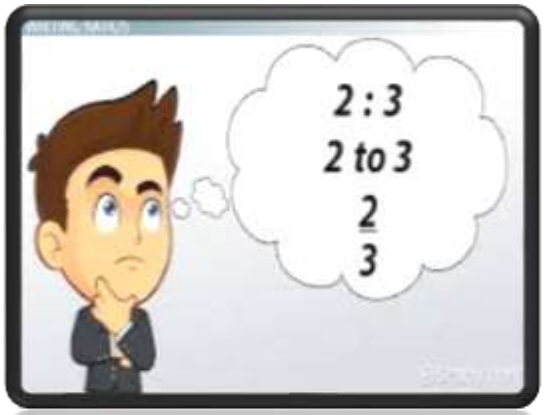
AL- Mustaqbal University College
Pharmacy Department

Principles of Pharmacy Practice

Lectuer: 5
Prof. Dr. Jabar Faraj AL-Wakeel
Assist. Prof. Dr. Shaimaa Munther

Percentage, Ratio Strength, and other Expressions of Concentration



Objectives:

Upon successful completion of this chapter, the student will be able to:

- ✓ Define the expressions percent weight-in-volume, percent volume-in-volume, and percent weight-weight.
- ✓ Define the expression ratio strength.
- ✓ Convert percent strength to ratio strength and ratio strength to percent strength.
- ✓ Calculate the percentage strength and ratio strength of a pharmaceutical preparation.
- ✓ Apply percent strength and ratio strength to calculate the quantity of an ingredient present in pharmaceutical preparation.
- ✓ Apply percent strength and ratio strength to calculate the quantity of an ingredient to use in compounding a pharmaceutical preparation.

Percentages

- The term percent and its corresponding sign (%) mean "by the hundred" or "in a hundred," and percentage means "rate per hundred"; so, 50 percent (or 50%) and a percentage of 50 are equivalent expressions.

- A percent may also be expressed as a ratio, represented as a common or decimal fraction. For example, 50% means 50 parts in 100 of the same kind, and may be expressed as 50⁄100 or 0.50. Percent.

- For computation, presents are usually changed to equivalent decimal fractions. This change is made by dropping the percent sign (%) and dividing the expressed numerator by 100.

- Thus, 12.5%, 12.5/100, or 0.125; and 0.05%, 0.05 /100, or 0.0005. We must not forget that in the reverse process (changing a decimal to a percent), the decimal is multiplied by 100 and the percent sign (%) is affixed.

Percentage Preparations

- The percentage concentrations of active and inactive constituents in various types of pharmaceutical preparations are defined as follows by the United States Pharmacopeia1:

- Percent weight-in-volume (w/v) expresses the number of grams of a constituent in 100 mL of solution or liquid preparation and is used regardless of whether water or another liquid is the solvent or vehicle.
  - Expressed as:_____ % w/v.

- Percent volume-in-volume (v/v) expresses the number of millilitres of a constituent in 100 mL of solution or liquid preparation.
  - Expressed as:_____ % v/v.

- Percent weight-in-weight (w/w) expresses the number of grams of a constituent in 100 g of solution or preparation.
  - Expressed as:_____ % w/w.

- The term percent, or the symbol %, when used without qualification means:
  - For solutions or suspensions of solids in liquids, percent weight-in-volume, (e.g. a powdered substance dissolved or suspended in a liquid)
  - For solutions of liquids in liquids, percent volume-in-volume; (e.g. a liquid component in a liquid preparation)
  - For mixtures of solids or semisolids, percent weight-in-weight; (e.g. a powdered substance mixed with a solid or semisolid, such as an ointment base)
  - For solutions of gases in liquids, percent weight-in-volume.

TABLE 6.1 EXAMPLES OF PHARMACEUTICAL DOSAGE FORMS IN WHICH THE ACTIVE INGREDIENT IS OFTEN CALCULATED AND EXPRESSED ON A PERCENTAGE BASIS

PERCENTAGE BASIS	EXAMPLES OF APPLICABLE DOSAGE FORMS
Weight-in-volume	Solutions (e.g., ophthalmic, nasal, otic, topical, large-volume parenterals), and lotions
Volume-in-volume	Aromatic waters, topical solutions, and emulsions
Weight-in-weight	Ointments, creams, and gels

Specific gravity

- Specific gravity may be a factor in a number of calculations involving percentage concentration.
- Many formulations are presented on the basis of weight, even though some of the ingredients are liquids.
- Depending on the desired method of measurement, it may be necessary to convert weight to liquid or, in some instances, vice versa. Thus, the student should recall the equations:

$$g = mL \times sp.\ gr$$

$$mL = g/sp.\ gr$$

Percentage Weight in Volume

Example-1: How many grams of dextrose are required to prepare 4000 mL of a 5% solution?

$$\frac{5\text{ g}}{100\text{ mL}} \times 4000\text{ mL} = 200\text{ g, } \textit{answer.}$$

Example-2: How many grams of potassium permanganate should be used in compounding the following prescription?

Potassium Permanganate 0.02%

Purified Water ad 250 mL

Sig. as directed.

$$0.02\% = 0.0002$$

$$250 \times 0.0002 = 0.05\text{ g, } \textit{answer.}$$

Example-3: How many grams of aminobenzoic acid should be used in preparing 8 fluidounces of a 5% solution in 70% alcohol?

$$8 \text{ fl. oz.} = 8 \times 29.57 \text{ mL} = 236.56 \text{ mL}$$

$$5\% = 0.05$$

$$236.56 \text{ g} \times 0.05 = 11.83 \text{ g, } \textit{answer.}$$

NOTE:

To calculate the percentage weight-in-volume of a liquid preparation, given the weight of the solute or constituent and the volume of the liquid preparation, it should be remembered that the volume, in millilitres, of the liquid represents the weight, in grams, of the liquid preparation as if it were pure water.

Example-4: What is the percentage strength (w/v) of a solution of urea, if 80 mL contains 12 g? 80 mL of water weighs 80 g

$$\frac{80 \text{ (g)}}{12 \text{ (g)}} = \frac{100 \text{ (\%)}}{x \text{ (\%)}}$$

$$x = 15\%, \textit{ answer.}$$

NOTE:

Calculating the volume of a solution or liquid preparation, given its percentage strength weight-in-volume and the weight of the solute or constituent, involves the following:

Example-5: How many millilitres of a 3% solution can be made from 27 g of ephedrine sulfate?

$$\frac{3\ (\%)}{100\ (\%)} = \frac{27\ (g)}{x\ (g)}$$

$x = 900$ g, weight of the solution if it were water

Volume (in mL) = 900 mL, *answer.*

Percentage Volume-in-Volume

- Liquids are usually measured by volume, and the percentage strength indicates the number of parts by volume of an ingredient contained in the total volume of the solution or liquid preparation considered as 100 parts by volume.

Example-6: How many millilitres of liquefied phenol should be used in compounding the following prescription?

Liquefied Phenol 2.5%

Calamine Lotion ad 240 mL

Sig. For external use

Volume (mL) × % (expressed as a decimal) = milliliters of active ingredient

240 mL × 0.025 = 6 mL, *answer.*

Or, solving by dimensional analysis:

$$\frac{2.5 \text{ mL}}{100 \text{ mL}} \times 240 \text{ mL} = 6 \text{ mL}, \textit{answer.}$$

Example-7: In preparing 250 mL of a certain lotion, a pharmacist used 4 mL of liquefied phenol. What was the percentage (v/v) of liquefied phenol in the lotion?

$$\frac{250\ (\text{mL})}{4\ (\text{mL})} = \frac{100\ (\%)}{x\ (\%)}$$

$$x = 1.6\%, \textit{ answer.}$$

Example-8: What is the percentage strength v/v of a solution of 800 g of a liquid with a specific gravity of 0.800 in enough water to make 4000 mL?

800 g of water measures 800 mL

800 mL ÷ 0.800 = 1000 mL of active ingredient

$$\frac{4000\ (\text{mL})}{1000\ (\text{mL})} = \frac{100\ (\%)}{x\ (\%)}$$

$$x = 25\%, \textit{ answer.}$$

NOTE:

The volume of a solution or liquid preparation, given the volume of the active ingredient and its percentage strength (v/v), may require first determining the volume of the active ingredient from its weight and specific gravity.

Example-9: Peppermint spirit contains 10% v/v of peppermint oil. What volume of the spirit will contain 75 mL of peppermint oil?

$$\frac{10\ (\%)}{100\ (\%)} = \frac{75\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 750\ \text{mL}, \textit{answer.}$$

Example-10: If a veterinary liniment contains 30% v/v of dimethyl sulfoxide, how many millilitres of the liniment can be prepared from 1 lb of dimethyl sulfoxide (sp gr 1.10)?

1 lb = 454 g

454 g of water measures 454 mL

454 mL ÷ 1.10 = 412.7 mL of dimethyl sulfoxide

$$\frac{30\ (\%)}{100\ (\%)} = \frac{412.7\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 1375.7 \text{ or } 1376\ \text{mL}, \textit{answer.}$$

Percentage Weight-in-Weight

Percentage weight-in-weight (true percentage or percentage by weight) indicates the number of parts by weight of active ingredient contained in the total weight of the solution or mixture considered as 100 parts by weight.

Example-11: How many grams of phenol should be used to prepare 240 g of a 5% (w/w) solution in water?

Weight of solution (g) × % (expressed as a decimal) = g of solute

240 g × 0.05 = 12 g, *answer.*

Example-12:How many grams of a drug substance are required to make 120 mL of a 20% (w/w) solution having a specific gravity of 1.15?

120 mL of water weighs 120 g
120 g × 1.15 = 138 g, weight of 120 mL of solution
138 g × 0.20 = 27.6 g plus enough water to make 120 mL, *answer.*

NOTE: Sometimes in a weight-in-weight calculation, the weight of one component is known but not the total weight of the intended preparation. This type of calculation is performed as demonstrated by the following example

Example-13: How many grams of a drug substance should be added to 240 mL of water to make a 4% (w/w) solution?

100% − 4% = 96% (by weight) of water
240 mL of water weighs 240 g

$$\frac{96\ (\%)}{4\ (\%)} = \frac{240\ (g)}{x\ (g)}$$

$$x = 10\ g,\ \textit{answer.}$$

Example-14: How should you prepare 100 mL of a 2% (w/w) solution of a drug substance in a solvent having a specific gravity of 1.25?

How should you prepare 100 mL of a 2% (w/w) solution of a drug substance in a solvent having a specific gravity of 1.25?

100 mL of water weighs 100 g
100 g × 1.25 = 125 g, weight of 100 mL of solvent
100% − 2% = 98% (by weight) of solvent

$$\frac{98\ (\%)}{2\ (\%)} = \frac{125\ (g)}{x\ (g)}$$

$$x = 2.55\ g$$

Therefore, dissolve 2.55 g of drug substance in 125 g (or 100 mL) of solvent, *answer.*

Calculating Percentage Strength Weight-in-Weight

If the weight of the finished solution or liquid preparation is not given when calculating its percentage strength, other data must be supplied from which it may be calculated: the weights of both ingredients, for instance, or the volume and specific gravity of the solution or liquid preparation.

Example-15: If 1500 g of a solution contains 75 g of a drug substance, what is the percentage strength (w/w) of the solution?

$$\frac{1500\ (g)}{75\ (g)} = \frac{100\ (\%)}{x\ (\%)}$$

$$x = 5\%, \textit{ answer.}$$

Example-16: If 5 g of boric acid is added to 100 mL of water, what is the percentage strength (w/w) of the solution?

100 mL of water weighs 100 g

100 g + 5 g = 105 g, weight of solution

$$\frac{105\ (g)}{5\ (g)} = \frac{100\ (\%)}{x\ (\%)}$$

$$x = 4.76\%, \textit{ answer.}$$

Example-17: If 1000 mL of syrup with a specific gravity of 1.313 contains 850 g of sucrose, what is its percentage strength (w/w)?

1000 mL of water weighs 1000 g

1000 g × 1.313 = 1313 g, weight of 1000 mL of syrup

$$\frac{1313\ (g)}{850\ (g)} = \frac{100\ (\%)}{x\ (\%)}$$

$$x = 64.7\%, \textit{ answer.}$$

Weight-in-Weight Calculations in Compounding

Weight-in-weight calculations are used in the following types of manufacturing and compounding problems.

Examples-18: What weight of a 5% (w/w) solution can be prepared from 2 g of active ingredient?

$$\frac{5\ (\%)}{100\ (\%)} = \frac{2\ (g)}{x\ (g)}$$

$$x = 40\ g,\ \textit{answer.}$$

Examples-19: How many milligrams of hydrocortisone should be used in compounding the following prescription?

Hydrocortisone 1/8%

Hydrophilic Ointment ad 10 g

Sig. Apply.

$$1/8\% = 0.125\%$$

$$10\ g \times 0.00125 = 0.0125\ g \text{ or } 12.5\ mg,\ \textit{answer.}$$

Example-20:

How many grams of benzocaine should be used in compounding the following prescription?

Benzocaine	***2%***
Polyethylene Glycol Base ad	***2***

Make 24 such suppositories

Sig. Insert one as directed

$2\ g \times 24 = 48\ g$, total weight of mixture

$48\ g \times 0.02 = 0.96\ g$, *answer.*

CALCULATIONS CAPSULE

Percentage Concentration

The amounts of therapeutically active and/or inactive ingredients in certain types of pharmaceutical preparations are expressed in terms of their percentage concentrations.

Unless otherwise indicated:

(a) Liquid components in liquid preparations have *volume-in-volume* relationships with calculations following the equation:

mL of preparation × % concentration[a] = mL of component

(b) Solid components in liquid preparations have *weight-in-volume* relationships with calculations following the equation:

mL of preparation × % concentration[a] = g of component

The terms of this equation are valid due to the assumption that the specific gravity of the preparation is 1, as if it were water, and thus each milliliter represents the weight of one gram.

(c) Solid or semisolid components in solid or semisolid preparations have *weight-in-weight* relationships with calculations following the equation:

g of preparation × % concentration[a] = g of component

[a] In these equations, "% concentration" is expressed decimally (e.g., 0.05, *not* 5%).

To be continued with ratio strengths and PPM calculations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