and that no heat whatever should be used in making fluidextracts;* these views are undoubtedly correct, when considered in connection with a few special cases, but do not apply with any practical force to the moderate use of heat where recommended by the official processes upon that portion of the percolate which represents the least active and least desirable constituents of the drug, for from seven-tenths to nine-tenths of the whole amount of percolate (frequently representing 95 percent of the activity of the drug) is reserved and is not subjected to heat at all. The official process of "fractional percolation" may, however, be applied to any fluidextract directed to be made by type process A, and by this method the application of all heat is avoided. This process will now be considered.

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c. Process C—fractional or divided percolation.—(1) This process is used for preparing fluidextracts, the constituents of which are injured by heat, or as a desirable alternative for processes A or B, or in case suitable facilities for distillation and concentration are lacking. When process B is adapted to process C, menstruum I only is used throughout the percolation.

(2) Divide 1,000 gm of the ground drug into three portions, consisting of 500 gm, 300 gm, and 200 gm. Mix the first portion (500 gm) with sufficient of the prescribed menstruum to render it evenly and distinctly damp, transfer the dampened powder to a suitable percolator, the capacity of which should not greatly exceed the bulk of the moist drug when packed firmly, and allow it to stand for about 15 minutes. Then pack the drug in the percolator, saturate it with the menstruum, and allow it to macerate for about the prescribed period of time. Then proceed with the percolation, first collecting and reserving 200 cc of percolate, and afterward collecting five successive portions of percolate of 300 cc each, numbering them in the order in which they are obtained.

(3) Dampen the second portion (300 gm) of the drug with a sufficient quantity of the first of the 300-cc portions of percolate from the preceding lot of drug, and carry out the percolation as just directed for the first lot, except that the five 300-cc portions of percolate from the first lot of drug shall first be used as menstruum, in the order in which they were received, followed, if necessary, by sufficient fresh menstruum to supply the following portions of percolate: Reserve the first 300 cc of percolate and then collect five successive portions of 200 cc each, numbering them in the order in which they are collected.

(4) Now dampen the third portion (200 gm) of the drug with a sufficient quantity of the first numbered portion of percolate from the second lot of drug, and proceed with the percolation as before, using as the menstruum the successive 200-cc portions of percolate from the second lot of drug in the order received. If no assay is directed, collect and reserve 500 cc of percolate. Mix the three reserved percolates from the three lots of drugs to make 1,000 cc of fluidextract.

(5) If the fluidextract being prepared by process C is to be adjusted to a standard, collect and reserve only 420 cc of percolate from the third portion of drug instead of the 500 cc directed above. Mix the three reserved percolates from the three lots of drug and assay a portion of the mixture; dilute the remainder to the volume determined as necessary by calculation from the assay, using as the

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diluent a sufficient quantity of menstruum of the same alcoholic strength as the original. Mix the product well.

d. Process D.—(1) This process is used for preparing fluidextracts with boiling distilled water as the menstruum, alcohol being added as a preservative to the concentrated percolate.

(2) To 1,000 gm of the coarsely ground drug add about 3,000 cc of boiling distilled water, mix well, and allow it to macerate in a suitable covered metallic percolator for 2 hours. Then allow the percolation to proceed at the specified rate, gradually adding boiling distilled water until the drug is exhausted. Evaporate the percolate on a water bath to the volume specified, cool, add the alcohol, and allow the mixture to stand in a stoppered container for 7 days. Then decant the clear liquid, filter the remainder into the decanted liquid, and wash the residue on the filter with a sufficient quantity of a mixture of alcohol and distilled water, of the same alcoholic strength as the filtered liquid, to make the fluidextract measure 1,000 cc. Mix the products well.

231. Storage.—Preserve fluidextracts in tightly closed containers and protect from direct sunlight or abnormal temperature.

232. Fluidextractum Cascarae Sagradae—fluidextract of cascara sagrada, U.S.P. XI (fluidextract of rhamnus purshiana).—*a. Prepared as follows.*—Cascara sagrada, in coarse powder, 1,000 gm; to make 1,000 cc of the fluidextract. Prepare a fluidextract by process D (par. 230). Evaporate the aqueous percolate until it measures 750 cc, and, when it is cold, gradually add 250 cc of alcohol and, if necessary, enough distilled water to make 1,000 cc.

b. Use.—Cathartic.

c. Average dose.—1 cc.

233. Fluidextractum Cascarae Sagradae Aromaticum—aromatic fluidextract of cascara, U.S.P. XI (aromatic fluidextract of rhamnus purshiana).—*a. Prepared as follows.*—Cascara sagrada, in coarse powder, 1,000 gm; magnesium oxide, 120 gm; pure extract of glycyrrhiza, 40 gm; saccharin, 2 gm; oil of anise, 0.65 cc; oil of coriander, 0.15 cc; methyl salicylate, 0.1 cc; alcohol, 200 cc; distilled water, a sufficient quantity to make 1,000 cc. Thoroughly mix the cascara sagrada with the magnesium oxide, moisten it uniformly with 2,000 cc of boiling distilled water, and set it aside in a shallow container for 48 hours, stirring it occasionally. Then pack it in a metallic percolator and percolate with boiling distilled water until the drug is exhausted. Evaporate the percolate, at a temperature not exceeding 100° C., to 750 cc, and while yet warm, dissolve in it the pure extract of glycyrrhiza. When cold, add the alcohol, in which the saccharin,

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methyl salicylate, and oils have been dissolved, and finally enough distilled water to make 1,000 cc.

b. Use.—Cathartic.

c. Average dose.—2 cc.

234. Fluidextractum Ergotae—fluidextract of ergot, U.S.P. XI (extractum secalis cornuti fluidum acidum, P.I.).—When assayed, possesses a potency, per cc, equivalent to not less than 0.5 gm of ergotoxine ethanesulfonate.

a. Prepared as follows.—Ergot recently ground and in coarse powder, 1,000 gm; purified petroleum benzin, a sufficient quantity. Pack the ergot in a cylindrical percolator, and slowly percolate with purified petroleum benzin until a few drops of the percolate leave no greasy stain when evaporated from filter paper. Reject the benzin solution, remove the drug from the percolator, and dry the drug by exposure to the air. Then proceed to make a fluidextract by process C (par. 230), using a menstruum consisting of 2 volumes of hydrochloric acid and 98 volumes of diluted alcohol, and obtaining 1,000 cc of finished fluidextract.

b. Use.—Ecbolic, also used to check uterine hemorrhage.

c. Average dose.—2 cc.

235. Fluidextractum Eriodictyi—fluidextract of eriodictyon, U.S.P. XI (fluidextract of yerba santa).—*a. Prepared as follows.*—Eriodictyon, in moderately coarse powder, 1,000 gm; to make 1,000 cc of the fluidextract. Prepare a fluidextract by process A (par. 230), using a mixture of 4 volumes of alcohol and 1 volume of distilled water as the menstruum. Macerate the drug during 48 hours, then percolate at a moderate rate, and reserve the first 800 cc of the percolate.

b. Use.—In flavoring syrups, expectorant.

c. Average dose.—1 cc.

236. Fluidextractum Glycyrrhizae—fluidextract of glycyrrhiza, U.S.P. XI (fluidextract of licorice root).—*a. Prepared as follows.*—Glycyrrhiza, in coarse powder, 1,000 gm; to make 1,000 cc of the fluidextract. Prepare a fluidextract by process D (par. 230), percolating at a moderate rate. Add enough ammonia water to the aqueous percolate to impart a distinctly ammoniacal odor, then boil the liquid actively under normal atmospheric pressure until it is reduced to a volume of about 1,500 cc. Filter the liquid, evaporate the filtrate on a water bath until the residue measures 750 cc, and gradually add 250 cc of alcohol and enough distilled water to make 1,000 cc. Mix thoroughly.

b. Use.—Flavoring agent.

c. Average dose.—2 cc.

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237. Fluidextractum Ipecacuanhae—fluidextract of ipecac, U.S.P. XI.—Yields from each 100 cc not less than 1.8 gm and not more than 2.2 gm of the ether-soluble alkaloids of ipecac.

a. Prepared as follows.—Ipecac, in fine powder, 1,000 gm; to make 1,000 cc of the fluidextract. Exhaust the ipecac by percolation, using a mixture of 3 volumes of alcohol and 1 volume of distilled water as the menstruum, macerating 72 hours and percolating slowly. Reduce the entire percolate to a volume of 1,000 cc by evaporation at a temperature not exceeding 60° C., and add 2,000 cc of distilled water. Allow the mixture to stand overnight, and evaporate the filtrate to a volume of 565 cc. To this add 35 cc of hydrochloric acid and 300 cc of alcohol, mix well, and filter. A portion of this is then assayed and adjusted so that each 100 cc contains 2.0 gm of the ether-soluble alkaloids of ipecac.

b. Uses and doses.—Expectorant, 0.06 cc; emetic, 1 cc.

238. Fluidextractum Rhei—fluidextract of rhubarb, N.F. VI.—*a. Prepared as follows.*—Rhubarb, in moderately coarse powder, 1,000 gm; to make 1,000 cc of the fluidextract. Prepare a fluidextract by process A (par. 230), using a mixture of 4 volumes of alcohol and 1 volume of water as the menstruum. Macerate the drug during 12 hours, and percolate rapidly.

b. Use.—Cathartic.

c. Average dose.—1 cc.

239. Fluidextractum Sarsaparillae—fluidextract of sarsaparilla, U.S.P. XI.—*a. Prepared os follows.*—Sarsaparilla, in coarse powder, 1,000 gm, to make 1,000 cc of the fluidextract. Prepare a fluidextract by process A (par. 230), using diluted alcohol as the menstruum. Macerate the drug during 48 hours and percolate at a moderate rate.

b. Use.—Flavoring agent.

c. Average dose.—2 cc.

240. Fluidextractum Sennae—fluidextract of senna, U.S.P. XI.—*a. Prepared as follows.*—Senna, in coarse powder, 1,000 gm; to make 1,000 cc of the fluidextract. Prepare a fluidextract by process A (par. 230), using a mixture of 1 volume of alcohol and 2 volumes of distilled water as the menstruum. Macerate the drug for 24 hours, then percolate at a moderate rate and reserve the first 800 cc of percolate.

b. Use.—Cathartic.

c. Average dose.—2 cc.

241. Fluidextractum Zingiberis—fluidextract of ginger, U.S.P. XI.—Contains in each 100 cc not less than 4.5 gm of the ether-soluble extractive.

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a. Prepared as follows.—Ginger, in moderately coarse powder, 1,000 gm; to make 1,000 cc of the fluidextract. Prepare a fluidextract by process A (par. 230), using a mixture of 9 volumes of alcohol and 1 volume of distilled water as the menstruum. Macerate the drug overnight and percolate at a moderate rate.

b. Use.—Carminative.

c. Average dose.—0.6 cc.

Section XVIII

OLEORESINS

	Paragraph
Definition	242
Method of preparation	243
Oleoresina Aspidii	244

242. Definition.—Pharmaceutic oleoresins are liquid preparations of drugs, containing volatile oils and resins, obtained by percolation of such drugs with acetone, ether, or alcohol, and subsequent distillation of the solvent from dissolved oleoresins. The one official oleoresin in the Pharmacopoeia directs the use of ether. The strength of oleoresins is uncertain, inasmuch as different samples of the same drug may contain entirely different amounts of their oleoresinous constituent. They do, however, represent the most concentrated form of liquid pharmaceuticals.

243. Method of preparation.—Oleoresins are prepared by percolating the powdered drug contained in a cylindrical percolator, provided with a cover and a receptacle suitable for volatile liquids, with the menstruum directed until exhausted, recovering the greater part of the liquid by distillation, and exposing the residue in a shallow dish to spontaneous evaporation until the remaining solvent has evaporated.

244. Oleoresina Aspidii—oleoresin of aspidium, U.S.P. XI (oleoresin of male fern).—Yields not less than 24 percent of crude filicin.

a. Prepared as follows.—Aspidium, reduced to coarse powder, 500 gm; ether, a sufficient quantity. Prepare the oleoresin as described in paragraph 243.

NOTE.—Ether is very inflammable, so care should be used in manufacturing this preparation that the vapors do not come in contact with open flame.

b. Use.—Tenifuge.

c. Average dose.—Caution: Single dose, once a day, 4 gm; followed in a few hours by a *saline* cathartic.

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SECTION XIX

EXTRACTS

	Paragraph
Definition	245
Forms of extracts	246
Method of preparation	247
Storage	248
Extractum Belladonnae	249
Extractum Cascarae Sagradae	250
Extractum Fellis Bovis	251
Extractum Glycyrrhizae	252
Extractum Glycyrrhizae Purum	253
Extractum Hepatis	254
Extractum Hyoscyami	255
Extractum Malti	256
Extractum Rhei	257
Extractum Stramonii	258

245. Definition.—Extracts are concentrated preparations of vegetable or animal drugs obtained by extracting the active constituents of the respective drugs with suitable menstrua, evaporating all or nearly all of the solvent, and adjusting the residual masses or powders to the prescribed standards.

246. Forms of extracts.—Extracts are made in two forms: Plastic masses known as "pilular extracts," and dry powders, known as "powdered extracts." The two forms of any one extract are interchangeable medicinally, but each has its pharmaceutical advantages. The pilular extracts are preferred for use in ointments, pills, and suppositories because the mass also acts as an excipient and a very fine powder cannot always be obtained from the powdered extracts. The powdered extracts are used for making dry preparations, such as capsules and powders.

247. Method of preparation.—*a.* In the manufacture of extracts, the drugs are extracted by percolation (par. 67*e*). The entire percolates are concentrated by distillation under reduced pressure, with few exceptions, in order to expose the drug principles to as little heat as possible. If the active principles of the drug are damaged by high temperatures or by prolonged heating, the temperature at which its percolate is concentrated is not to exceed 60° C. at any stage.

b. Extracts which must be adjusted to prescribed standards may need diluents for that purpose. While the Pharmacopoeia directs that glucose be used in pilular extracts, and starch dried at 100° C. in powdered extracts, other diluents may be used. The scope of

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this manual does not include methods of assays for extracts, however, they may be obtained by reference to the respective books. Powdered extracts which are made from drugs that contain a material amount of inactive oily or fatty matter should have this removed in order to obtain a satisfactory product. This is usually done by mixing petroleum benzin with the extract, just before assay, stirring well, and discarding the benzin in which the oils and fats have been dissolved. This process may be repeated in order to obtain a more highly defatted extract.

248. Storage.—Extracts should be stored in tightly closed containers at a temperature not exceeding normal conditions, and should not be exposed during storage to direct sunlight.

249. Extractum Belladonnae—extract of belladonna, U.S.P. XI (extractum belladonnae foliorum).—Yields from each 100 gm not less than 1.15 gm and not more than 1.35 gm of the alkaloids of belladonna leaf.

a. Prepared as follows.—(1) *Pilular extract.*—Prepare an extract by percolating 1,000 gm of belladonna leaf, using a mixture of 3 volumes of alcohol and 1 volume of distilled water as the menstruum. Macerate the drug during 16 hours and then percolate it at a moderate rate. Evaporate the percolate to a pilular consistency under reduced pressure and at a temperature not exceeding 60° C., and adjust the remaining extract, after assaying, by dilution with glucose, so that the finished extract will contain 1.25 gm of the alkaloids of belladonna in each 100 gm.

(2) *Powdered extract.*—Prepare an extract by percolating 1,000 gm of belladonna leaf, using alcohol as the menstruum. Macerate the drug during 16 hours, and then percolate it slowly. Evaporate the percolate to a soft extract under reduced pressure and at a temperature not exceeding 60° C., add 50 gm of dry starch, and continue the evaporation, at the same temperature, until the product is dry. Powder the residue. Remove the fat as described in paragraph 247, assay, and add sufficient starch, dried at 100° C., to make the finished extract contain in each 100 gm, 1.25 gm of the alkaloids of belladonna leaf. Pass through a fine sieve.

b. Use.—Antispasmodic of the intestinal tract.

c. Average dose.—0.015 gm.

250. Extractum Cascarae Sagradae—extract of cascara sagrada, U.S.P. XI (extract of rhamnus purshiana).—Represents, in each 1 gm, 3 gm of cascara sagrada.

a. Prepared as follows.—Mix 900 gm of cascara sagrada, in coarse powder, with 4,000 cc of boiling distilled water, and macerate the

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mixture during 3 hours. Then percolate the drug, in a metal percolator, to exhaustion, using boiling distilled water as the menstruum and collecting about 5,000 cc of the percolate. Evaporate the percolate to dryness on a steam bath, powder it, and add enough dried starch to make 300 gm. Mix and pass through a fine sieve.

b. Use.—Cathartic.

c. Average dose.—0.3 gm.

251. Extractum Fellis Bovis—extract of ox bile, U.S.P. XI (powdered extract of ox gall).—Represents, in each 1 gm, 8 gm of ox bile.

a. Prepared as follows.—Evaporate 800 gm of ox bile to a volume of 200 cc and slowly add 500 cc of alcohol with constant stirring. Allow to stand for 24 hours, with occasional stirring, then decant the clear liquid. Mix the residue with 250 cc of alcohol, filter, and wash the filter with 250 cc of alcohol. Combine the alcoholic solutions, filter, if necessary, and evaporate it to dryness at a temperature not exceeding 80° C. Powder the residue and mix it with enough dried starch to make 100 gm.

b. Use.—To replace or augment hepatic secretions.

c. Average dose.—0.4 gm.

252. Extractum Glycyrrhizae—extract of glycyrrhiza, U.S.P. XI (extract of licorice root; licorice).—A commercial extract of glycyrrhiza prepared from the rhizome and roots of species of glycyrrhiza (Fam. Leguminosae) and having a sweetish taste which is not more than very slightly acrid. This extract is the commercial product known as "stick licorice." The U.S.P. directs no method of preparation but states minimum requirements to prevent adulteration.

253. Extractum Glycyrrhizae Purum—pure extract of glycyrrhiza, U.S.P. XI (pure extract of licorice root).—*a. Prepared as follows.*—Moisten 1,000 gm of glycyrrhiza, in coarse powder, with boiling distilled water, transfer it to a metallic percolator, and percolate with boiling distilled water until the drug is exhausted. Concentrate the percolate to about one-half of its original volume by boiling. Filter, and immediately evaporate the filtrate on a water bath until the residue has a pilular consistency.

b. Use.—Flavoring agent.

254. Extractum Hepatis—extract of liver, U.S.P. XI (dry liver extract).—Contains that soluble fraction of mammalian livers which increases the number of red blood corpuscles in the blood of persons suffering from pernicious anemia. This fraction, which has been dried, conforms to outlined specifications.

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a. Use.—Treatment of pernicious anemia.

b. Average dose.—To be stated on the label of the container.

255. Extractum Hyoscyami—extract of hyoscyamus, U.S.P. XI (extract of henbane).—Yields from each 100 gm, not less than 0.135 gm and not more than 0.175 gm of the alkaloids of hyoscyamus.

a. Prepared as follows.—(1) *Pilular extract.*—Prepare an extract by percolating 1,000 gm of hyoscyamus, in moderately coarse powder, using a mixture of 3 volumes of alcohol and 1 volume of distilled water as the menstruum. Macerate the drug during 16 hours and then percolate it at a moderate rate. Evaporate the percolate to a pilular consistency under reduced pressure and at a temperature not exceeding 60° C., and adjust the remaining extract, after assaying, by dilution with glucose, so that the finished extract will contain, in each 100 gm, 0.155 gm of the alkaloids of hyoscyamus.

(2) *Powdered extract.*—Prepare an extract by percolating 1,000 gm of hyoscyamus, in moderately coarse powder, using alcohol as a menstruum. Macerate the drug during 16 hours and then percolate it slowly. Evaporate the percolate to a soft extract under reduced pressure, and at a temperature not exceeding 60° C., add 50 gm of dry starch, and continue the evaporation at the same temperature until the product is dry. Powder the residue, extract the fat as described in paragraph 247, assay, and add enough dried starch to make the finished extract contain, in each 100 gm, 0.155 gm of the alkaloids of hyoscyamus. Mix and pass through a fine sieve.

b. Use.—Antispasmodic of the intestinal tract.

c. Average dose.—0.5 gm.

256. Extractum Malti—extract of malt, U.S.P. XI.—A product obtained by extracting malt, the partially and artificially germinated grain of one or more varieties of "Hordeum vulgare" linné (Fam. Gramineae). The malt is infused with water at 60° C., the expressed liquid concentrated at a temperature not exceeding 60° C., and the extract mixed with 10 percent, by weight, of glycerine. It contains dextrin, maltose, a small amount of glucose, and amylolytic enzymes. It is capable of converting not less than five times its weight of starch into water-soluble sugars.

a. Use.—Nutrient and digestant.

b. Average dose.—15 gm.

257. Extractum Rhei—extract of rhubarb, U.S.P. XI (powdered extract of rhubarb).—Represents in each 1 gm, 2 gm of rhubarb.

a. Prepared as follows.—Prepare an extract by percolating 1,000 gm of rhubarb, in moderately coarse powder, using a mixture of 4 volumes of alcohol and 1 volume of distilled water as the menstruum.

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Macerate the drug during 48 hours and then percolate it at a moderate rate. Evaporate the percolate to dryness at a temperature not exceeding 70° C. Powder the residue and add enough dried starch to make 500 gm. Mix and pass through a fine sieve.

b. Use.—Laxative.

c. Average dose.—0.5 gm.

258. Extractum Stramonii—extract of stramonium, U.S.P. XI.—Yields from each 100 gm not less than 1.10 gm and not more than 1.30 gm of the alkaloids of stramonium.

a. Prepared as follows.—(1) *Pilular extract.*—Prepare an extract by percolating 1,000 gm of stramonium, in moderately coarse powder, using a mixture of 3 volumes of alcohol and 1 volume of distilled water as the menstruum. Macerate the drug during 16 hours and then percolate it at a moderate rate. Evaporate the percolate to a pilular consistency under reduced pressure and at a temperature not exceeding 60° C., and adjust the remaining extract, after assaying, by dilution with glucose, so that the finished extract will contain in each 100 gm, 1.20 gm of the alkaloids of stramonium.

(2) *Powdered extract.*—Prepare an extract by percolating 1,000 gm of stramonium in moderately coarse powder, using alcohol as the menstruum. Macerate the drug during 16 hours and then percolate it slowly. Evaporate the percolate to a soft extract, under reduced pressure, and at a temperature not exceeding 60° C., add 50 gm of dry starch, and continue the evaporation, at the same temperature, until the product is dry. Powder the residue, remove the fat as described in paragraph 247, assay, and add enough starch, dried at 100° C., to make the finished extract contain, in each 100 gm, 1.20 gm of the alkaloids of stramonium.

b. Use.—Antispasmodic.

c. Average dose.—0.02 gm.

Section XX

POWDERS

	Paragraph
Definition	259
Pulveres Effervescentes Compositi	260
Pulvis Cretae Compositus	261
Pulvis Ipecacuanhae et Opii	262

259. Definition.—Powders, as a pharmaceutical classification, are intimate mixtures of medicinal substances, with or without diluents, in a dry powdered form. Some are dispensed as bulk powders and one is wrapped in papers, containing individual doses. In each case the powders must be finely subdivided and thoroughly mixed.

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260. Pulveres Effervescentes Compositi—compound effervescent powders, U.S.P. XI (seidlitz powders).—Contained in two papers. The mixture in a blue paper weighs not less than 9.5 gm and not more than 10.5 gm, and contains not less than 23 percent and not more than 27 percent $NaHCO_3$, and not less than 73 percent and not more than 78 percent of $KNaC_4H_4O_6 \cdot 4H_2O$. The white paper contains not less than 2 gm and not more than 2.4 gm of $H_2C_4H_4O_6$.

a. Prepared as follows.—Sodium bicarbonate, dry and passed through a No. 60 standard mesh sieve, 30 gm; potassium and sodium tartrate, dry and passed through a No. 60 standard mesh sieve, 90 gm; tartaric acid, dry and passed through a No. 40 standard mesh sieve, 26 gm. Mix the sodium bicarbonate intimately with the potassium and sodium tartrate, divide the mixture into 12 equal parts, and wrap each part in a blue paper. Then divide the tartaric acid into 12 equal parts, and wrap each part in a white paper.

b. Use.—Saline cathartic.

c. Average dose.—The contents of a white and blue paper dissolved separately in about 1 fluid ounce of water and the solutions mixed.

261. Pulvis Cretae Compositus—compound chalk powder, U.S.P. XI.—*a. Prepared as follows.*—Prepared chalk, 30 gm; acacia, in fine powder, 20 gm; sucrose, in fine powder, 50 gm. Mix the powders intimately by trituration and pass through a No. 60 sieve.

b. Use.—Antacid, also used in making chalk mixture.

c. Average dose.—2 gm.

262. Pulvis Ipecacuanhae et Opii—powder of ipecac and opium, U.S.P. XI (Dover's powder).—*a. Prepared as follows.*—Ipecac, in very fine powder, 10 gm; powdered opium, 10 gm; lactose, coarsely powdered, 80 gm. Triturate the ingredients together thoroughly until the mixture is reduced to a very fine, uniform powder.

b. Use.—Anodyne and diaphoretic.

c. Average dose.—0.3 gm.

SECTION XXI

PILLS

	Paragraph
Definition	263
Method of preparation	264
Pilulae Ferri Carbonatis	265
Pilulae Hydrargyri Chloridi Mitis Compositae	266

263. Definition.—Pills are globular or ovoid dosage forms of medicinal substances intended for administration by mouth.

264. Method of preparation.—The manufacture of pills by hand can be roughly divided into three parts: First, making the mass; second, dividing the mass; third, rolling the pills.

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a. Making the mass.—The making of a pill mass is performed by thoroughly blending the powders by triturating in a mortar, adding the necessary quantity of excipient, and working the mixture with a pestle until a plastic mass is formed. An excipient is a substance added to the mixed powders to cause adhesiveness, in order that a mass may be made. Examples of excipients are syrup, glucose, honey, and mucilage of acacia. They should be medicinally inert.

b. Dividing the mass.—After the mass is formed, it is then rolled into a cylinder and divided into a number of equal segments corresponding to the number of pills to be made.

c. Rolling the pills.—Each cut segment is then taken up between the finger and thumb and rolled by means of a rotating movement until perfectly spheric. The pills may then be dusted with an inert powder to prevent sticking.

265. Pilulae, Ferri Carbonatis—pills of ferrous carbonate, U.S.P. XI (Blaud's pills).—Contains in each pill not less than 0.06 gm of $FeCO_8$.

a. Prepared as follows.—Ferrous sulfate, in clear crystals, 16 gm; potassium carbonate, 8 gm; sucrose, finely powdered, 4 gm; althea, in very fine powder, 1 gm; tragacanth, finely powdered, 1 gm; distilled water, a sufficient quantity. This makes 100 pills. Triturate the potassium carbonate in a mortar with a sufficient quantity (about 5 drops) of glycerine, add the ferrous sulfate and sucrose, previously triturated together to a uniform, fine powder, and mix the mass thoroughly until it assumes a greenish color. When the reaction is complete, incorporate the tragacanth and althea and add distilled water, if necessary, to obtain a mass of pilular consistence. Divide it into 100 pills.

b. Use.—Treatment of iron deficiencies.

c. Average dose.—3 pills.

d. Storage.—Preserve in well-closed containers.

266. Pilulae Hydrargyri Chloridi Mitis Compositae—compound pills of mild mercurous chloride, N.F. VI (compound cathartic pills).—*a. Prepared as follows.*—Compound extract of colocynth, 8 gm; mild mercurous chloride, 6 gm; resin of jalap, in fine powder, 2 gm; gamboge, in very fine powder, 1.5 gm; diluted alcohol, a sufficient quantity. This makes 100 pills. Prepare the pills as described in paragraph 264.

b. Use.—Cathartic.

c. Average dose.—2 pills.

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SECTION XXII

TABLETS

	Paragraph
Definition	267
Types of tablets	268
Toxitabellae Hydrargyri Bichloridi Magnae	269
Toxitabellae Hydrargyri Bichloridi Parvae	270

267. Definition.—Tablets are unit dosage forms of medication, containing medicinal substances usually intended for internal administration, either compressed or molded. They may be coated with a suitable substance to disguise the taste, to retard decomposition, or to allow disintegration at the proper place in the alimentary tract.

268. Types of tablets.—Tablets may be divided into three types as follows:

a. Compressed tablets.—These are lenticular masses of medicinal substances forced into a solid mass by compression. This is invariably accomplished by means of a mechanical device containing a mold of the proper size and a plunger to force the ingredients into a compressed tablet. Most compressed tablets contain an excipient, such as acacia, to prevent crumbling, and, in cases where the active ingredient possesses very small bulk, a diluent to make the tablet a convenient size to handle. Starch is an excellent diluent for these cases because it swells on being taken, and hastens the disintegration of the tablet in the stomach.

b. Tablet triturates.—These are flat disks containing medicinal substances which have had an inert filler added, moistened, and then forced into the orifices of a special tablet mold. The active substance is built up to the proper bulk for the desired number of tablets with a diluent, usually milk sugar. This mixture is then dampened with dilute alcohol and the mass forced into the molds of the tablet machine by a spatula. The mass is left there until firm and is then removed by forcing a studded plate over the holes in the mold. The tablets are then allowed to dry completely. An excipient may be used if the tablets tend to crumble. One part of cane sugar to 5 parts of milk sugar will usually suffice to prevent crumbling.

c. Hypodermic tablets.—These are frequently prepared by the method just described for making tablet triturates. The essential difference between hypodermic tablets and tablet triturates is the fact that hypodermic tablets must be completely soluble, leaving no residue, as they are intended to be dissolved in water and used hypodermically.

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269. Toxitabellae Hydrargyri Bichloridi Magnae—large poison tablets of mercury bichloride, U.S.P. XI (large corrosive sublimate tablets).—Contain an average of not less than 0.45 gm and not more than 0.55 gm of $HgCl_2$, with a sufficient quantity of a suitable excipient or diluent. These tablets must be of a distinctive color, not white; they must be of an angular or irregular shape, not discoid. When sold in small quantities suitable for household use, they must be dispensed in glass containers of distinctive, angular or irregular shape, having irregular or roughened sides or edges. On the exterior of each container must be placed a red printed label bearing the word "Poison" and a statement indicating the amount of mercury bichloride in each tablet. They are used as a disinfectant.

270. Toxitabellae Hydrargyri Bichloridi Parvae—small poison tablets of mercury bichloride, U.S.P. XI (small corrosive sublimate tablets).—Contain an average of not less than 0.1125 gm and not more than 0.1375 gm of $HgCl_2$, with a sufficient suitable excipient. The same instructions as to shape, color, container, and label as listed above under large poison tablets of mercury bichloride must be adhered to in the manufacture and dispensing of these tablets.

SECTION XXIII

OINTMENTS

	Paragraph
Definition	271
Methods of preparation	272
Types of ointment bases	273
Storage	274
Unguentum	275
Unguentum Acidi Benzoici Compositum	276
Unguentum Acidi Borici	277
Unguentum Acidi Tannici	278
Unguentum Aquae Rosae	279
Unguentum Belladonnae	280
Unguentum Chrysarobini	281
Unguentum Gallae	282
Unguentum Hydrargyri Ammoniati	283
Unguentum Hydrargyri Chloridi Mitis	284
Unguentum Hydrargyri Forte	285
Unguentum Hydrargyri Mite	286
Unguentum Hydrargyri Oxidi Flavi	287
Unguentum Ichthammolis	288
Unguentum Iodi	289
Unguentum Phenolis	290
Unguentum Picis Pini	291
Unguentum Sulfuris	292
Unguentum Zinci Oxidi	293

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271. Definition.—Ointments are solid preparations for external application, with friction, containing medicinal substances incorporated in a fatty or petrolatum base.

272. Methods of preparation.—Ointments are prepared by two general methods as described below.

a. Fusion.—When an ointment or ointment base is to be made by melting several agents together, the ingredient having the highest melting point should be melted first, and then the one having the next so that the ones having lower melting points will not be injured by heat. In most cases the heat of a water bath is sufficient. A mixture of agents having different solidifying points should generally be stirred while cooling to prevent granulation caused by the ingredient having the highest melting point solidifying first. The medicinal substance to be incorporated may be slowly sifted into the melted material, stirring constantly until it congeals, or may be incorporated into the congealed base.

b. Incorporation.—This method is more frequently used for making cintments than any other. The medicating ingredients must be reduced to a fine state of subdivision in order to facilitate their absorption and obtain a smooth, nongritty product. The usual mode of procedure is to place the vehicle upon an ointment slab and the medicating substance close by. The latter is first incorporated into a small portion of the vehicle by rubbing with a spatula until smooth, and this is then added to the balance of the base.

273. Types of ointment bases.—*a.* Ointment bases are usually classified by their action on the skin. Thus we find that the prefixes *epi*, *endo*, or *dia* are attached to the root *derma* to indicate that the base is intended to act upon the surface of the skin, by penetrating into the tissues, or by passing through the skin. By adding "tic" to the root, an adjective is formed that describes the action of the base indicated. Thus we have—

(1) *Epidermatic* bases such as petrolatum, paraffin, etc., that act upon the surface of the skin bearing medication intended to be astringent, antiseptic, protective, or counterirritant.

(2) *Endodermatic* bases are intended to penetrate but not pass through the skin. Examples of this type base are—lard, suet, and vegetable oils such as castor oil or linseed oil, which act as emollients to soften the skin, or bear some ingredients intended to act as a local anesthetic, irritant, etc.

(3) *Diadermatic* bases are intended to pass through the skin and bear medication which will have a systemic action. Examples of

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these bases are wool fat and cocoa butter which often bear mercurials or iodides.

b. Much advancement has been made recently in the knowledge concerning ointment bases. It has been found that oxycholesterol, the chief water-absorbing principle of wool fat, can be extracted and used alone or in combination with other bases. "Aquaphor" and "Merck's Absorption Base" are examples of this utilization of sterols.

274. Storage.—Ointments should always be preserved in well-closed containers to prevent oxidation of the active ingredient and, in some cases, of the base. The top of the container and the threads of the container should always be wiped off with absorbent cotton after using.

275. Unguentum—ointment, U.S.P. XI (simple ointment).—*a. Prepared as follows.*—Wool fat, 5 gm; white wax, 5 gm; white petrolatum, 90 gm. Melt the white wax in a suitable dish on a water bath, add the other ingredients, warm until they are liquefied, then discontinue the heating, and stir the mixture until it congeals.

b. Use.—Ointment base.

276. Unguentum Acidi Benzoici Compositum—compound ointment of benzoic acid, N.F. VI (Whitfield's ointment).—*a. Prepared as follows.*—Benzoic acid, 12 gm; salicylic acid, 6 gm; wool fat, 5 gm; white petrolatum, 77 gm. Powder the acids very finely, and incorporate them with the wool fat and a portion of the petrolatum until a smooth, homogeneous mixture is obtained. Add the remainder of the petrolatum, and mix thoroughly.

b. Use.—Fungicide.

277. Unguentum Acidi Borici—boric acid ointment, U.S.P. XI (boracic acid ointment).—Contains not less than 9 percent and not more than 11 percent of H_3BO_3.

a. Prepared as follows.—Boric acid, finely powdered, 10 gm; wool fat, 5 gm; white wax, 5 gm; white petrolatum, 80 gm. Melt the white wax in a suitable dish on the water bath, add the wool fat and the white petrolatum, and heat the mixture gently until it is liquefied. Gradually add the warm liquid to the boric acid contained in a warm mortar, triturating thoroughly, and stir the mixture until it congeals.

b. Use.—Mild antiseptic dressing.

278. Unguentum Acidi Tannici—tannic acid ointment, U.S.P. XI.—*a. Prepared as follows.*—Tannic acid, 20 gm; glycerine, 20 gm; wool fat, 3 gm; yellow wax, 3 gm; petrolatum, 54 gm. Dissolve the tannic acid in the glycerine with the aid of gentle heat. Melt the

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yellow wax on a water bath, add the wool fat and the petrolatum and gradually incorporate this warm liquid with the tannic acid solution.

b. Use.—An application for hemorrhoids.

c. Caution.—During the manufacture and storage, this ointment must not come in contact with iron utensils or containers.

279. Unguentum Aquae Rosae—rose water ointment, U.S.P. XI.—*a. Prepared as follows.*—(1) Spermaceti, 125 gm; white wax, 120 gm; expressed almond oil, 560 gm; sodium borate, 5 gm; rose water, 50 cc; distilled water, 140 cc; oil of rose, 0.2 cc; to make about 1,000 gm of ointment. Reduce the spermaceti and the white wax to small pieces and melt them on a water bath; add the expressed almond oil, and continue the heat until the temperature of the mixture is raised to 70° C. Dissolve the sodium borate in the distilled water and rose water, warmed to the temperature of the melted wax and fat, and gradually add the warm solution to the melted mixture, stirring rapidly and continuously until it has cooled to about 45° C. Then incorporate the oil of rose.

(2) Rose water ointment must be free from rancidity. If the ointment has been chilled, warm it slightly before attempting to incorporate other ingredients with it.

b. Use.—Ointment base.

c. Storage.—Preserve in pure tin, collapsible tubes.

280. Unguentum Belladonnae—belladonna ointment, U.S.P. XI.—Yields not less than 0.118 percent and not more than 0.132 percent of the alkaloids of belladonna leaf.

a. Prepared as follows.—Pilular extract of belladonna, 10 gm; diluted alcohol, 5 cc; wool fat, 5 gm; yellow wax, 5 gm; petrolatum, 75 gm. Triturate the extract with the diluted alcohol until a smooth mixture is obtained, add the yellow wax, wool fat, and petrolatum, which have been melted together in a suitable dish on a water bath, and mix thoroughly.

b. Use.—For the therapeutic effect of belladonna.

281. Unguentum Chrysarobini—chrysarobin ointment, U.S.P. XI.—*a. Prepared as follows.*—Chrysarobin, 6 gm; wool fat, 5 gm; yellow wax, 5 gm; chloroform, 4 gm; liquid petrolatum, 6 gm; petrolatum, a sufficient quantity to make 100 gm. Triturate the chrysarobin with the liquid petrolatum and the chloroform. Melt the wool fat, yellow wax, and 50 gm of the petrolatum in a suitable dish on a water bath, and add this warm liquid to the chrysarobin mixture, triturating thoroughly. Finally incorporate sufficient petrolatum to make the finished product weigh 100 gm.

b. Use.—Antiparasitic.

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282. Unguentum Gallae—nutgall ointment, U.S.P. XI.—*a. Prepared as follows.*—Nutgall, in very fine powder, 20 gm; wool fat, 5 gm; yellow wax, 5 gm; petrolatum, 70 gm. Melt the yellow wax in a suitable dish on a water bath, add the wool fat and the petrolatum, and continue heating until the mixture is liquefied. Stir the mixture until it congeals, and then thoroughly incorporate the nutgall.

b. Use.—Application for hemorrhoids.

c. Caution.—During its manufacture and storage this ointment must not come in contact with iron utensils or containers.

283. Unguentum Hydrargyri Ammoniati—ammoniated mercury ointment, U.S.P. XI (white precipitate ointment).—Contains an amount of ammoniated mercury corresponding to not less than 7.1 percent and not more than 8.7 percent of Hg.

a. Prepared as follows.—Ammoniated mercury, in very fine powder, 10 gm; wool fat, 5 gm; white wax, 5 gm; white petrolatum, 80 gm. Melt the white wax in a suitable dish on a water bath, add the wool fat and the white petrolatum, and heat the mixture gently until it is liquefied. Gradually add the warm liquid to the ammoniated mercury contained in a warm mortar, triturating thoroughly, and stir the mixture until it congeals.

b. Use.—Parasiticide in cutaneous eruptions.

284. Unguentum Hydrargyri Chloridi Mitis—ointment of mild mercurous chloride, N.F. VI (calomel ointment).—*a. Prepared as follows.*—Mild mercurous chloride, 30 gm; hydrous wool fat, 35 gm; white petrolatum, 35 gm. Mix them intimately.

b. Use.—Prophylactic.

285. Unguentum Hydrargyri forte—strong mercurial ointment, U.S.P. XI (mercurial ointment).—Contains not less than 47.5 percent and not more than 52.5 percent of Hg.

a. Prepared as follows.—Mercury, 500 gm; oleate of mercury, 20 gm; wool fat, 300 gm; white wax, 50 gm; white petrolatum, 130 gm. Triturate the oleate of mercury in a warm mortar with the mercury added gradually, and when all of the mercury is dispersed set the mixture aside for about 15 minutes. Melt together the wool fat, white wax, and white petrolatum, allow the mixture to cool partially, add about 25 gm of it to the mercurial mixture, and continue the trituration until the globules of mercury are no longer visible under a lens magnifying ten diameters. Then add the remainder of the wool fat, white wax, and white petrolatum mixture, and mix thoroughly.

b. Use.—Antisyphilitic.

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286. Unguentum Hydrargyri Mite—mild mercurial ointment, U.S.P. XI (blue ointment).—Contains not less than 28 percent and not more than 32 percent of Hg.

a. Prepared as follows.—Strong mercurial ointment, 600 gm; white wax, 20 gm; white petrolatum, 380 gm. Melt the white wax in a suitable dish on a water bath, add the white petrolatum, and heat the mixture gently until it is liquefied. Discontinue the heat, stir the mixture until it congeals, and then uniformly incorporate the strong mercurial ointment.

b. Use.—Antiparasitic.

287. Unguentum Hydrargyi Oxidi Flavi—yellow mercuric oxide ointment, U.S.P. XI.—Contains not less than 0.9 percent and not more than 1.1 percent of HgO.

a. Prepared as follows.—Yellow mercuric oxide, in very fine powder, 1 gm; liquid petrolatum, 1 gm; wool fat, 5 gm; yellow wax, 5 gm; petrolatum, 88 gm. Triturate the yellow mercuric oxide with the liquid petrolatum until the mixture is smooth. Melt the yellow wax in a suitable dish on a water bath, add the wool fat and the petrolatum, and heat gently until the mixture is liquefied. Gradually incorporate the yellow mercuric oxide mixture with this warm liquid.

b. Use.—Antiseptic, chiefly on the eyelids.

288. Unguentum Ichthammolis—ointment of ichthammol, N.F. VI.—*a. Prepared as follows.*—Ichthammol, 10 gm; petrolatum, 90 gm. Thoroughly incorporate the ichthammol with the petrolatum.

b. Use.—Antiseptic and emollient.

289. Unguentum Iodi—iodine ointment, U.S.P. XI.—Contains not less than 6.5 percent and not more than 7.5 percent of total I.

a. Prepared as follows.—Iodine, 4 gm; potassium iodide, 4 gm; glycerine, 12 gm; wool fat, 5 gm; yellow wax, 5 gm; petrolatum, 70 gm. Dissolve the iodine and the potassium iodide in the glycerine, preferably in a glass mortar. Melt the yellow wax on a water bath, add the wool fat and the petrolatum, and heat the mixture gently until it is liquefied. Gradually incorporate this warm liquid with the iodine solution.

b. Use.—Counterirritant.

290. Unguentum Phenolis—phenol ointment, U.S.P. XI (ointment of carbolic acid).—Contains not less than 1.8 percent and not more than 2.2 percent of C_6H_5OH.

a. Prepared as follows.—Phenol, 2 gm; yellow wax, 5 gm; petrolatum, 93 gm. Melt the yellow wax and phenol on a water bath, add the petrolatum, and stir the mixture until it congeals.

b. Use.—Antiseptic dressing.

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291. Unguentum Picis Pini—pine tar ointment, U.S.P. XI (unguentum picis liquidae).—*a. Prepared as follows.*—Pine tar, 50 gm; yellow wax, 15 gm; petrolatum, 35 gm. Melt the yellow wax on a water bath, add the petrolatum, and to the melted mixture add the pine tar previously warmed, and incorporate thoroughly. Strain the mixture through muslin, and stir until it congeals.

b. Use.—Stimulant application.

292. Unguentum Sulfuris—sulfur ointment, U.S.P. XI.—Contains not less than 13.5 percent and not more than 16.5 percent of sulfur.

a. Prepared as follows.—Precipitated sulfur, 15 gm; wool fat, 5 gm; yellow wax, 5 gm; white petrolatum, 75 gm. Melt the yellow wax in a suitable dish on a water bath, add the wool fat and the white petrolatum, and heat the mixture gently until it is liquefied. Gradually incorporate the warm liquid with the precipitated sulfur until a uniform mixture is obtained.

b. Use.—Antiparasitic.

293. Unguentum Zinci Oxidi—zinc oxide ointment, U.S.P. XI (zinc ointment).—Contains not less than 18.5 percent and not more than 21.5 percent of ZnO.

a. Prepared as follows.—Zinc oxide in very fine powder, 20 gm; liquid petrolatum, 10 gm; wool fat, 5 gm; white wax, 5 gm; white petrolatum, 60 gm. Mix the wool fat and the liquid petrolatum, and thoroughly levigate the zinc oxide with this mixture. Melt together the white wax and white petrolatum, allow the mixture to cool until it becomes a soft mass, and then thoroughly incorporate the zinc oxide mixture.

b. Use.—Antiseptic and astringent dressing.

SECTION XXIV

PASTES

	Paragraph
Definition	294
Pasta Zinci Oxidi	295
Pasta Zinci Oxidi cum Acido Salicylico	296

294. Definition.—Dermatologic pastes are medicaments for external use, of ointment-like consistence, containing starch, zinc oxide, dextrin, or other medicinal substances. They should be free from gritty substances.

295. Pasta Zinci Oxidii—paste of zinc oxide, N.F. VI (Lassar's plain zinc paste).—*a. Prepared as follows.*—Zinc oxide, 25 gm; starch, 25 gm; white petrolatum, 50 gm. Mix them intimately.

b. Use.—In dermatitis.

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296. Pasta Zinci Oxidi cum Acido Salicylico—paste of zinc oxide with salicylic acid, N.F. VI (Lassar's zinc paste with salicylic acid).—*a. Prepared as follows.*—Salicylic acid, 2 gm; paste of zinc oxide, a sufficient quantity to make 100 gm. Thoroughly triturate the salicylic acid with a portion of the paste; then add the remaining paste, and rub until a smooth mixture is formed.

b. Use.—In dermatitis.

Section XXV

SUPPOSITORIES

	Paragraph
Definition	297
Sites of action	298
Bases used in suppositories	299
Weights and shapes of suppositories	300
Suppositoria Glycerini	301

297. Definition.—Suppositories are solid bodies of various weights and shapes, adapted for introduction into different orifices of the human body, and melting or softening at body temperature.

298. Sites of action.—Suppositories may be used for their local effect, as in hemorrhoids and vaginitis, or they may contain medicinal substances intended to be absorbed from the large intestine for general systemic action. The dose of a drug administered by rectum for systemic effect is generally twice that of the same drug administered orally, because absorption through the large intestine is not as great as that through the duodenum.

299. Bases used in suppositories.—The vehicles usually employed are oil of theobroma (cocoa butter) and glycerinated gelatin. Sodium stearate is used in suppositories of glycerine, U.S.P.

a. Oil of theobroma suppositories.—For suppositories made with oil of theobroma the following general processes may be employed:

The medicinal substance, the prescribed quantity.
Oil of theobroma, grated, a sufficient quantity.

(1) Reduce the medicinal substance, if dry, to a very fine powder, or, if an extract, soften it with an appropriate liquid, then mix it thoroughly in a mortar with about an equal weight of grated oil of theobroma, and incorporate the remainder of the oil of theobroma until a homogeneous, plastic mass is obtained, adding, if necessary, a small quantity of expressed oil of almond or wool fat. Roll the mass on a graduated tile until a cylinder of the proper length is formed. Divide this into the required number of equal parts, and with a spatula, or other mechanical aid, form them into the desired shape.

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(2) If the process of cold compression is preferred, mix the medicinal substance in a suitable mortar with about an equal weight of grated oil of theobroma, as above directed, then thoroughly incorporate it with the remainder of the oil of theobroma, previously finely grated, chilling the mortar, if necessary, to preserve the pulverulent form of the mixture. Transfer the powdered mass to the cylinder of an appropriate suppository compressor and by the use of this apparatus prepare the desired number of compressed suppositories.

(3) If the process of fusion is preferred, mix the medicinal substance with about an equal weight of grated oil of theobroma, as above directed, then thoroughly incorporate it with the remainder of the oil of theobroma, previously melted by a gentle heat on a water bath, in a suitable vessel provided with a lip. Allow to cool to about 38° C., and, when the mixture begins to congeal, pour it immediately into suitable well-cooled molds. Keep the molds at a freezing temperature until the suppositories have hardened and are ready to be removed.

(4) For suppositories containing chloral hydrate, phenol, or other substances which soften the vehicle, raise the melting point of the mixture by the addition of a small quantity of spermaceti or other suitable hardening agents, but the suppositories must melt at body temperature.

b. Glycerinated gelatin suppositories.—For suppositories made with glycerinated gelatin, the following process may be used:

The medicinal substance, the prescribed quantity.
Glycerinated gelatin.
Glycerine.
Distilled water, each, a sufficient quantity.

(1) Mix the medicinal substance, if solid and soluble, in distilled water or glycerine, or if a miscible liquid, with a little distilled water, and add sufficient glycerine to make the weight of the mixture one-half that of the finished mass. Then thoroughly incorporate it with an equal weight of melted glycerinated gelatin, and pour it at once into suitable molds which have been greased with a small amount of white petrolatum. Cool the molds thoroughly before removing the suppositories. Molds for urethral suppositories should be warmed sufficiently before pouring the mass to facilitate the proper filling of the mold. Suppositories of a more firm consistence may be prepared by replacing a portion of the distilled water or glycerine with mucilage of acacia.

(2) If the medicinal substance is insoluble in water or glycerine, thoroughly triturate it in a warm mortar with a sufficient quantity of

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glycerine to make the weight of the mixture one-half that of the finished mass. Then thoroughly incorporate it with an equal weight of melted glycerinated gelatin, and pour it into suitable molds as above directed. With bulky powders, about one-half of the glycerine may be replaced with distilled water before trituration.

(3) Glycerinated gelatin suppositories should be protected against the effects of heat, moisture, and dry air by keeping them in tightly closed containers and in a cool place.

(4) Glycerinated gelatin is prepared as follows: Gelatin, 100 gm; glycerine, 100 gm; distilled water, a sufficient quantity to make 200 gm. Pour upon the gelatin sufficient distilled water, which has been previously boiled and cooled, to cover it; allow it to stand for 1 hour, pour off the water, and allow the gelatin to drain for a few minutes. Then transfer it to a dish, add the glycerine, and heat on a water bath until the gelatin is dissolved. Strain the solution while hot, transfer it to a tared dish, and heat it on a water bath until the product weighs 200 gm. When the mass has cooled, cut it into pieces and preserve in well-closed containers.

300. Weights and shapes of suppositories.—Rectal suppositories should weigh about 2 gm each and should be tapered. Urethral suppositories (bougies) should be pencil-shaped, pointed at one extremity, and either 7 cm in length, weighing about 2 gm each, or 14 cm in length, weighing about 4 gm each. Vaginal suppositories should be globular or oviform in shape and weigh about 5 gm each.

301. Suppositoria Glycerini—suppositories of glycerine, U.S.P. XI (glycerine suppositories).—*a. Prepared as follows.*—Glycerine, 92 gm; sodium stearate, 8 gm; distilled water, 5 gm; to make about 30 rectal suppositories. Heat the glycerine in a porcelain dish, on a water bath, to about 95° C., add the sodium stearate, and stir the mixture gently with a glass rod, maintaining the specified temperature, until the sodium stearate is dissolved. Then add the distilled water, mix thoroughly, and immediately pour the hot liquid into suitable molds. Remove the suppositories when they are completely cold, and preserve in tightly-stoppered glass containers in a cool place.

b. Use.—Evacuant.

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CHAPTER 6

MATERIA MEDICA

Paragraphs
SECTION I. General 302
II. Classification of active principles 303
III. Table of uses and doses 304
IV. Toxicology 305–308

SECTION I

GENERAL

Paragraph
General 302

302. General.—Drugs are obtained from animal, mineral, or vegetable sources, and the science that deals with their study is known as "Materia Medica."

a. Drugs from animal sources include gland products, vaccines, antitoxins, serums, and many other biological products. The study of these drugs is comprehensive and the methods of preparation are of such complex nature that they will not be included in the scope of this manual.

b. Drugs from mineral sources include pure chemicals, such as sodium bicarbonate and potassium iodide, and mixed mineral products, such as petroleum oil and ichthammol. They are either manufactured synthetically or are obtained from natural sources, with subsequent purification. Many of the active constituents obtained from natural sources are also manufactured synthetically at a considerable reduction in cost. It is believed by many pharmacologists, however, that the therapeutic effect of some of the synthesized drugs is inferior to that of those drugs obtained from natural sources.

c. Drugs obtained from vegetable sources include herbs, bark, leaves and alkaloids, or other plant constituents that are found to be medicinally active. "Crude drugs" are commercial forms of natural animal or plant drugs as they are brought to the market. Their employment in medicine is due to the fact that they contain or yield more or less definite chemical bodies of medicinal value. These bodies are known as "active constituents." In some cases these constituents are found in all parts of a plant, so that the whole plant is marketed as the crude drug; but mostly they occur in one part only, such as the leaf or root, or are stored in greatest abundance in one

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part, so that that part is selected for market and is the crude drug. Sometimes, as in the case of opium, an exudate contains the active constituents and is the crude drug, no structural part of the plant being marketed at all.

SECTION II

CLASSIFICATION OF ACTIVE PRINCIPLES

Paragraph
Classification of active principles 303

303. Classification of active principles.—A constituent is called an "active principle" when to it may be attributed, wholly or in part, the physiologic action of the drug. Active principles of organic drugs are divided into the following groups:

a. Plant acids and their salts include such principles as the citric acid of lemons, the tartaric acid of grapes, and some of their salts. The sweet principle of licorice is really glycyrrhizic acid, or its salts.

b. Alkaloids are a class of organic bodies of alkaline reaction composed of carbon, hydrogen, and nitrogen, and sometimes other elements. This class includes many of our most powerful drugs. They combine with acids to form the corresponding salts without liberation of hydrogen, as shown in the following example:

$$C_{21}H_{22}N_2O_2 + HCl = C_{21}H_{22}N_2O_2HCl$$
Strychnine — Strychnine hydrochloride

The pure alkaloids are, as a rule, not readily soluble in water, but they dissolve more or less readily in alcohol, ether, chloroform, and oils. The alkaloidal salts, on the contrary, are quite soluble in water, but only fairly so in alcohol. To distinguish these basic substances, the Pharmacopoeia makes names of alkaloids end in *ine* (Latin *ina*). Examples of alkaloids are quinine, cocaine, strychnine, and atropine.

c. Neutral principles.—Besides acid and basic substances, plants furnish a large number of proximate principles which are chemically neutral. Their names end in *in* (Latin *inum*) in accordance with the pharmacopoeial rule to distinguish them from alkaloids. The most important of this group are the glucosides, which are so named because, on decomposition, they yield some form of sugar, usually glucose. This is a loose group and, except for their decomposition product, have no essential characteristics in common. Examples of glucosides are amygdalin, found in wild cherry bark; and digitalin in digitalis.

d. Toxalbumins or *toxins* are poisonous compounds, probably protein, occurring in plants, and some constitute the poisonous products

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of bacteria and snake venom. An example of this group is "ricin," from the castor bean.

e. The ferments or *enzymes* is a class of bodies capable of instituting chemical changes without apparently entering into reaction or forming a part of the end products. They are nearly all destroyed at a temperature of about 60° C. Examples are—invertase, which transfers cane sugar into fructose and glucose; and maltase, which converts maltose into glucose.

f. The sugars, *starches*, and *gums* are carbohydrates of very slight pharmacological action and of little importance as remedies, but of importance in dietetics. The gums are closely related to sugars and starches. Examples of sugars, starches, and gums are, respectively, mannite, from manna; cornstarch, from corn; and gum arabic, from the acacia tree.

g. The tannins or *tannic acids* are a class of imperfectly defined astringent bodies of the aromatic group. They are all acids, which form salts. They occur mostly in the bark of trees and in the plant-galls which result from the punctures of insects. Tannic acid is an example of this class. It is derived from oak galls.

h. The fixed oils, *fats*, and *waxes*.—(1) The fixed oils and fats are mixtures of three bodies—olein, palmitin, and stearin, or close relatives of these, and, in addition, usually small amounts of other bodies. With alkalies they form soaps and glycerine. The oils differ from the fats only in the relative proportions of these basic ingredients, the oils having more of the olein, which gives them a liquid consistence at ordinary temperatures, and the fats more of the stearin and palmitin, which makes them solid or semisolid. The fixed oils have a greasy feeling and are nonvolatile, so that they leave a permanent grease spot. They cannot be distilled because they are decomposed by heat. They are insoluble in water and alcohol (except castor oil and croton oil, which dissolve in alcohol). They are usually extracted by compression or a suitable solvent, such as benzin, which is subsequently evaporated to remove it from the oil.

(2) The waxes are esters of the fatty acids and higher alcohols with hydrocarbon radicals higher in the series than the propane series. They are of firmer consistency than the fats and cannot be saponified with alkalies. Examples of fixed oils, fats, and waxes are, respectively, castor oil, lanolin, and spermaceti.

i. The volatile oils are substances to which many plants owe their characteristic or essential odors. On this account they are often spoken of as "essential oils." They differ from fixed oils in that they are volatile and can be distilled, they do not form soaps with

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alkalies, and they are soluble enough in water to impart their odor and taste. They are found in a definite part of the plant from which they are derived. Some are found in the fruit, as oil of orange; some in the leaves, as oil of peppermint; some in the bark, as oil of cinnamon; etc.

j. The resins are all, or nearly all, mixtures of several different substances. They are an ill-defined group, forming amorphous masses. They are insoluble in water and soluble in ether, chloroform, and most of them are soluble in alcohol. Rosin is an example of this group.

k. The oleoresins are natural plant exudates which contain both volatile oil and resin. Balsam of copaiba is an example of a natural oleoresin.

l. The gum resins, as the name copaiba indicates, are generally resins or oleoresins in natural admixture with a gum. Asafetida is an example.

m. The balsams are resinous or oleoresinous exudates which contain benzoic or cinnamic acid, or both, together with varying mixtures of their esters. Cinnamic acid or its esters imparts a "balsamic" odor. Examples of this class are balsam of tolu and balsam of peru.

SECTION III

TABLE OF USES AND DOSES

Paragraph
Table of uses and doses 304

304. Table of uses and doses.—The following is a table of commonly used official drugs with their uses and official doses.

Drug	Therapeutic use	Average dose
		Gm or cc
Acetanilid	Analgesic, antipyretic	0. 2
Acetic acid diluted	Refrigerant	2. 0
Aconite	Nerve sedative, diaphoretic	. 06
Agar	Demulcent, bulk laxative	10. 0
Aloe	Cathartic	. 25
Aloin	Cathartic	. 015
Aminophylline	Vasodilator	. 1
Aminopyrine	Antipyretic, analgesic	. 3
Ammonium bromide	Sedative	1. 0
Ammonium carbonate	Expectorant, nauseant	. 3
Ammonium chloride	Expectorant, urine acidifier	1. 0
Ammonium salicylate	Antirheumatic	1. 0
Amyl nitrite	Vasodilator	. 2

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Drug	Therapeutic use	Average dose
		Gm or cc
Antipyrine	Antipyretic, analgesic	.3
Apomorphine hydrochloride	Expectorant	.001
Apomorphine hydrochloride	Emetic	.005
Arsenic trioxide	Alterative, tonic	.002
Asafetida	Carminative	.4
Aspirin	Antipyretic, analgesic	.3
Atropine	Mydriatic, anhydriotic, brain stimulant.	.0004
Atropine sulfate	*See* Atropine	.0005
Barbital	Hypnotic, sedative	.3
Barbital sodium	*See* Barbital	.3
Belladonna leaf	Antispasmodic, anhydriotic	.06
Belladonna root	*See* Belladonna leaf	.045
Benzocaine	Local anesthetic	.3
Benzoic acid	Antiseptic	1.0
Betanaphthol	Antiseptic	.25
Bismuth subcarbonate	Protective	1.0
Bismuth subgallate	*See* Bismuth subcarbonate	1.0
Bismuth subnitrate	*See* Bismuth subcarbonate	1.0
Boric acid	Mild antiseptic	.5
Caffeine	Diuretic, stimulant	.2
Caffeine, citrated	*See* Caffeine	.3
Caffeine sodio-benzoate	*See* Caffeine	(oral) .3
Caffeine sodio-benzoate	*See* Caffeine	(hypo) .2
Calcium bromide	Sedative	1.0
Calcium carbonate	Antacid	1.0
Calcium chloride	Supply blood-calcium	1.0
Calcium gluconate	*See* Calcium chloride	(oral) 5.0 (intravenous) 1.0
Calcium lactate		1.0
Calomel	Cathartic	.15
Camphor	Circulatory stimulant	.2
Camphor, monobromated	*See* Camphor	.125
Carbromal	Sedative	.5
Cascara sagrada	Laxative	1.0
Castor oil	Cathartic	15.0
Cerium oxalate	Antiemetic	.2
Charcoal	Adsorbent	1.0
Chloral hydrate	Hypnotic	.6
Chlorobutanol	Hypnotic, antiseptic	.6
Chloroform	General anesthetic, anodyne	.3
Cinchophen	Analgesic in arthritis	.5
Cocaine	Local anesthetic, stimulant	.015

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Drug	Therapeutic use	Average dose
		Gm or cc
Cocaine hydrochloride	*See* Cocaine	.015
Codeine	Analgesic, hypnotic, sedative	.03
Codeine phosphate	*See* Codeine	.03
Codeine sulfate	*See* Codeine	.03
Colchicine	Analgesic in arthritis	.0005
Creosote	Antiseptic, expectorant, local anesthetic.	.25
Digitalis	Cardiac stimulant, diuretic	.1
Dionin	*See* Ethylmorphine hydrochloride.	.015
Emetine hydrochloride	Emetic, amebacide	.06
Ephedrine hydrochloride	Vasoconstrictor	.025
Ephedrine sulfate	*See* Ephedrine hydrochloride	.025
Epinephrine	Cardiac stimulant, vasoconstrictor.	.0005
Epsom salt	Saline cathartic	15.0
Ergot	Uterine stimulant	2.0
Erythrol tetranitrate, dil	Vasodilator	.03
Eserine salicylate	Myotic, antiflatulent	.002
Ether	General anesthetic, carminative	1.0
Ethylmorphine hydrochloride	Analgesic	.015
Eucalyptol	Local stimulant, antiseptic	.3
Eugenol	Local anesthetic, antiseptic	.1
Ferrous carbonate, mass	Hematinic	.25
Gentian	Simple bitter	1.0
Ginger	Carminative	.6
Glycyrrhiza	Demulcent expectorant	2.0
Guaiacol	Bronchial stimulant, antiseptic	.5
Homatropine hydrobromide	Mydriatic	.0005
Hydrastis	Simple bitter	2.0
Hydrochloric acid, diluted	Supply acid in gastric hypoacidity.	2.0
Hyoscine hydrobromide	Mydriatic, brain sedative	.0005
Hyoscyamus	*See* Belladonna	.2
Iodine	Germicide, iodine deficiencies	.01
Ipecac	Expectorant	.06
Ipecac	Emetic	1.0
Iron and ammonium citrates	Hematinic	2.0
Iron, reduced	Hematinic	.5
Iron sulfate	*See* Iron, reduced	.2
Magnesium carbonate	Antacid	.60
Magnesium carbonate	Laxative	8.0
Magnesium oxide	Antacid	.25
Magnesium oxide	Laxative	3.0
Magnesium sulfate	Saline cathartic	15.0
Menthol	Antiseptic, counterirritant	.06
Mercurous chloride	*See* Calomel	.15
Methenamine	Urinary antiseptic	.3

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Drug	Therapeutic use	Average dose
		Gm or cc
Methylene blue	Urinary antiseptic	.15
Morphine hydrochloride	Hypnotic, analgesic	.008
Morphine sulfate	*See* Morphine hydrochloride	.008
Neocinchophen	Analgesic in arthritis	.5
Nutmeg	Carminative, aromatic	.5
Nux vomica	Tonic, circulatory stimulant	.1
Oil of anise	Carminative	.1
Oil of bitter almond	Medicinal flavoring agent	.03
Oil of castor	*See* Castor oil	15.0
Oil of chaulmoogra	Treatment of leprosy	1.0
Oil of chenopodium	Anthelmintic	1.0
Oil of cinnamon (cassia)	Carminative, flavoring agent	.1
Oil of cod liver	Antirachitic, antixerophthalmic	8.0
Oil of eucalyptus	Antiseptic	.5
Oil of gaultheria	Antirheumatic, flavoring agent	.75
Oil of juniper	Irritant diuretic	.1
Oil of olive	Emollient, laxative	30.0
Oil of peppermint	Carminative, flavoring agent	.1
Oil of santal	Urinary antiseptic	.5
Oil of sassafras	Carminative, aromatic	.1
Oil of spearmint	Carminative, aromatic	.1
Oil of turpentine, rectified	Anthelmintic, antiseptic	.3
Opium	*See* Morphine	.06
Pancreatin	Digestant	.5
Papaverine hydrochloride	Narcotic, antispasmodic	.06
Paraldehyde	Hypnotic, sedative	2.0
Pepsin	Digestant	.5
Phenacetin	Analgesic, antipyretic	.3
Phenobarbital	Hypnotic, sedative	.03
Phenobarbital sodium	*See* Phenobarbital	.03
Phenol	Antiseptic, germicide, caustic	.06
Phenolphthalein	Cathartic	.06
Phenolsulfonphthalein	Kidney functional test	.006
Phenyl salicylate	Intestinal antiseptic	.3
Phosphoric acid, diluted	Supply phosphates	1.0
Physostigmine salicylate	*See* Eserine salicylate	.002
Pilocarpine nitrate	Myotic, diaphoretic	.005
Pituitary, anterior	Growth and sex stimulant	.3
Pituitary, whole	Uterine and growth stimulant	.06
Pituitary, posterior	Uterine stimulant	.006
Potassium acetate	Diuretic	1.0
Potassium bitartrate	Aperient	2.0
Potassium bromide	Sedative	1.0
Potassium chloride	Replace chlorides in body fluids	1.0
Potassium citrate	Systemic alkalizer, diuretic	1.0
Potassium guaiacolsulfonate	Bronchial antiseptic	.5
Potassium iodide	Antisyphilitic, expectorant, diuretic.	.3

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Drug	Therapeutic use	Average dose
		Gm or cc
Potassium nitrate	Antiasthmatic	.3
Potassium permanganate	Disinfectant	.06
Potassium thiocyanate	Vasodilator	.3
Quinidine sulfate	Control auricular fibrillation	.2
Quinine	Antimalarial, bitter tonic	1.0
Quinine hydrochloride	*See* Quinine	.3
Quinine sulfate	*See* Quinine	1.0
Reduced iron	*See* Iron, reduced	.5
Resorcin	Antiseptic	.125
Rhubarb	Laxative	1.0
Rochelle salt	Saline cathartic	10.0
Salol	*See* Phenyl salicylate	.3
Santonin	Anthelmintic	.06
Scopolamine hydrobromide	Mydriatic, brain sedative	.0005
Senna	Cathartic	2.0
Sodium acetate	Diuretic	1.5
Sodium benzoate	Antiseptic	1.0
Sodium bicarbonate	Alkalizer, antacid	1.0
Sodium bromide	Sedative	1.0
Sodium citrate	Systemic alkalizer, diuretic	1.0
Sodium iodide	Expectorant, diuretic	.3
Sodium nitrite	Vasodilator	.06
Sodium perborate	Bactericide	.06
Sodium phosphate	Saline cathartic	4.0
Sodium salicylate	Analgesic in arthritis	1.0
Sodium sulfate	Saline cathartic	15.0
Sodium thiocyanate	Vasodilator	.3
Sodium thiosulfate	Antiparasitic	1.0
Stramonium	Antispasmodic, anodyne	.075
Strophanthin	Cardiac stimulant, diuretic	.0005
Strychnine nitrate	Circulatory stimulant	.002
Strychnine sulfate	*See* Strychnine nitrate	.002
Sulfonethylmethane	Hypnotic	.75
Sulfur	Antiparasitic, cathartic	4.0
Sulfuric acid aromatic	Tonic, astringent	.5
Tartar emetic	Expectorant	.003
Terebene	Expectorant	.25
Theophylline	Diuretic	.25
Theophylline with ethylene diamine.	*See* Aminophylline	.1
Theophylline with sodium acetate	Diuretic	.2
Thymol	Antiseptic, anthelmintic	.125
Thyroid	Hypothyroidism	.06
Thyroxin	*See* Thyroid	.0005
Valerian	Antispasmodic, sedative	.75

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SECTION IV

TOXICOLOGY

Paragraph
Definitions 305
Symptoms of poisoning 306
Diagnosis of poisoning 307
Antidotes 308

305. Definitions.—*a. Toxicology* is the science which treats of the nature, properties, effects, identification, and antidotal treatment of poisons. The technician should be able to recognize the type of poison taken, through his knowledge of its characteristic action and effect upon the patient, and administer the proper emergency antidote. Whenever poisoning is suspected, a medical officer should be called IMMEDIATELY and such antidotal measures as necessary administered. Time is an essential factor in the treatment of acute poisoning, and delay in the administration of proper treatment may cost a life.

b. A *poison* is any substance which, without acting mechanically, uniformly causes a disturbance of bodily functions, injury, disease, or death when applied to or introduced into the human or animal body. AR 40–590 defines a potent poison as any substance which is likely to destroy human life or seriously endanger health when applied externally to the body or when taken internally in a dose of less than one teaspoonful—4 cc, or in the solid state—4 gm.

c. Acute poisoning is caused by taking a toxic or lethal dose of a poison or smaller doses at short intervals. The acute symptoms are caused by the rapid absorption of the poison by the blood, as a result of which it comes in contact with the tissues and organs of the body, and thereby impairs or stops their normal function.

d. Chronic poisoning is caused by taking, inhaling, or absorbing through the skin, for an extended period, small quantities of a cumulative poison, which produces progressive deterioration of function of tissue. The treatment of this type of poisoning will not be considered in this manual as its treatment is not of an emergency nature.

e. An *antidote* is any measure or agent that will remove, prevent the absorption of, or counteract the physiologic effects of a poison. The three classes of antidotes are—

(1) *Mechanical antidote.*—One that will remove a poison or prevent its absorption.

(2) *Chemical antidote.*—One that will react chemically with the poison to form a nontoxic compound. Poisons are rendered nontoxic by the formation of insoluble compounds or soluble nontoxic compounds, or by oxidizing the poison.

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(3) *Physiologic antidote.*—One whose action on the system is opposite to that of the poison.

306. Symptoms of poisoning.—Absorbed poisons quickly pass from the blood stream into the tissues of the various organs. The poison interferes with the normal functioning of the organ and produces abnormal or pathologic symptoms. Poisoning is indicated if a person suffers intense pain, becomes delirious, sinks into a stupor, has convulsions, or vomits freely after taking a drug or a food, provided, however, the symptoms are not caused by disease. The symptoms may vary with the amount of poison taken and absorbed and with the length of time the poison has been in the system. Most poisons exhibit three stages and some poisons, such as the anesthetics, exhibit four degrees or stages of poisoning. The treatment of poisoning will vary, therefore, according to the degree or stage of poisoning.

a. First degree poisoning is a period of very brief duration. If a person is observed in this state, it is easy to perceive the nature of the poison and the necessity for prompt action. The antidotes usually employed are mechanical and chemical because much of the poison still remains within the stomach.

b. Second degree poisoning is the period producing marked symptoms which indicate the true nature of the poisoning. Physiologic antidotes should be used first. They are usually administered in small amounts and repeated frequently, a precaution taken in order to avoid poisoning by an overdose of the antidote. The value of physiologic antidotes depends upon their producing an opposite effect on the system from that of the poison. Mechanical and chemical antidotes should follow the use of physiologic antidotes because some of the poison may still be in the stomach or intestines.

c. Third degree poisoning is the stage during which the poison produces the full effects upon the system. The vital organs are depressed, often to the point of ceasing to function, and death occurs. Physiologic antidotes and measures are used during the third degree of poisoning.

307. Diagnosis of poisoning.—The diagnosis of poisoning is difficult because many poisons develop symptoms resembling those of disease and because few poisons exhibit symptoms sufficiently characteristic to identify the poison positively. The physical effects of poisons which aid in diagnosis include—

a. Poisons identified by their corrosive action.—Corrosion, swelling, and bleaching of the skin, mouth, and throat indicate poisoning by caustic acids, alkalies, phenols, and metallic salts.

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b. Poisons identified by color of the stain.—Iodine stains the skin and mucous membranes black; bromine stains deep brown; nitric acid and picric acid stain yellow; phenol bleaches the skin.

c. Poisons identified by odor of breath.—Creosote, phenol, ether, chloroform, oil of bitter almond, and alcohol impart a distinctive odor to the breath. In phosphorus poisoning the odor is like that of garlic.

d. Poisons identified by color of urine.—Phenol, salol, creosote, and resorcinol impart a dark green color to the urine; antipyrine and trional after long use impart a red color; pyrogallol, a brown or black color; picric acid, a yellow color; santonin, a bright yellow color, which changes to scarlet on the addition of a caustic alkali.

e. Gastrointestinal tract.—Corrosive and irritant poisons will cause nausea and vomiting.

f. Respiration.—Respiration is labored in most forms of acute poisoning, particularly after vomiting, after poisoning by corrosives which cause swelling of the glottis, after muscular spasms in poisoning by strychnine, and after depression of the respiratory center by hydrocyanic acid, morphine, and other respiratory depressants.

g. Pulse.—In acute poisoning the pulse is quick and feeble, due to shock.

h. Body temperature.—Quinine, acetanilid, and salicylates depress the heat center, lowering temperature.

i. Disturbances of the nerves and muscles.—Strychnine overstimulates the motor nerves, causing convulsions; lead paralyzes the muscles of the hands, causing wristdrop; conium paralyzes the nerve endings in muscles, causing muscular paralysis.

j. Eye.—Morphine contracts the pupils of the eyes to "pinpoints"; atropine dilates the pupil of the eye; santonin and chronic digitalis poisoning give yellow vision; and wood alcohol causes blindness.

k. Ear.—Strychnine increases sensitiveness to sound; quinine causes a ringing sensation; salicylates, a buzzing sensation.

l. Skin.—Aconite causes a tingling sensation, then numbness, and finally anesthesia; nitrites dilate the skin capillaries, causing redness; silver salts cause blackish blotches; iodides cause a skin rash.

m. Cerebrum.—Narcotics cause stupor and coma; chronic poisoning by cocaine and alcohol causes severe psychic disturbances.

n. Heart.—Aconite, aconitine, chloral hydrate, acetanilid, phenacetin, antipyrine, and nicotine paralyze the heart muscles.

308. Antidotes.—The treatment of poisoning demands—

a. Removing the bulk of the poison from the stomach by gastric lavage or emetics. (Do not use in case of poisoning by strong min-

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eral acids or caustic alkalies as the mucous membranes may be further destroyed.)

b. Antidoting the residual poison not removed by gastric lavage.

c. Elimination from the system the poison that has been absorbed.

d. Immediate symptomatic treatment, when indicated.

e. A list of common poisons with their antidotes follows.

Acetanilid—Emetics; stimulants, such as coffee; heat.

Acid, acetic—Alkalies such as sodium and potassium bicarbonates; soap and magnesia; olive oil; milk.

Acid, carbolic—Alcohol and water (4 fl oz of each), or whiskey, brandy, etc., followed by an emetic; magnesium or sodium sulfate.

Acids, mineral—Milk of magnesia; chalk; demulcent drinks; fixed oils; do not use emetics or stomach tube.

Acid, oxalic—*See* Oxalic acid.

Aconite—Recumbent position; emetics; stimulants; heat to extremities.

Alcohol—Evacuate stomach; strong coffee; aromatic spirits of ammonia; external heat.

Alkalies, caustic—Vinegar and water; lemon juice; orange juice; olive oil; milk; do not use emetics or stomach tube.

Alkaloids—Tannic acid; solution of iodine; charcoal; evacuate stomach.

Ammonia—*See* Alkalies.

Antipyrine—*See* Acetanilid.

Arsenic—Prepare a chemical antidote by adding ammonia to tincture of iron chloride, washing the precipitate, and administering it; emetics; demulcent drinks; external heat.

Atropine—Tannic acid and emetics; morphine and pilocarpine as physiologic antidotes; external heat.

Barbiturates—Stimulants with strong coffee; ephedrine and caffeine; emetics.

Belladonna—*See* Atropine.

Bromides—Evacuate stomach; caffeine or strong coffee.

Caffeine—Emetics; stimulants; heat.

Camphor—Emetics; heat; stimulants; alcohol.

Carbolic acid—*See* Acid, carbolic.

Carbon monoxide—Fresh air; oxygen inhalation; artificial respiration.

Chloral hydrate—Emetics; stomach pump; caffeine; artificial respiration; cold to head.

Chloroform—When inhaled, remove the drug; lower head of the patient; pull tongue forward; fresh air; artificial respiration; ammonia by inhalation. When swallowed, emetics; sodium bicarbonate; fresh air; artificial respiration; ammonia by inhalation.

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Codeine—*See* Morphine.
Colchicine—Tannic acid; emetics; cathartics; demulcent drinks.
Copper salts—Emetics; albumin (egg white); demulcent drinks.
Corrosive sublimate—*See* Mercury and its compounds.
Creosote—*See* Acid, carbolic.
Cresol (or *Lysol*)—*See Acid*, carbolic.
Croton oil—Emetics; magnesium sulfate or sodium sulfate; demulcents.
Cyanides—*See* Hydrocyanic acid.
Digitalis—Emetics; tannic acid; alcohol; complete rest.
Ether—*See* Chloroform.
Formaldehyde—Emetics or stomach tube; inhalation of ammonia; demulcents.
Hydrocyanic acid—Fresh air; ammonia inhalation; hydrogen peroxide; artificial respiration.
Hyoscyamus—*See* Atropine.
Iodine—Paste of starch or flour followed by emetics; demulcents.
Lead salts—Epsom salts or the sulfate or phosphate of soda by mouth, followed by emetics.
Mercuric chloride—*See* Mercury and its compounds.
Mercury and its compounds—White of eggs; emetics; milk; evacuants.
Morphine—Emetics; potassium permanganate; Lugol's solution; cathartics; keep patient awake.
Nitroglycerine—Emetics; cathartics; atropine; black coffee; horizontal position.
Nux vomica—*See* Strychnine.
Opium—*See* Morphine.
Oxalic acid—Chalk or lime water; do not use the alkalies of sodium and potassium; demulcents.
Phenobarbital—*See* Barbiturates.
Phenol—*See* Acid, carbolic.
Pilocarpine—Emetics; evacuants; stimulants; artificial respiration.
Potassium permanganate—White of egg; evacuation of the stomach.
Silver salts—Sodium chloride; emetics; demulcent drinks; evacuants.
Strychnine—Tannic acid and evacuation of the stomach by lavage; ether or chloroform inhalations, or barbiturates or chloral if convulsive.
Sugar of lead—*See* Lead salts.
Tartar emetic—Vegetable astringents, such as tannic acid.
Wood alcohol—Emetic; sodium bicarbonate in repeated doses; purgatives; ammonia inhalations.
Zinc salts—Sodium carbonate; emetics; warm demulcent drinks.

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CHAPTER 7

PRESCRIPTION STUDY

		Paragraphs
SECTION I.	The prescription	309–311
II.	Definitions of medical terms	312
III.	Incompatibility	313–315
IV.	Hints in practical pharmacy	316–325

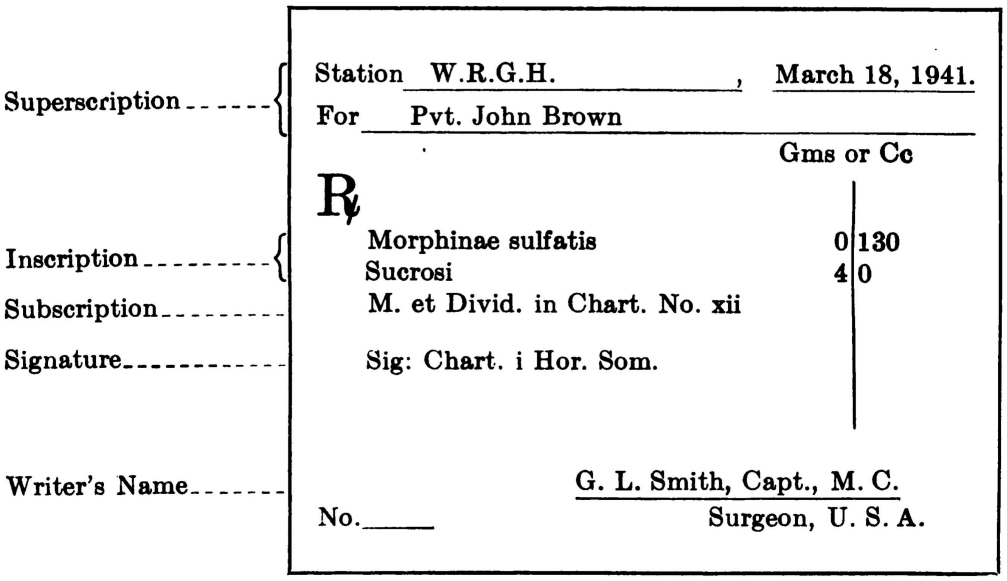
SECTION I

THE PRESCRIPTION

	Paragraph
Definition	309
Form	310
Table of Latin words and abbreviations	311

309. Definition.—A military prescription is a written order from a military surgeon for a remedy, usually accompanied by directions for its compounding and administration. Its design is to procure for the patient a special remedy, in such quantity as is deemed needful.

310. Form.—The form of the military prescription is shown in the following diagram:



a. The superscription includes the patient's name and grade, the date, and the station; the inscription, the sign "℞," the ingredients and quantities; the subscription, the directions to the compounder; the signature, the directions to the patient to be put on the label; and the writer's signature.

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b. The inscription opens with the symbol "℞." This was probably, in the original, the sign of Jupiter, ♃, placed at the head as a prayer for favor and healing to that deity—such a custom being common in the days of mythology and superstition. It is now generally understood as standing for the imperative form of the Latin verb "recipio," meaning "I take." Hence the imperative form is "recipe," "take" or "take thou."

c. The next consideration is that portion of the inscription in which the ingredients are written. The subscription and signature usually contain some Latin terminology, but, inasmuch as these portions are usually abbreviated, it will suffice to acquaint the technician with the noun endings in the inscription. As stated before, the ℞ denotes the imperative form, "recipe," which is instruction to the compounder to take the following ingredients as appear in the prescription, with their quantities, and prepare them as instructed in the signature. Latin nouns generally fall into three classes (declensions) according to their nominative singular endings. Those ending in "a," "us" or "um," and "as" are shown in examples below:

Declension	Latin	English
First declension, nominative	Morphina	Morphine.
Second declension, nominative	Sucrosum	Sucrose.
Third declension, nominative	Sulfas	Sulfate.

The only other case ending that will be considered is the genative singular for nouns of each of the three declensions, because that ending is most commonly found in the inscription of prescriptions. The typical noun case endings for the genative singular are as follows:

Declension	Latin	English
First declension, genative singular	Morphinae	Morphine.
Second declension, genative singular	Sucrosi	Sucrose.
Third declension, genative singular	Sulfatis	Sulfate.

Hence it is seen that the ending of the first declension nouns is changed from "a" to "ae," the second declension from "um" or "us" (as the ending may be) to "i," and the third declension from "as" to "atis" to form the genative singular. The inscription of the prescription now reads, "Take of (the) sulfate of morphine, 0.130;

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(take) of sucrose, 4.0. There are also some nouns of the fourth declension that are irregular and follow no set rule. Therefore, they will not be considered.

311. Table of Latin words and abbreviations.—As previously stated, the subscription is usually abbreviated. The signature may be written or abbreviated in Latin or English. A table of Latin words and abbreviations most commonly used in prescription writing follows:

Abbreviation	Latin	English
aa	Ana	Of each
A c	Ante cibos	Before food
Ad	Ad	To; up to
Add	Adde	Add
Ad lib	Ad libitum	At pleasure
Agit	Agita	Shake or stir
Alb	Albus	White
Ante	Ante	Before
Aq	Aqua	Water
Aq bull	Aqua bulliens	Boiling water
Aq frig	Aqua frigida	Cold water
Bis	Bis	Twice
B i d	Bis in die	Twice daily
Cap	Capiat	Let the patient take
Caps	Capsula	Capsule
Chart	Chartula	A little paper
Coch mag	Cochleare magnum	A tablespoonful
Coch med	Cochleare medium	A dessertspoonful
Coch parv	Cochleare parvum	A teaspoonful
Cola	Cola	Strain
Comp	Compositus	Compound
c	Cum	With
Da; det	Da; detur	Give; let be given
d	Dies	Day
Dl	Dilue	Dilute
Disp	Dispensa	Dispense
D.T.D	Dentur Tales Doses	Dispense of such doses
Divid	Divide	Divide
El	Elixir	Elixir
Ex	Ex	From
Et	Et	And
E m p	Ex modo praescripto	After the manner prescribed
Ext	Extractum	An extract
Filt	Filtra	Filter
Flav	Flavus	Yellow
Fl	Fluidus	Fluid
Ft	Fac; fiat, fiant	Make, let be made
Gm	Gramma	Gram

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Abbreviation	Latin	English
gr	Granum	Grain
gtt	Gutta	A drop
Hor som; h s	Hora somni	At bedtime
In	In	In; into
Liq	Liquor	A liquor
M	Misce	Mix
Magn	Magnus	Large
Mass	Massa	A mass
Mist	Mistura	A mixture
Non rep	Non repetatur	Do not repeat
No	Numerus	Number
O	Octarius	A pint
O D	Oculus dexter	Right eye
Omn hor	Omni hora	Every hour
Omn man	Omni mane	Every morning
Opt	Optimus	Best
O S	Oculus sinister	Left eye
Per	Per	Through
Pil	Pilula	Pill
Post cib; p c	Post cibum	After eating
P r n	Pro re nata	According to circumstances
Pulv	Pulvis	A powder
q i d	Quater in die	Four times a day
q s	Quantum sufficiat	A sufficient quantity
Rx	Recipe	Take
Rept	Repetatur	Let it be repeated
Sat	Saturatus	Saturated
s a	Secundum artum	According to art
ss	Semi	One half
Sig	Signa	Label; let it be labeled
s	Sine	Without
Si op sit; s o s	Si opus sit	If it is needed
Sol	Solutio	Solution
Solv	Solve	Dissolve
Spir	Spiritus	Spirit
Stat	Statim	At once
Syr	Syrupus	Syrup
Tab	Tabella	Tablet
Tal	Talis	Of such
t i d	Ter in die	Three times a day
Tr; Tinct	Tinctura	Tincture
Trit	Tritura	Triturate
Ung	Unguentum	Ointment
Ut dict	Ut dictum	As directed
Vin	Vinum	Wine
Vit ov	Ovi vitellum	Yolk of an egg

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SECTION II

DEFINITIONS OF MEDICAL TERMS

Paragraph
Definitions of medical terms 312

312. Definitions of medical terms.—The following is a list of terms used in medicine, with definitions and examples:

Adjuvant.—A drug that assists the action of another to which it is added. Compound elixir of pepsin.

Alterative.—An agent that favorably modifies the process of nutrition and repair, without exerting a demonstrable influence upon any particular organ. Potassium iodide.

Analeptic.—An agent that aids in the restoration of health after illness.

Analgesic.—A drug which relieves pain. Opium and its alkaloids, acetanilid.

Anesthetic, general.—A drug used to abolish sensation and produce sleep. Ether, chloroform.

Anhidrotic.—An agent which lessens the secretion of sweat. Atropine.

Anodyne.—A drug that relieves pain. Opium and its derivatives. Phenacetin.

Antacid.—A drug that counteracts or neutralizes acids or acidity. Lime water, carbonates, and bicarbonates.

Antarthritic.—A drug which relieves pain in and sometimes corrects the cause of arthritis. Salicylates, cinchophen.

Anthelmintic.—A drug used to expel intestinal worms. Oleoresin aspidium, carbon tetrachloride.

Antiasthmatic.—A drug which tends to relieve or prevent asthma. Ephedrine, epinephrine.

Antiblennorrhagic.—An agent used in the prevention or treatment of gonorrhea. Potassium permanganate, sulfanilamide.

Antidysenteric.—A drug used to control diarrhea. Milk of bismuth.

Antiemetic.—A drug used to prevent vomiting. Cerium oxalate, bismuth subnitrate.

Antileutic.—*See* Antisyphilitic.

Antimalarial.—A drug used to combat malaria. Cinchona, quinine.

Antineuralgic.—A drug used in the treatment of neuralgia. Salicylates, acetanilid.

Antiphlogistic.—A drug used to prevent the progress of inflammation. Cataplasm of kaolin.

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Antipruritic.—A drug which relieves itching. Phenol (in dilute solutions).

Antipyretic.—A drug which reduces fever. Phenacetin, antipyrine.

Antirheumatic.—A drug used in treating rheumatism. Salicylates.

Antiscorbutic.—An agent used for the prevention and treatment of scurvy. Cevitamic acid.

Antiseptic.—A drug limiting bacterial growth. Boric acid, chlorobutanol.

Antispasmodic.—A drug which relieves convulsions or spasms. Bromides, chloral.

Antisyphilitic.—A drug used in the treatment of syphilis. Neoarsphenamine.

Aperient.—A mild laxative. Effervescent sodium phosphate.

Astringent.—A drug which contracts tissues and lessens secretions. Alum, zinc sulfate.

Cardiac sedative.—A drug which reduces heart action or force. Morphine.

Cardiac stimulant.—A drug which stimulates the heart. Digitalis.

Carminative.—A drug used to relieve colic, griping, or flatulence. Cardamom, ginger.

Cathartic.—A drug used to produce evacuation of the bowels. Castor oil, aloes.

Caustic.—An agent capable of destroying or corroding the soft tissues of the body, producing a slough. Chromic acid, silver nitrate, phenol.

Counterirritant.—An agent which produces superficial irritation and is used to counter the effect of an adjacent or deep-seated abnormal process. Mustard.

Demulcent.—An agent used to soothe and protect inflamed or abraded tissues, particularly the mucous membranes. Glycerine, tragacanth.

Detergent.—A cleaning agent. Liquid soap, soft soap.

Diaphoretic.—A drug which stimulates increased secretion of the sweat glands. Pilocarpine, Dover's powder.

Disinfectant.—An agent which destroys micro-organisms. Phenol, cresol.

Diuretic.—A drug which increases kidney excretion. Potassium acetate.

Drastic.—A powerful and irritating purgative. Jalap.

Ecbolic.—A drug which accelerates parturition. Ergot.

Emetic.—A drug which produces vomiting. Apomorphine, ipecac.

Emmenagogue.—A drug used to produce or increase the menstrual flow. Apiol, ergot.

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Emollient.—A drug used externally to soften or soothe the skin. Bland oils.

Escharotic.—*See* Caustic.

Expectorant.—A drug which promotes the secretion and excretion of mucous from the respiratory tract. Ammonium chloride, ipecac.

Febrifuge.—*See* Antipyretic.

Galactagogue.—An agent which increases the secretion of milk. Malt extract.

Germicide.—*See* Disinfectant.

Hemostatic.—An agent used to check hemorrhage. Tannin, epinephrine.

Hydrogogue cathartic.—A drug which produces copious watery stools. Jalap, colocynth.

Hypnotic.—A drug used to produce sleep. Opium, chloral.

Irritant.—An agent inducing irritation. Cantharides, mustard.

Laxative.—A mild cathartic. Sulfur, prepared agar.

Mydriatic.—A drug which causes dilatation of the pupil of the eye. Atropine.

Myotic.—A drug which causes contraction of the pupil of the eye. Pilocarpine.

Narcotic.—A drug which produces stupor or complete insensibility. Opium.

Oxytocic.—A drug which increases the expulsive power of the uterus. Ampoules of pituitary extract.

Parasiticide.—A drug used to destroy parasites. Sulfur, mild mercurial ointment.

Purgative.—A strong cathartic. Magnesium sulfate, croton oil.

Rubefacient.—A drug which produces redness of the skin. Capsicum, mustard.

Somnifacient.—*See* Hypnotic.

Soporific.—*See* Hypnotic.

Stomachic.—A drug used to stimulate the appetite and gastric secretions. Gentian, cinchona.

Styptic.—An agent that controls hemorrhage by local application. Alum, tannic acid.

Sudorific.—*See* Diaphoretic.

Tenicide (tenifuge).—A drug used to expel tapeworms. Aspidium.

Vasodilator.—A drug which dilates the smaller blood vessels and thereby lowers arterial tension. Nitroglycerine.

Vasoconstrictor.—A drug which constricts the smaller blood vessels and thereby increases arterial pressure. Epinephrine.

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Vermifuge (vermicide).—*See* Anthelmintic.
Vesicant.—A drug which causes blistering. Cantharides.

SECTION III

INCOMPATIBILITY

Paragraph
General 313
Definitions 314
Common incompatibilities 315

313. General.—The problem of incompatibility is one that will face the technician throughout his pharmaceutical experience. It covers a wide range of substances and reactions. His ability to compound an elegant preparation, possessing the maximum intended therapeutic value, depends upon his knowledge of the individual ingredients and their reactions with the other ingredients in the preparation. It is imperative that the technician carefully examine each formula that he is to fill and look for objectionable incompatibilities between the ingredients that can be overcome by the proper action. There are some examples of incompatible preparations in which the incompatibility is intentional. An example is a formula calling for sulfurated potash and zinc sulfate. It is evident at a glance, that the writer intends the preparation to contain a precipitate. It is ordinarily, however, considered to be a practice of "elegant pharmacy" to dispense clear solutions when possible.

314. Definitions.—*a. Incompatibility* means disagreement. In pharmacy it embraces the study of the properties of substances which, when prescribed in the same combination or when mixed together, show some physical change or undergo decomposition, or in some other manner, show repellent or antagonistic qualities. Prescription incompatibility is grouped into three classes according to the nature of the disagreement as defined below.

b. Therapeutic incompatibility is exemplified in preparations containing ingredients which are antagonistic in their therapeutic actions. This type will not be considered, as its correction is outside of the province of pharmacy, with the exception of one phase, that of excessive dosage. It is of utmost importance that the dosage of each ingredient be checked before filling, and, if found to be excessive, steps should be taken to contact the writer with a view to its correction. A prescription MUST NEVER BE DISPENSED until the dosage of each ingredient has been checked by the compounder and found to be safe.

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c. Physical incompatibility is concerned with combinations of ingredients which are physically repellant to each other, such as oil and water, or with prescriptions or mixtures in which changes take place at the time of their compounding or subsequent thereto, in which no chemical alteration or decomposition of the ingredients is involved.

d. Chemical incompatibility is concerned with changes which take place in prescriptions or preparations in which, through chemical dissociation or decomposition, alterations in composition are produced which may or may not be evidenced by a changed appearance of the preparation, or which may or may not have an effect upon its therapeutic value.

315. Common incompatibilities.—The following generalities can be expected to do no more than assist the technician in dealing with many of the incompatibilities that may arise in his prescription practice:

a. Therapeutic incompatibilities include excessive dosage. There are factors that influence the dose of a drug that a person may safely take. Among the important ones are those listed below:

(1) *The patient.*—The weight or size of a patient may vary the amount of a drug a person may take. Obviously a large person can take more of a drug than a small one. Temperament plays a part in the administration of drugs affecting the nervous system. A nervous person can take more of a sedative and less of a stimulant than a phlegmatic one.

(2) *Pathological conditions.*—Disease may greatly alter the amount of a drug a patient may take. Persons in great pain can tolerate large amounts of narcotics; heart cases can tolerate more digitalis than a normal person, etc. In short, the need for a drug may affect the amount of it that can be taken safely.

(3) *Habituation.*—Prolonged administration of a drug may decrease the susceptibility of a person for a drug, making necessary an increase in the dose. This is often true of the opiates, of which a habituated person can take doses that would prove fatal to one not so habituated.

(4) *Idiosyncracy.*—Some persons are susceptible to some drugs, and doses of these drugs, that in an ordinary person would be beneficial, will be dangerous or even fatal to one having an idiosyncracy to the drug. The technician, except in rare instances of a previous experience with an individual, has no way to judge the effects of idiosyncracies in prescription compounding.

(5) *Frequency of administration.*—This frequently alters the amount of a drug that should be prescribed. Whenever the com-

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pounder finds a large dose, whether the individual dose is large or not, he should take into consideration the total amount of the drug given in a day, and the length of time the remedy is to be continued.

(6) *Period of activity.*—Drug action may be evanescent, steady, or cumulative. Aconite, for instance, acts quickly and its action does not last very long. It may, therefore, be administered in very frequent doses, and a single large dose is more active than the same amount given over a period of time. Other drugs act more slowly and the action persists for some time. In drugs of this kind, if given frequently, the effects of a previous dose may not have worn off when the next dose is given, and a cumulative action results; the drug accumulates in the system until a powerful and perhaps dangerous action may result.

(7) *Synergistic action.*—Some drugs increase the action of other drugs when they are given together. The physician often intends this, and deliberately prescribes together drugs which are synergists to one another. This may, however, occur inadvertently, and in that case, a dose of a drug which is only moderately large, might have a dangerous result.

b. Physical incompatibilities.—(1) Mixtures containing oil and water can often be dispensed in the form of a smooth, homogeneous preparation by the use of a gum or other emulsifying agent.

(2) Phenol may be made water-soluble by using an amount of glycerine equal to its own volume.

(3) When metallic salts are dissolved in medicated waters, an oily separation sometimes develops due to the selective action of the solvent. In some cases it is advisable to remove the excessive oil globules by filtration. In others it may be more desirable to reduce the "salting out" tendency by obtaining the writer's permission to use more of the solvent and to increase the dose accordingly.

(4) Gums, mucilages, and albuminous materials are generally incompatible with strongly alcoholic liquids. Their precipitation can usually be avoided by diluting the alcoholic liquid with water.

(5) Precipitation frequently takes place in mixtures containing fluidextracts or tinctures having widely different alcoholic content. This may involve the separation of active principles that are desirable in the mixture. The proper procedure would obviously be to dispense the entire mixture with a "Shake Well" label. The addition of a small amount of mucilage or syrup of acacia often prevents resinous matter from adhering to the sides of the bottle.

(6) Liquefaction is likely to occur when certain organic compounds like camphor, thymol, menthol, and salol are mixed or rubbed

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together (formation of eutectic mixture). When two or more of these ingredients are used in a mixture, which is intended to be in the form of a dry powder, it may be desirable to employ an absorbent powder, such as starch.

(7) Phenobarbital and all of the barbituric acid derivatives dissolve freely in alcohol, but are only very sparingly soluble in water. When prescribed in liquid preparations, they should be first dissolved in alcohol and then the other liquids added. If the proportion of alcohol present in the final liquid is not relatively high, precipitation may occur on standing. The sodium salts of the barbituric acid derivatives are soluble in water, but aqueous solutions may decompose on standing.

(8) Physical incompatibilities can very often be avoided by using care in the order of mixing the ingredients. It is always easier to prevent an incompatibility than it is to remedy one that has already taken place. The technician is frequently able to make a presentable mixture containing two or more ingredients that are known to be incompatible by mixing the offending agents with other ingredients in the mixture with which they may be compatible. For example, by bringing the incompatible ingredients together in the form of separate dilutions, advantage may be taken of a certain amount of protective or buffering action which seems to retard their precipitation.

c. Chemical incompatibilities.—(1) Alkaloids generally are precipitated from solutions of their salts by the action of alkalies or by the usual alkaloidal precipitating agents, such as tannic acid, mercuric chloride, or solutions of iodine. The soluble bromides act in like manner. It is good policy to place a "Shake Well" label on the bottle of a mixture when there is the slightest suspicion that such a precipitation may occur, notwithstanding the fact that the liquid may be perfectly clear at the time when it is dispensed.

(2) When a liquid mixture containing bismuth subnitrate and a carbonate or bicarbonate is dispensed in a tightly-stoppered bottle, an explosion is likely to occur. The subnitrate of bismuth undergoes a sufficient amount of hydrolysis to liberate a trace of free acid which, in the presence of the carbonate or bicarbonate, brings about a slow evolution of carbon dioxide. In this case the patient should be warned to keep the bottle very loosely stoppered. A better procedure is to obtain permission to use bismuth subcarbonate in place of bismuth subnitrate in the mixture.

(3) A common incompatibility frequently develops when chloral hydrate is dispensed with soluble salts in a hydro-alcoholic solution

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as, for example, in an elixir. An oily layer often separates, consisting of alcohol, chloral, chloral alcoholate, and perhaps some of the dissolved salt, depending upon the nature and the concentration of the mixture. It is always best to direct that such a mixture be well shaken before it is used, even though no separation may be noted when the mixture is dispensed.

(4) Zinc sulfate is sometimes prescribed with Dobell's solution. The result is that the insoluble zinc borate is precipitated and is frequently removed from the solution by filtration. In case both of the foregoing agents are really desired, it is better to obtain permission to dispense them separately.

(5) Colloidal silver solutions are made turbid by precipitation when an electrolyte, such as an acid, a base, or a salt is added to the mixture. For this reason it is advisable not to use other ingredients in aqueous solutions of the various silver proteinates. Solutions of chlorides form a precipitate when prescribed with silver proteinates, forming the insoluble silver chloride.

(6) Free acids may cause the separation of sparingly soluble organic acids from solutions of their soluble salts. Sometimes there is sufficient alcohol present to redissolve this precipitate.

(7) Sodium barbital and sodium phenobarbital generally form precipitates in their water solutions upon the addition of an excess of free acid. This is due to the decomposition of the sodium salt and the separation of free barbital or phenobarbital, both of which are insoluble in water but soluble in alcohol.

(8) Procaine hydrochloride behaves like an alkaloidal salt and is consequently incompatible with soluble alkalies and with the usual alkaloidal precipitating agents.

(9) Quinine sulfate causes precipitation when dispensed with acetic acid and an excess of potassium acetate. Similar precipitations are also brought about by the action of certain other acids, along with their corresponding potassium salts, upon quinine sulfate solutions.

(10) Aminopyrine frequently gives difficulty in that it forms a sticky mass with acetylsalicylic acid, and also with citric, tartaric, and salicylic acids. In solution, aminopyrine often gives pronounced colors, particularly with many oxidizing agents, such as ferric salts and with acacia.

(11) Free acids can be expected to liberate gases from solutions containing carbonates, bicarbonates, sulfites, bisulfites, thiosulfates, nitrites, and sulfides.

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(12) Ferric chloride usually gives pronounced color changes with phenol, resorcinol, salicylates, tannic acid, and tannin-containing drugs.

(13) Ephedrine behaves generally like a true alkaloid in that its salts are freely soluble in water. Ephedrine alkaloid, however, differs from most free alkaloids by being appreciably soluble in water, as well as in alcohol, and the immiscible solvents. For this reason, ephedrine base is not so apt to be precipitated in aqueous solutions by the action of the usual alkaloidal precipitating agents, although caution should be exercised with complex mixtures and a "Shake Well" label placed on the bottle.

Section IV

HINTS IN PRACTICAL PHARMACY

	Paragraph
The prescription	316
Solutions and mixtures	317
Emulsions	318
Ointments	319
Suppositories	320
Powders	321
Papers	322
Triturates	323
Capsules	324
General precautions	325

316. The prescription.—*a.* Read the prescription carefully, noting the quantity of each ingredient.

b. Do not hesitate to ask if in doubt about the name of a certain drug, proper weight, or dose.

c. Check the weight of each ingredient.

d. Make certain that the balance is correctly balanced.

e. Check off with pencil the name of each ingredient on the prescription in the process of compounding.

f. Do not weigh the ingredients on the bare scale pan. Always place a piece of pan-paper on each pan and zero the balance.

g. After the prescription has been compounded, make such notes on it as may be necessary so that subsequent compounding will be done in like manner.

317. Solutions and mixtures.—*a.* Supersaturated solutions should not be dispensed.

b. All solutions should be filtered or strained through cotton or gauze to remove particles of dirt or other foreign insoluble matter.

c. Rapid solution is often effected by first powdering the solute.

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d. When two or more solids are to be dissolved, each should be dissolved in separate portions of the solute and then the several solutions mixed.

e. Tinctures of vegetable drugs and solutions of animal substances should not be added directly to chemical salts but should be added after maximum dilution.

f. Precipitates, when desired, or when unavoidable, should be as fine as possible. Where a precipitate is desired or cannot be prevented, the two ingredients should be dissolved separately and mixed, each with about half the other ingredients, so that the precipitate will be as uniform and finely divided as possible. The two dilutions should then be mixed with constant agitation.

g. Solutions for use in the eye must be free from suspended particles. Filter them until a careful examination shows *no* suspended material.

h. Acacia or tragacanth can be used as suspending agents for mixtures. If the prescription contains more than 20 percent alcohol, or is strongly acid, tragacanth should be used. The amount of suspending agent used should depend upon the volume of the mixture and not the quantity of insoluble substance. In most cases, 5 percent of acacia or 1 percent of tragacanth is sufficient.

i. Alkaloids are commonly insoluble in water; their salts are usually soluble. In cases where the compounder has a choice, the salts should be used for aqueous liquids, the alkaloids themselves for highly alcoholic liquids or for oily solutions.

318. Emulsions.—*a.* All emulsions require "Shake Well" labels.

b. All emulsions should be strained.

c. A 4–2–1 ratio (oil, water, acacia) will produce a satisfactory emulsion with all fixed oils, liquid petrolatum, and other viscous substances. For other immiscible substances (volatile oils, etc.) a 4–4–2 or 2–2–1 ratio is recommended. The technique of these methods may be found in paragraph 119.

d. A whiter emulsion is obtained when acacia is used as an emulsifying agent, yet tragacanth is preferred as an emulsifying agent in emulsions containing high percentages of alcohol.

e. The mortar must be perfectly dry when making an emulsion.

f. Add the diluent very slowly, with constant trituration, to the "primary emulsion" or nucleus, to prevent cracking.

g. Alcohol, glycerine, syrup, water soluble salts, etc., tend to "crack" emulsions. Limited amounts of each may be incorporated into the *diluted* primary.

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h. Volatile oils are more easily emulsified and the emulsions are often more palatable if they are mixed with fixed oils before emulsifying. The "bottle method" of emulsification is recommended here to lessen loss of volatile ingredients where the fixed oil is not used.

319. Ointments.—*a.* Do not use a rancid ointment base.

b. Use anhydrous wool fat in making an ointment containing a large amount of water or other fluid, if there is a choice.

c. The medicinal agents must first be mixed with a small portion of the base to insure a smooth finished product.

d. Ointments intended for application to the eyes should be mixed in a glass mortar or on a glass slab. All incorporated solid ingredients should be impalpable.

e. Do not use an iron spatula in making ointments containing iodine or tannic acid.

f. Use warm water in making a cold cream to prevent a lumpy or granular product.

g. Do not dispense ointments containing gritty or crystalline material.

h. Pilular extracts, properly softened with dilute alcohol, should be used in preparing ointments, rather than powdered extracts.

i. When fusion is required, avoid excess heating.

320. Suppositories.—*a.* All suppositories should be marked "Keep in a Cool Place."

b. Hygroscopic suppositories (e. g., glycerogelatin) should be dispensed in tightly closed glass containers or individually wrapped in waxed paper or tinfoil.

c. When using an excess to compensate for unavoidable losses, use an excess of *both* medicament and base and adjust final produce to the theoretical weight to insure proper dosage.

d. Clean hands will insure suppositories free from streaks.

e. Use dusting powder sparingly.

f. Pilular extracts or fluidextracts will yield more uniformly colored suppositories than powdered extracts.

g. Oil of theobroma, or cocoa butter, is the most commonly used base for suppositories. It melts at body temperature, releasing its medicament gradually after introduction.

h. Glycerinated gelatin does not melt at body temperature, but slowly dissolves in the secretions of the mucous membranes.

321. Powders.—*a.* All bulk powders should be sieved.

b. While the combination of potent drugs, such as extract of belladonna and phenobarbital, in bulk powders should be discouraged because of danger of variable dosage, such prescriptions are frequently

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written. Extra care must be exercised in these cases to insure uniform distribution, and repeated sieving is suggested.

322. Papers.—*a.* See paragraph 321.

b. The contents of each paper should be weighed to insure accuracy of dosage. Practice will, however, develop skill in blocking, a method which is frequently used, particularly for bulky powders which do not contain potent ingredients.

c. For the greatest accuracy in folding and packaging, each powder should be weighed. When powders are not weighed individually the usual procedure is to make the subdivision by means of a spatula only, merely judging the quantity as nearly as possible by the eye. In folding papers, care should be taken to obtain uniformity so that there will be no varying height or length. All papers should fit snugly into the box, selection of the box depending upon the size and number of the papers.

323. Triturates.—*a.* Triturates consist of one part of medicine intimately mixed with varying parts of sugar of milk, depending upon the strength desired. Other inert diluents are sometimes used.

b. The United States Pharmacopoeia recognizes triturations containing 10 percent of the active ingredient and 90 percent of milk sugar.

c. Triturates are used to a great extent in dispensing potent drugs such as strychnine, atropine, and arsenic, obviating the necessity of weighing out minute quantities of such drugs.

324. Capsules.—*a.* Clean, dry hands are essential. Finished capsules should be cleansed and should show no trace of powder or fingerprints. This may be accomplished by rubbing the filled capsule between the folds of a towel or piece of gauze to remove any powder clinging to the outside.

b. The smallest sized capsule which will conveniently hold the ingredients should be used.

c. Each filled capsule should be adjusted to the correct weight. With practice, skill in blocking the powder will yield capsules varying less than 5 percent from the theoretical.

d. When the amount of powder to be placed in a capsule is insufficient to fill a given size, and too great to place in the next smaller size, a diluent, such as lactose, may be added.

e. In filling capsules with drugs that stain the gelatin, the capsule may be held with a strip of paper, or rubber gloves may be used.

f. When liquids are dispensed in sealed capsules, more than the number required should be filled and tested before dispensing to detect any that may be leaking.

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g. Sealing capsules is accomplished by pressing the cap upon a small piece of absorbent cotton saturated with water, placing it on the other half of the capsule, and giving it a twist.

h. Such substances as acetanilid, acetphenetidin, antipyrine, phenol, camphor, thymol, and menthol liquefy when triturated together. Should these be prescribed in a powder, or should very hygroscopic substances be added, it is sometimes helpful to add an inert and absorbent substance such as light magnesium oxide, kaolin, or starch. It is preferable to mix each ingredient separately with some of the absorbent substance and then prepare the mixture, thus lessening the reaction.

i. Occasionally it is desirable to prepare a capsule that will not dissolve in the stomach, but will pass into the small intestine before disintegrating and releasing its contents. For that purpose a coating (enteric coating) of salol is applied to the capsule in the following manner: Heat a small amount of salol slowly in an evaporating dish until it just liquefies. Introduce six or eight capsules to be coated and rotate the dish very rapidly until the capsules are uniformly coated and the coating is hard; repeat until all of the capsules are coated.

325. General precautions.—*a.* Do not triturate potassium chlorate with organic matter. There is danger of an explosion.

b. Camphor may be powdered easily by the addition of a small amount of ether or alcohol.

c. Every medicinal substance sent out from the dispensary must have a neat and distinct label upon it.

d. It is good pharmaceutical practice to attach a "Poison" label when dispensing medicines containing poisons.

e. Attach "For External Use" label to liniments and other preparations intended to be used externally.

f. Never dispense an emulsion or mixture containing insoluble material without a "Shake Well" label.

g. Always remember the five cardinal points in labeling a prescription: patient's name and rating, date, number, directions, and the name of the prescriber.

h. In refilling prescription, thoroughly clean the soiled container, affix a new label, and, in case of a bottle, use a new cork.

i. Two technicians should check prescriptions when possible.

j. If the man who compounds a prescription is required to check his own work, he should keep on the counter all the containers from which he takes the ingredients until the prescription is compounded, then proceed to check off each item and its quantity.

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k. If in doubt as to just what was used or the quantity used, throw away the entire prescription and start again. It is better to lose some material than to dispense the wrong medicine.

l. Paste the label evenly on the front of the bottle, a little above the center. Avoid an excess of paste. To smooth the label on the bottle, place a piece of clean paper over it and rub. To make labels stick on tin, coat the tin first with a thin layer of tincture of benzoin and let dry. Then apply paste and lastly the label.

m. Be neat in dispensing. Be sure that utensils and bottles are clean, corks are whole, and that packages are wrapped neatly.

n. In filling prescriptions for eye solutions, the greatest care should be taken, not only in accurate weighing and measuring the amounts called for, but also in maintaining scrupulous cleanliness. See that all containers and utensils are absolutely clean. All eye solutions and eye washes should be filtered through a high grade of filter paper, and distilled water only should be used in making them.

o. Cleanliness and accuracy are the two attributes absolutely necessary to the pharmacy technician. In compounding and dispensing medicines he holds the life of a patient or patients in his hands, and it is mandatory that he execute his duties in such a manner that the patient will receive the exact medicine ordered, prepared and dispensed with a view to neatness at all times. Nothing so reflects upon the Medical Department as the consequences resulting from the neglect or carelessness of the pharmacy technician.

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CHAPTER 8

SUPPLY AND ADMINISTRATION

	Paragraphs
SECTION I. General	326
II. Supply	327–331
III. Administration of the pharmacy	332–335

SECTION I

GENERAL

	Paragraph
General	326

326. General.—Pharmacies, like all other Army installations, are governed by Army Regulations, amplified or expanded by local regulations and orders promulgated by the station commander and the hospital commander. Each technician should therefore familiarize himself with the provisions of paragraph 18, AR 40–590, and all local regulations pertinent to the pharmacy.

SECTION II

SUPPLY

	Paragraph
General	327
Medical Department Supply Catalog	328
Nonstandard articles	329
Requisitioning from the medical supply officer	330
Requisitions by the medical supply officer	331

327. General.—One of the most important administrative functions connected with the pharmacy is the maintainance of adequate medicinals and equipment necessary to their proper dispensing. This duty usually falls upon the noncommissioned officer in charge who must make routine requisitions to the medical supply officer for both expendable and nonexpendable items of the Medical Department Supply Catalog as well as certain nonstandard items for which the necessity must be shown. The maintenance of adequate supplies in the medical supply is the responsibility of the medical supply officer and will not be discussed at this time.

328. Medical Department Supply Catalog.—This catalog is divided into nine classes of supplies which are discussed in the first few pages of the publication. The pharmacy technician is concerned

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primarily with Class 1 medical supplies under which is listed, in numerical and alphabetical order, all drugs, chemicals, and biological products which are dealt with chiefly in the pharmacy. Other services, however, draw from this class to satisfy their particular needs. The Class 4, or laboratory equipment and supplies, will necessarily be consulted when apparatus is needed for the pharmacy. Familiarity will be necessary with certain items grouped under Class 7, such as cleaning and preserving equipment and supplies, stationery and miscellaneous office equipment and supplies, and miscellaneous hospital equipment and supplies.

329. Nonstandard articles.—These are items which are not listed in the Medical Department Supply Catalog. They are classified just as they would be if they were standard items. Thus nonstandard drugs would be called "NonStandard I" items and nonstandard apparatus would be "NonStandard IV." These items are usually abbreviated "NS I or NS IV."

330. Requisitioning from the medical supply officer.—*a. Standard articles and nonstandard articles carried in stock at the medical supply.*—The items required are listed according to catalog number and descriptions and units desired on W. D., M. D. Form No. 16, checked and approved by the pharmacy officer and submitted to the medical supply officer for his approval of quantities and items. A receipt is obtained on the same form. This form is further classified to accommodate the various types of items desired.

(1) *W. D., M. D. Form No. 16a (white).*—For expendable items, whether standard or nonstandard, if carried in stock. Items not carried in stock must be certified as to the necessity for the item.

(2) *W. D., M. D. Form No. 16b (blue).*—For nonexpendable items. This form is intended to be used for the temporary issue of nonexpendable items, and is followed by a Memorandum Receipt which is usually issued periodically in consolidated form.

(3) *W. D., M. D. Form No. 16c (yellow).*—For items exchanged for new articles of some kind. Usually such items are nonexpendable, but Form No. 16c is sometimes used for expendable items where close control of them is required.

(4) *W. D., M. D. Form No. 16d (pink).*—This is a credit slip, and is used to return items no longer needed to the medical supply. In the case of nonexpendable items, this acts as a credit to the Memorandum Receipt.

b. Nonstandard items not carried in stock at the medical supply.—Items which are nonstandard and which are obtained by local purchase from funds alloted for this purpose must be supported by certificates

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showing their necessity. This may be on the requisition itself or accompany it in a separate letter of request.

331. Requisitions by the medical supply officer.—*a.* Since the source of supply beyond the medical supply officer is not of concern to the technician, only a brief reference will be made to this phase of supply with the belief that it may be of value in facilitating cooperation by the pharmacy personnel with the medical supply in maintaining adequate stocks. The supplies are obtained by the medical officer from general depots at stated times of the year, and interim requisitions are a source of inconvenience to all concerned. The requisitions submitted to the depots are classified as follows:

(1) *Semiannual.*—For all items which are standard articles of medical and hospital supplies, except deteriorating items, included in the Medical Department Supply Catalog.

(2) *Quarterly standard.*—For all deteriorating supplies, such as biological products.

(3) *Quarterly nonstandard.*—For nonstandard supplies required during the quarter. The necessity for these items must be stated on the requisition.

(4) *Emergency.*—For any article or articles for which there is urgent need.

b. In addition to the requisition depots, the medical supply officer may purchase articles necessary to prevent suffering or distress among the sick and injured from Medical Department funds customarily allotted for this purpose.

Section III

ADMINISTRATION OF THE PHARMACY

	Paragraph
General	332
The pharmacy officer	333
The noncommissioned officer in charge	334
Records	335

332. General.—The administration of the pharmacy is carried out by a commissioned officer who is usually assigned to this in addition to his primary duties, and who is under the general supervision of the surgeon and the station commander.

333. The pharmacy officer.—This officer is in charge of the pharmacy and is responsible for carrying on the work of the drug room. All matters of general policy and property responsibility are also functions of the pharmacy officer, but it is not customary for

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him to perform any duties in actual compounding. All responsibility contingent to the handling, storing and dispensing of narcotic drugs, poisons, and alcohol are also his responsibility.

334. The noncommissioned officer in charge.—The actual detailed daily management is carried out by the noncommissioned officer of the highest rank in large pharmacies or by a pharmacy technician in smaller installations. He exercises actual supervision over the work being done and frequently compounds and dispenses medicinals himself. The pharmacy officer holds him responsible for the adherence to set policies and for the conduct of his subordinates. This noncommissioned officer or technician usually carries the keys to the pharmacy, stockroom, and safe. He is also held for the accuracy of all records and their safekeeping.

335. Records.—Inspection of the prescription file of the pharmacy by an inspector or the station commander, or his representative, is required by Army Regulations. They should therefore be a matter of particular pride and detailed accuracy.

a. Stock records.—The technician is referred to paragraph 18*b*, AR 40–590, for the method to be used in maintaining accurate balances on alcohol, alcoholic liquors, and narcotics.

b. Prescription files.—(1) The prescription files are kept as three separate records, each carrying a different series of numbers. Since duplicate numbers may occur, should they not be distinguished, narcotic and alcoholic prescriptions (alcoholic is interpreted as referring to prescriptions containing grain alcohol, whiskey, or wine, and not to the various alcoholic galenicals which are compounded as stock preparations, the alcohol content of which is recorded and credited to the stock record at the time of their manufacture) may have their number preceded by the letter "N" to designate the file in which they are recorded. Similarly, the numbers of civilian prescriptions which are referred to in paragraph 18*b*(1)(*b*), AR 40–590, may be preceded by the letter "C."

(2) Methods of filing prescriptions may vary with the availability of materials with which permanent records can be made. Pasting the prescriptions in a large filing book has been used extensively, and the book is listed in the supply table for this purpose. This method, however, proves time-consuming and may be deviated from in several ways. One practicable method is to utilize a punch, paper, 2-hole (item No. 76330 M. S. C.) for perforating each prescription. These daily prescriptions may be kept in a compartment box or on a spindle file until a group of one thousand is accumulated. Two rectangles of some rigid material such as

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plywood, sheet metal, or fabrikoid that are slightly larger than the size of the prescription blank should be procured and perforated with holes corresponding to those of the punch. By placing one of these protective supports on each side of the group of prescriptions and threading a continuous loop through the holes with heavy cord, a permanent file may thus be manufactured. By affixing the numbers of the first and last prescriptions on the top supporting leaf, a ready reference is maintained to any number within.

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APPENDIX

REFERENCES AND BIBLIOGRAPHY

1. References.—The rapidly changing methods of treatment of diseases limits the use of this manual to a consideration of only those elementary principles involved in preparations of long established usage. For knowledge concerning the newer medicaments so often placed in the pharmacy as nonstandard class I supplies, the technician is referred to the "New and Nonofficial Remedies" published annually by the American Medical Association through its council on pharmacy and chemistry and to the literature available from the manufacturers holding the process patent rights and trademarks to certain of these medicinal agents. The most recently published Pharmacopoea, with its supplements, and the National Formulary should always be consulted where medicinals have been incorporated in these publications.

2. Bibliography.—*a.* Copyrighted material from various sources has been drawn upon in the preparation of this manual, and credit is due the following references which have served and whose authors and copyright holders have cooperated in the use of the material:

The United States Pharmacopoea.
The National Formulary.
Remington: *Practice of Pharmacy.*
Scoville and Powers: *The Art of Compounding.*
Mansfield: *Materia Medica, Toxicology and Pharmacology.*
Arny and Fischelis: *Principles of Pharmacy.*
Bastedo: *Materia Medica, Pharmacology and Therapeutics.*

b. The publishers or authors of these texts are not responsible for any inaccuracy of quotation nor any errors in the statement of quantities or percentage strengths.

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INDEX

	Paragraph	Page
Acids	51	47
Organic	58	57
Active principles, classification	303	156
Addition reactions	55	52
Addition, weights and measures	10	15
Administration of the pharmacy	332	188
Alcohols	58	57
Aldehydes	58	57
Alkaloids	58	57
Alligation	27	29
Antidotes	308	165
Apothecaries' system	6	11
Aqua:		
Ammoniae	72	86
Ammoniae, fortior	73	86
Anisi	74	87
Aurantii florum	75	87
Camphorae	76	87
Chloroformi	77	87
Cinnamomi	78	87
Destillata	79	87
Destillata sterilisata	80	87
Foeniculi	81	88
Menthae piperitae	82	88
Menthae viridis	83	88
Rosae	84	88
Rosae fortior	85	88
Aquae:		
Definitions (waters)	69	85
Methods of preparation	70	85
Official processes for aromatic	71	85
Aromatic:		
Acids	58	57
Compounds	58	57
Esters	58	57
Ethers	58	57
Arsenic compounds, organic	58	57
Atomic weight	45	40
Avogadro's hypothesis	40	36
Avoirdupois system	7	12
Bacteriology, definition of	2	3
Balances	4	8
Bases	52	48

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

INDEX

	Paragraph	Page
Baths	59	75
Bichloride tablets	269–270	145
Biology, definition of	2	3
Botany, definition of	2	3
Boyle's law	39	36
Bromine	58	57
Calcination	60	76
Capsules, practical hints on	324	183
Carbohydrates	58	57
Carbonization	60	76
Catalog, Medical Department Supply	328	186
Charles' law	41	36
Chemical:		
Change	55	52
Formula	44	39
Nomenclature	50	45
Chemistry:		
Definition of	2	3
Definitions	35	33
Inorganic	43–55	37
Organic	56–58	56
Chlorine compounds, organic	58	57
Colation	62	78
Collodion, definition	186	118
Collodion, storage	187	118
Collodium	188	118
Collodium, flexile	189	118
Comminution	65	78
Contusion	65	78
Crystallization	68	82
Crystallization, water of	68	82
Dalton's law of constant proportions	36	35
Dalton's law of multiple proportions	37	35
Decantation	63	78
Decoction	67	80
Density	16	21
Desiccation	60	76
Digestion	67	80
Dispensatory	2	3
Displacement	55	52
Distillation	60	76
Destructive	60	76
Fractional	60	76
Steam	60	76
Division, weights and measures	10	15
Doses, calculation of	32	31
Doses, table of	304	158
Dover's powder	262	142

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

INDEX

	Paragraph	Page
Elements	43	37
Elixir:		
Amygdalae compositum	173	113
Aromaticum	174	113
Bromidorum trium	175	114
Cardamomi compositum	176	114
Ferri, quininae et strychninae	177	114
Glycyrrhizae	178	115
Iso-alcoholicum	179	115
Pepsini compositum	180	116
Pepsini et rennini	181	116
Phenobarbitali	182	117
Sodii bromidi	183	117
Terpini hydratis	184	117
Terpini hydratis et codeinae	185	117
Elixirs, definition	172	113
Elutriation	65	78
Emulsifying agents	118	98
Emulsions:		
Definitions	117	97
Methods of preparing	119	98
Practical hints on	318	181
Emulsum:		
Asafoetidae	120	99
Olei morrhuae	121	100
Olei terebinthinae	122	100
Petrolati liquidi	123	101
Enteric coating	324	183
Equivalents, derivation of	9	12
Equivalents, table of	9	12
Esters	58	57
Ethers	58	57
Exsiccation	60	76
Extraction	67	80
Extracts:		
Definition	245	137
Forms of	246	137
Method of preparation	247	137
Storage	248	138
Extractum:		
Belladonnae	249	138
Cascarae sagradae	250	138
Fellis bovis	251	139
Glycyrrhizae	252	139
Glycyrrhizae purum	253	139
Hepatis	254	139
Hyoscyami	255	140
Malti	256	140
Rhei	257	140
Stramonii	258	141

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

INDEX

	Paragraph	Page
Filtration	61	77
Fluidextracts:		
Definition	229	129
Methods of preparation	230	129
Storage	231	133
Fluidextractum:		
Cascarae sagradae	232	133
Cascarae sagradae aromaticum	233	133
Ergotae	234	134
Eriodictyi	235	134
Glycyrrhizae	236	134
Ipecacuanhae	237	135
Rhei	238	135
Sarsaparillae	239	135
Sennae	240	135
Zingiberis	241	135
Formulas, enlarging	31	31
Formulas, reducing	30	31
Fusion	60	76
Glycerine suppositories	301	154
Glycerinated gelatin	299	152
Glycerites, definition	152	108
Glyceritum:		
Acidi tannici	153	109
Amyli	154	109
Phenolis	155	109
Graduates	4	8
Gram, definition of	5	10
Heat, methods and applications	74–75	87
Henry's law	42	36
Hydrocarbons	58	57
Ignition	60	76
Incineration	60	76
Incompatabilities	313	175
Infusa, U.S.P., general formula	199	120
Infusion	67	80
Infusions, definition	198	120
Infusum digitalis	200	121
Iodine, compounds containing	58	57
Ketones	58	57
Latin, table of words and abbreviations in	311	170
Levigation	65	78
Liniments, definition	190	118

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

	Paragraph	Page
Linimentum:		
Calcis	191	119
Camphorae	192	119
Camphorae et saponis	193	119
Chloroformi	194	119
Saponis mollis	195	119
Liquor:		
Acidi arsenosi	88	89
Acidi borici	89	90
Alumini acetatis	90	90
Amaranthi	91	90
Antisepticus	92	91
Aromaticus alkalinus	93	91
Calcii hydroxidi	94	91
Cresolis saponatus	95	91
Ephedrinae sulfatis	96	92
Epinephrinae hydrochloridi	97	92
Ergosterolis irradiati	98	92
Formaldehydi	99	92
Hepatis	100	92
Hepatis purificatus	101	93
Histaminae phosphatis	102	93
Hydrogenii peroxidi	103	93
Iodi compositus	104	93
Magnesii citratis	105	93
Parathyroidei	106	94
Picis carbonis	107	94
Pituitarii posterii	108	94
Potassii arsenitis	109	95
Potassii hydroxidi	110	95
Potassii iodidi	111	95
Sodae et menthae	112	95
Sodii boratis compositus	113	96
Sodii chloridi physiologicus	114	96
Sodii hypochloritis	115	96
Sodii hypochloritis dilutus	116	96
Liquors (solutions), definition	86	89
Liquors, types	87	89
Liter, definition of	5	10
Lotio calaminae	150	108
Lotio calaminae phenolata	151	108
Lotions, definition	149	108
Maceration	67	80
Magma magnesiae	148	107
Magmas, definition of	147	107
Materia medica, definition of	2	3
Materia medica, general	302	155
Medical terms, definitions	312	172
Mercuric chloride tablets	269–270	145
Mercury compounds, organic	58	57

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

INDEX

	Paragraph	Page
Meter, definition of	5	10
Metric system	5	10
Milk of magnesia	148	107
Mineralogy, definition of	2	3
Mistura:		
Cretae	144	106
Definition of (mixtures)	143	106
Opii et glycyrrhizae composita	145	107
Rhei composita	146	107
Mixtures, definition of (mistura)	143	106
Molecular weight	46	41
Mucilages, definition	140	105
Mucilago acaciae	141	106
Mucilago tragacanthae	142	106
Multiplication, weights and measures	10	15
National Formulary	2	3, 191
Neutralization	53	49
New and Nonofficial Remedies	2, App.	3
Noncommissioned officer in charge	334	189
Nonstandard supplies	329	187
Ointment bases	273	146
Ointments:		
Definition	271	146
Methods of preparation	272	146
Practical hints on	319	182
Storage	274	147
Oleoresina aspidii	244	136
Oleoresins, definition	242	136
Oleoresins, method of preparation	243	136
Oleates, definition	196	120
Oleatum hydrargyri	197	120
Organic compounds, classes	58	57
Oxidation	55	52
Papers, practical hints on	322	183
Pasta zinci oxidi	295	151
Pasta zinci oxidi cum acido salicylico	296	152
Pastes, definition	294	151
Percolation	67	80
Pharmaceutical operations and apparatus	59–68	75
Pharmaceutical preparations	69–301	85
Pharmacodynamics, definition of	2	3
Pharmacognosy, definition of	2	3
Pharmacology, definition of	2	3
Pharmacopoeia, contents of	2	3
Pharmacy, definition of	2	3
Pharmacy officer	333	188
Phenols	58	57

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

INDEX

	Paragraph	Page
Physics, definition of	2	3
Physiology, definition of	2	3
Pills, definition	263	142
Pills, method of preparation	264	142
Pilulae ferri carbonatis	265	143
Pilulae hydrargyri chloridi mitis compositae	266	143
Poisoning, symptoms of	306	164
Poisoning, diagnosis of	307	164
Poisons, list of	308	165
Posology, definition of	2	3
Powders, definition	274	147
Powders, practical hints on	321	182
Practical pharmacy, hints in	316–325	180
Precautions, general	325	184
Precipitation	64	78
Prescription:		
Definition of	309	168
Files	335	189
Form of	310	168
Proportions	20	23
Pulveres effervescentes compositi	260	142
Pulverization	65	78
Pulvis cretae compositus	261	142
Pulvis ipecacuanhae et opii	262	142
Radicals	49	45
Ratio	19	23
Reciprocal proportions, law of	38	35
Records	335	189
Rectification	60	76
Reduction	55	52
Requisitions by medical supply officer	331	188
Requisitions for the pharmacy	330	187
Salts	54	50
Simple decomposition	55	52
Solubility, table of	54	50
Solute	66	79
Solutions:		
Definition (liquors)	86	89
Percentage	23	24
Preparation of	22	24
Stock	25	27
Types	66	79
Solutions and mixtures, practical hints on	317	180
Solvent, classification	66	79
Solvent, definition	66	79
Specific gravity, definition of	11	16
Specific volume	15	21
Spirits, definition	156	109

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

INDEX

	Paragraph	Page
Spirits, methods of preparation	157	110
Spiritus:		
Aethylis nitritis	158	110
Ammoniae aromaticus	159	110
Anisi	160	110
Aurantii compositus	161	111
Camphorae	162	111
Chloroformi	163	111
Cinnamomi	164	111
Frumenti	165	111
Glycerylis trinitratis	166	112
Lavandulae	167	112
Menthae piperitae	168	112
Menthae viridis	169	112
Oleorum volatilium	170	112
Vini vitis	171	113
Straining	62	78
Structural formulae, organic	57	56
Structural formulas	48	44
Sublimation	60	76
Subtraction, weights and measures	10	15
Sulfur compounds, organic	58	57
Supernatant liquid	64	78
Supply	327–331	186
Suppositories	320	182
Syrups:		
Definitions	124	101
Methods of preparation	126	101
Preservation	127	102
Types	125	101
Syrupus	128	102
Acidi citrici	129	103
Acidi hydriodici	130	103
Aurantii	131	103
Aurantii florum	132	104
Balsami tolutani	133	104
Glycyrrhizae	134	104
Ipecacuanhae	135	104
Picis pini	136	104
Pruni virginianae	137	105
Rhei aromaticus	138	105
Sarsaparillae compositus	139	105
Tablets, definition	267	144
Tablets, types of	268	144
Therapeutics, definition of	2	3
Thermometers	17	21

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

	Paragraph	Page
Tinctura:		
Aconiti	205	123
Aurantii amari	206	123
Aurantii dulcis	207	124
Balsami tolutani	208	124
Belladonnae	209	124
Benzoini	210	124
Benzoini composita	211	124
Cardamomi composita	212	124
Digitalis	213	125
Gentianae composita	214	125
Hyoscyami	215	125
Iodi	216	126
Iodi fortior	217	126
Iodi mitis	218	126
Lavandulae composita	219	126
Limonis	220	127
Myrrhae	220	127
Nucis vomicae	221	127
Opii	222	127
Opii camphorata	223	127
Persionis	224	128
Rhei aromatica	225	128
Stramonii	226	128
Valerianae	227	128
Tinctures:		
Definition	201	122
Methods of preparation	203	122
Storage	204	123
Strength of	202	122
Torrefaction	60	76
Toxicology, definition of	2	3
Toxicology definitions	305	163
Toxitabellae hydrargyri bichloridi magnae	269	145
Toxitabellae hydrargyri bichloridi parvae	270	145
Triturates, practical hints on	323	183
Trituration	65	78
Unguentum (simple ointment)	275	147
Acidi benzoici compositum	276	147
Acidi borici	277	147
Acidi tannici	278	147
Aquae rosae	279	148
Belladonnae	280	148
Chrysarobini	281	148
Gallae	282	149
Hydrargyri ammoniati	283	149
Hydrargyri chloridi mitis	284	149
Hydrargyri forte	285	149
Hydrargyri mite	286	150

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INDEX

	Paragraph	Page
Unguentum (simple ointment)—continued		
Hydrargyri oxidi flavi	287	150
Ichthammolis	288	150
Iodi	289	150
Phenolis	290	150
Picis pini	291	151
Sulfuris	292	151
Zinci oxidi	293	151
Valence	47	42
Waters (aquae), definition	69	85
Zoology, definition of	2	3

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