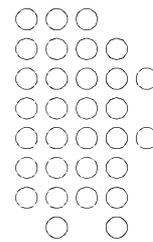


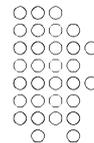
6. Percentage, Ratio Strength, and Other Expressions of Concentration



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-in-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 a pharmaceutical preparation.
- Apply percent strength and ratio strength to calculate the quantity of an ingredient to use in compounding a pharmaceutical preparation.



PERCENTAGE



- | The term percent and its corresponding sign (%)
 - | mean "by the hundred" or "in a hundred,"
 - | 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.
 - | its numerator is expressed but its denominator is left understood.
 - | is always an abstract quantity, and that, as such, it may be applied to anything.
- | Percentage means "rate per hundred"; so 50 percent (or 50%) and a percentage of 50 are equivalent expressions.

- | For the purposes of computation, percents are usually changed to equivalent decimal fractions.
 - | is made by dropping the percent sign (%) and dividing the expressed numerator by 100.
 - | 12.5% = 12.5/100 or 0.125;
 - | 0.05 % = 0.05/100, or 0.0005.
 - | changing a decimal to a percent:
 - | the decimal is multiplied by 100 and the percent sign (%) is affixed.
 - | as a convenient means of expressing the **concentration of an active or inactive material** in a pharmaceutical preparation.



PERCENTAGE PREPARATIONS



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

1 ***Percent weight-in-volume (w/v)***

- 1 expresses the number of ***grams of a constituent in 100 mL of solution or liquid*** preparation,
- 1 is used regardless of whether water or another liquid is the solvent or vehicle.
- 1 Expressed as: ____% w/v.

PERCENTAGE PREPARATIONS



1 ***Percent volume-in-volume (v/v)***

- 1 expresses the ***number of milliliters of a constituent in 100 mL of solution or liquid*** preparation.
- 1 Expressed as: ____% v/v.

1 ***Percent weight-in-weight (w/w)***

- 1 expresses the ***number of grams of a constituent in 100 g of solution*** or preparation.
- 1 Expressed as: ____% w/w.

1 The term **percent**, or symbol, **%** , when used without qualification means:

- 1 for solutions or suspensions of **solids in liquids**, *percent weight-in-volume*;
- 1 for solutions of **liquids in liquids**, *percent volume-in-volume*;
- 1 for **mixtures of solids or semisolids**, *percent weight-in-weight*;
- 1 for solutions of **gases in liquids**, *percent weight-in-volume*.



Special Considerations in Percentage Calculations

- 1 In general, the nature of the ingredients in a pharmaceutical preparation determines the basis of the calculation.
 - 1 a powdered substance dissolved or suspended in a liquid vehicle would generally be calculated on a weight-in-volume basis;
 - 1 a powdered substance mixed with a solid or semisolid, such as an ointment base, would generally be calculated on a weight-in-weight basis.
 - 1 a liquid component in a liquid preparation would be calculated on a volume-in-volume basis.
- 1 **Table 6.1** presents examples of the usual basis for calculations of concentration for some dosage forms.



TABLE 6.1 EXAMPLES OF PHARMACEUTICAL DOSAGE FORMS CALCULATED ON A PERCENTAGE BASIS^a

PERCENTAGE CONCENTRATION	EXAMPLES OF APPLICABLE DOSAGE FORMS
Weight-in-volume	Solutions (e.g., ophthalmic, otic, topical), lotions, sprays
Volume-in-volume	Aromatic waters, lotions
Weight-in-weight	Ointments, creams, suppositories

^a In these examples, not all the components may be expressed on a percentage basis. For example, the active therapeutic ingredient may be expressed in definitive units of measure (e.g., mg/mL, mg/g), whereas a pharmaceutical ingredient may be calculated on a percentage basis.



- I In most instances, use of percentage concentrations in the manufacture and labeling of pharmaceutical preparations is restricted to instances in which the dose of the active therapeutic agent (ATI) is not specific.
 - I For example, the ATIs in ointments, lotions, external solutions, and similar products may commonly be expressed in percent strength (e.g., a 1% hydrocortisone ointment).
- I In most dosage forms, such as tablets, capsules, injections, oral solutions, and syrups, among others, the amounts of ATIs are expressed in definitive units of measure, such as milligrams per capsule, milligrams per milliliter, or other terms.
 - I On the other hand, in many pharmaceutical formulations, pharmaceutical components such as flavoring agents, solvents, excipients, preservatives, and so on, may be expressed in terms of their percentage concentration.

- | **Specific gravity** is 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.
- | It may be necessary to convert weight to liquid or, in some instances, vice versa.
- | Thus, the student should recall the equations from the previous chapter, namely:



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

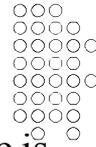
$$mL = \frac{g}{sp\ gr}$$

PERCENTAGE WEIGHT-IN-VOLUME

- | In a **true expression of percentage** (i.e., *parts per one hundred parts*),
 - | the percentage of a *liquid preparation* (e.g., **solution, suspension, lotion**, etc.) would represent the *grams of solute or constituent in 100 g of the liquid preparation*.
- | a different definition of percentage for solutions and for other liquid preparations:
 - | represent grams of a solute or constituent in **100 mL** of solution or liquid preparation.
 - | the "correct" strength of a **1% (w/v)** solution or other liquid preparation is defined as containing *1 g of constituent in 100 mL of product*.

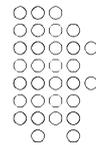


PERCENTAGE WEIGHT-IN-VOLUME



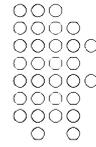
- | This variance to the definition of true percentage is based on an assumption that the solution/liquid preparation has a specific gravity of 1, as if it were water.
 - | each 100 mL of solution/liquid preparation is presumed to weigh 100 g and thus is used as the basis for calculating percentage weight-in-volume (e.g., 1% w/v = 1% of [100 mL taken to be] 100 g = 1 g in 100 mL).

Weight of Active Ingredient in a *Specific Volume*, Given its *Percentage Weight-in- Volume*



- | Taking **water** to *represent any solvent or vehicle*, we may prepare *weight-in- volume percentage solutions* or liquid preparations by the *metric system* if we use the following rule.
 - | *Multiply* the required number of *milliliters* by the *percentage strength*, expressed as a *decimal*, to obtain the *number of grams of solute or constituent* in the solution or liquid preparation.
$$\text{Volume (mL)} \times \% \text{ (expressed as a decimal)}$$
$$= \text{g of solute or constituent}$$

Examples



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

4000 mL represent 4000 g of solution

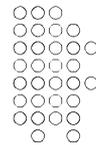
5% = 0.05

4000 g X 0.05 = 200 g, answer.

- 1 Or, solving by dimensional analysis:

5 g/100 mL X 4000 mL = 200 g, answer.

Examples



- 1 *How many grams of potassium permanganate should be used in compounding the following prescription?*

Potassium Permanganate 0.02%

Purified Water ad 250.0 mL

Sig. As directed.

250 mL represent 250 g of solution

0.02% = 0.0002

250 g X 0.0002 = 0.05 g, answer.



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

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

236.56 mL represents 236.56 g of solution

$$5 \% = 0.05$$

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

Percentage Weight-in-Volume of Solution, Given Weight of Solute or Constituent and Volume of Solution or Liquid Preparation



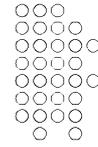
- 1 *Example: What is the percentage strength (w/v) of a solution of urea, if 80 mL contain 12 g?*

80 mL of water weigh 80 g

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

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

Volume of Solution or Liquid Preparation, Given Percentage Strength Weight-in-Volume and Weight of Solute

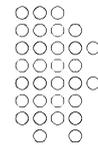


- | Example: *How many milliliters of a 3% solution can be made from 27 g of ephedrine sulfate?*

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

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*,
- | The *percentage strength* indicates the *number of parts by volume of the active ingredient contained in the total volume of the solution or liquid preparation considered as 100 parts by volume.*
- | If there is any possibility of misinterpretation, this kind of percentage should be specified: e.g., 10 %*(v/v)*.

Volume of Active Ingredient in a Specific Volume, Given Percentage Strength Volume-in-Volume.



Example: *How many milliliters of liquefied phenol should be used in compounding the following prescription?*

Liquefied Phenol 2.5%
Calamine Lotion ad 240.0 mL
Sig. For external use.

- | ***Volume (mL) X % (expressed as a decimal) = milliliters of active ingredient***
- | 240 mL X 0.025 = 6 mL, answer.
- | Or, solving by dimensional analysis:
- | (2.5 mL/ 100 mL)X 240 mL = 6 mL, answer.

Percentage Volume-in-Volume of Solution or Liquid Preparation, Given Volume of Active Ingredient and Volume of Solution

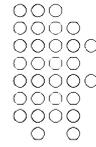


- | the required volumes may have to be calculated from given weights and specific gravities.
- | Example: *In preparing 250 mL of a certain lotion, a pharmacist used 4 mL of liquefied phenol. What was the percentage (v/v) of liquefied phenol in the lotion?*

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

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

- 1 *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 measure 800 mL

$800 \text{ g} \div 0.800 = 1000 \text{ mL}$ of active ingredient

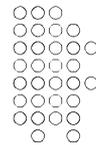
$$x = \frac{1000(\text{mL})}{4000(\text{mL})} \times 100\%$$

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

Or, solving by dimensional analysis:

$$\frac{800 \text{ mL}}{0.800} \times \frac{1}{4000 \text{ mL}} \times 100\% = 25\%, \text{ answer.}$$

Volume of Solution or Liquid Preparation, Given Volume of Active Ingredient and its Percentage Strength (v/v).



- 1 *may require first determining the volume of the active ingredient from its weight and specific gravity.*
- 1 *Examples: Peppermint spirit contains 10% (v/v) of peppermint oil. What volume of the spirit will contain 75 mL of peppermint oil?*

$$10\% = \frac{75(\text{mL})}{x(\text{mL})}, \quad x = 750 \text{ mL}, \text{ answer.}$$

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



$$1 \text{ lb} = 454 \text{ g}$$

$$454 \text{ g of water measure } 454 \text{ mL}$$

$$454 \text{ mL} \div 1.10 = 412.7 \text{ mL of dimethyl sulfoxide}$$

$$30\% = \frac{412.7 \text{ (mL)}}{x \text{ (mL)}}, \quad x = 1375.7 \text{ mL, or } 1376 \text{ mL, answer.}$$

Or, solving by dimensional analysis:

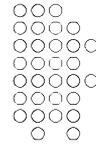
$$\frac{1 \text{ lb}}{30\%} \times \frac{454 \text{ g}}{1 \text{ lb}} \times \frac{1 \text{ mL}}{1 \text{ g}} \times \frac{1}{1.10} \times 100\% = 1375.7 \text{ or } 1376 \text{ mL, answer.}$$

PERCENTAGE WEIGHT-IN-WEIGHT



- 1 *true percentage or percentage by weight*
- 1 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.
- 1 Liquids are not customarily measured by weight. Therefore, a weight-in-weight solution or liquid preparation of a solid or a liquid in a liquid should be so designated: e.g., 70% (w/w).

Weight of Active Ingredient in a Specific Weight of Solution or Liquid Preparation, Given its Weight-in-Weight Percentage Strength.

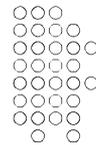


- 1 *How many grams of phenol should be used to prepare 240 g of a 0.5% (w/w) solution in water?*

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

$$240 \text{ g} \times 0.05 = 12 \text{ g, answer.}$$

Weight of Active Ingredient in a Specific Weight of Solution or Liquid Preparation, Given its Weight-in-Weight Percentage Strength.



- 1 *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 weigh 120 g

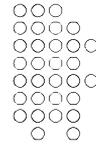
120 g X 1.15 = 138 g, weight of 120 mL of solution

138 g X 0.20 = 27.6 g plus enough water to make 120 mL,
answer.

- 1 Or, solving by dimensional analysis:

$$120 \text{ mL} \times \frac{1.15 \text{ g}}{1 \text{ mL}} \times \frac{20\%}{100\%} = 27.6 \text{ g, answer.}$$

*Weight of Either Active Ingredient or Diluent,
Given Weight of the Other and Percentage
Strength (w/w) of Solution.*



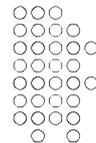
- | The weights of active ingredient and diluent are proportional to their percentages.
- | Example: *How many grams of a drug substance should be added to 240 mL of water to make a 4 % (w/w) solution?*

100%- 4% = 96% (by weight) of water

240 mL of water weigh 240 g

$$\frac{96(\%)}{4(\%)} = \frac{240(g)}{x(g)}, x = 10 \text{ g, answer.}$$

- | It is usually impossible to prepare a specified volume of a solution or liquid preparation of given weight-in-weight percentage strength, because the *volume displaced by the active ingredient* cannot be known in advance.
- | If an excess is acceptable, we may make a volume somewhat more than that specified by taking the given volume to refer to the solvent or vehicle and from this quantity calculating the weight of the solvent or vehicle (the specific gravity of the solvent or vehicle must be known).
 - | Using this weight to calculate the corresponding weight of the active ingredient needed.



Example: 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 weigh 100 g
- | 100 g X 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.

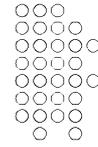
Calculating Percentage Strength Weight-in-Weight



- | 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,
 - | the volume and specific gravity of the solution or liquid preparation.
- | Examples: *If 1,500 g of a solution contain 75 g of a drug substance, what is the percentage strength (w/w) of the solution?*

$$\frac{1500(g)}{75(g)} = \frac{100(\%)}{x(\%)}, x = 5\%, \text{ answer.}$$

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

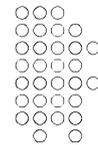


100 mL of water weigh 100 g

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

$$x = \frac{5(g)}{105(g)} \times 100\%, \quad x = 4.76\%, \text{ answer.}$$

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

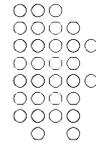


1000 mL of water weigh 1000 g

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

$$x = \frac{850(g)}{1313(g)} \times 100\%, \quad x = 64.7\%, \text{ answer.}$$

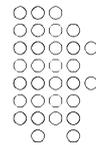
Weight-in-Weight Calculating in Compounding



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

$$\frac{2(g)}{x(g)} = 5\%, \quad x = 40 \text{ g, answer.}$$

Weight-in-Weight Mixtures of Solids and Semisolids



- | Solids and semisolids are usually measured by weight,
- | The percentage strength of a mixture of solids indicates the number of parts by weight of the active ingredient contained in the total weight of the mixture considered as 100 parts by weight.

USE OF PERCENT IN COMPENDIAL STANDARDS



- | Percent is used in the United States Pharmacopeia to express the degree of tolerance permitted in the purity of single chemical entities and in the labeled quantities of ingredients in dosage forms.
 - | Aspirin contains not less than 99.5% and not more than 100.5% of $C_9H_8O_4$ (pure chemical aspirin) calculated on a dried basis.
 - | Aspirin Tablets contain not less than 90.0% and not more than 110.0% of the labeled amount of $C_9H_8O_4$."
- | Although dosage forms are formulated with the intent to provide 100% of the quantity of each ingredient declared on the label, some tolerance is permitted to allow for analytic error, unavoidable variations in manufacturing and compounding, and for deterioration to an extent considered insignificant under practical conditions.

Calculation involved percent in compendial standards.



- | *If ibuprofen tablets are permitted to contain not less than 90 % and not more than 110% of the labeled amount of ibuprofen, what would be the permissible range in content of the drug, expressed in milligrams, for ibuprofen tablets labeled 200 mg each?*

$$90\% \text{ of } 200 \text{ mg} = 180 \text{ mg}$$

$$110\% \text{ of } 200 \text{ mg} = 220 \text{ mg}$$

$$\text{range} = 180 \text{ mg to } 220 \text{ mg, answer.}$$



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:

$$\text{mL of preparation} \times \% \text{ concentration}^a = \text{mL of component}$$

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

$$\text{mL of preparation} \times \% \text{ concentration}^a = \text{g of component}$$

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:

$$\text{g of preparation} \times \% \text{ concentration}^a = \text{g of component}$$

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

CASE IN POINT 6.1³: A patient with myasthenia gravis has undergone treatment to separate and remove certain abnormal antibodies and other unwanted elements from the blood (plasmapheresis). The desired red blood cell component is then returned back to the blood, but the patient has lost protein and blood volume.

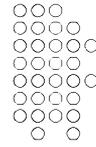
The patient's physician orders 2000 mL of a 5% w/v solution of albumin in 0.9% w/v sodium chloride injection to replace lost protein and fluid.

In filling the order, the pharmacist decides to use a piece of automated equipment to compound the mixture. The equipment must be programmed with the specific gravities of the solutions being mixed. The pharmacist selects to use a 25% w/v albumin solution as the source of the albumin plus a 0.9% sodium chloride injection.

From the literature, the pharmacist finds that 0.9% sodium chloride has a specific gravity of 1.05. Using a precise 25-mL pycnometer with a tare weight of 28 g, the pharmacist fills it with the 25% w/v albumin solution and determines the weight of the flask and its content to be 58 g.

- What is the specific gravity of the albumin solution?
- How many milliliters of the 25% w/v albumin solution are needed to make 2000 mL containing 5% w/v albumin?
- What is the weight of the 25% albumin solution needed to fill the order?
- If the pharmacist mixed the required number of milliliters of the 25% albumin solution with a sufficient 0.9% w/v sodium chloride injection to make the required 2000 mL mixture, what would be the specific gravity of the resultant solution?

Case in point 6.1 (p. 87)



- a) $58 \text{ g (weight of filled pycnometer)} - 28 \text{ g (weight of pycnometer)} = 30 \text{ g (weight of 25 mL of albumin solution)}$;
 $30 \text{ g} \div 25 \text{ mL} = 1.2$, specific gravity of albumin solution, answer.
- b) $2000 \text{ mL} \times 0.05 \text{ (5\%)} = 100 \text{ g of albumin needed}$;
 $25 \text{ g}/100 \text{ mL} = 100 \text{ g}/x \text{ mL}$; $x=400 \text{ mL}$ albumin solution needed, answer.
- c) $400 \text{ mL} \times 1.2 \text{ (specific gravity)} = 480 \text{ g}$, albumin solution needed, answer.
- d) $2000 \text{ mL (total solution)} - 400 \text{ mL (albumin solution)} = 1600 \text{ mL (0.9\% sodium chloride solution)}$;
 $1600 \text{ mL} \times 1.05 \text{ (specific gravity)}$
 $= 1680 \text{ g (weight of 0.9\% sodium chloride solution)}$;
 $1680 \text{ g} + 480 \text{ g} = 2160 \text{ g (total weight of the 2000 mL)}$;
 $2160 \text{ g} \div 2000 \text{ mL} = 1.08$, specific gravity of the mixture, answer.

CASE IN POINT 6.2: A pharmacist receives the following prescription but does not have hydrocortisone powder on hand. However, the pharmacist does have an injection containing 100 mg of hydrocortisone per milliliter of injection. A search of the literature indicates that the injection has a specific gravity of 1.5.

R: Hydrocortisone 1.5%
 Cold Cream qs 30 g

- (a) How many grams of hydrocortisone are needed to fill the prescription?
 (b) How many milliliters of the hydrocortisone injection would provide the correct amount of hydrocortisone?
 (c) How many grams of cold cream are required?
- a) $30 \text{ g} \times 0.015 \text{ (1.5\% w/w)} = 0.45 \text{ g hydrocortisone needed, answer.}$
- b) $0.1 \text{ g}/1 \text{ mL} = 0.45 \text{ g}/x \text{ mL}$; $x = 4.5 \text{ mL}$ hydrocortisone injection, answer.
- c) $4.5 \text{ mL} \times 1.5 \text{ (specific gravity)} = 6.75 \text{ g (weight of hydrocortisone injection)}$; $30 \text{ g} - 6.75 \text{ g} = 23.25 \text{ g cold cream needed, answer.}$

RATIO STRENGTH



- | The concentration of weak solutions or liquid preparations is frequently expressed in terms of ratio strength.
- | Ratio strength is merely another way of expressing the percentage strength of solutions or liquid preparations (and, less frequently, of mixtures of solids).
 - | For example, 5% means 5 parts per 100 or 5:100.
- | Although 5 parts per 100 designates a ratio strength, it is customary to translate this designation into a ratio, the first figure of which is 1; thus, 5:100 = 1: 20.

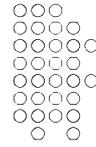
- | 1/1000, used to designate a concentration, is to be interpreted as follows:

- | For solids in liquids = 1 g of solute or constituent in 1000 mL of solution or liquid preparation.
- | For liquids in liquids = 1 mL of constituent in 1000 mL of solution or liquid preparation.
- | For solids in solids = 1 g of constituent in 1000 g of mixture.

- | The ratio and percentage strengths of any solution or mixture of solids are proportional, and either is easily converted to the other by the use of proportion.



Ratio Strength Given Percentage Strength.

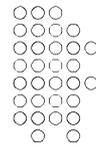


- Express 0.02% as a ratio strength.

$$\frac{0.02(\%)}{100(\%)} = \frac{1(\textit{part})}{x(\textit{parts})}, \quad x = 5000$$

Ratio strength = 1 : 5000, answer.

Percentage Strength Given Ratio Strength.

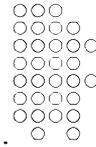


- Express 1 : 4000 as a percentage strength.

$$\frac{100(\%)}{x(\%)} = \frac{4000(\textit{parts})}{1(\textit{part})}, \quad x = 0.025\%, \textit{answer.}$$

NOTE:

- | To change ratio strength to percent strength, it is sometimes convenient to "convert" the last two zeros in a ratio strength to a percent sign (%),
- | change the remaining ratio to a common fraction, and then to a decimal fraction in expressing percent.
- | Examples:
 - | 1:100 = 1/1% = 1%
 - | 1:200 = 1/2% = 0.5%
 - | 3:500 = 3/5% = 0.6%
 - | 1:2500 = 1/25% = 0.04%
 - | 1:10,000 = 1/100% = 0.01%



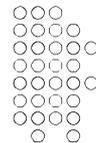
*Ratio Strength of Solution or Liquid Preparation,
Given Weight of Solute in a Specified Volume.*

- | Examples: *A certain injectable contains 2 mg of a drug per milliliter of solution. What is the ratio strength (w/v) of the solution?*

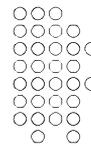
$$2 \text{ mg} = 0.002 \text{ g}$$

$$\frac{0.002(g)}{1(g)} = \frac{1(mL)}{x(ml)}, \quad x = 500 \text{ mL}$$

Ratio strength=1:500, answer.



- What is the ratio strength (w/v) of a solution made by dissolving five tablets, each containing 2.25 g of sodium chloride, in enough water to make 1800 mL?



2.25 g X 5 = 11.25 g of sodium chloride

$$\frac{11.25(g)}{1(g)} = \frac{1800(mL)}{x(mL)}, \quad x = 160 mL$$

Ratio strength = 1 : 160, answer.

Problems Involving Ratio Strength.



- translate the problem into one based on percentage strength
- solve it according to the rules and methods discussed under percentage preparations.
- Examples:** *How many grams of potassium permanganate should be used in preparing 500 mL of a 1:2500 solution?*

1:2500 = 0.04%

500 (g) X 0.0004 = 0.2 g, answer.

Or,

1:2500 means 1 g in 2500 mL of solution

$$\frac{2500(mL)}{500(mL)} = \frac{1(g)}{x(g)}, \quad x = 0.2 g, \text{ answer.}$$

- 1 **How many milligrams of gentian violet should be used in preparing the following solution?**

Gentian Violet Solution 500 mL

1:10,000

Sig. Instill as directed.

$$1:10,000 = 0.01\%$$

$$500 \text{ (g)} \times 0.0001 = 0.050 \text{ g or } 50 \text{ mg, answer.}$$

- 1 Or,

1:10,000 means 1 g of 10,000 mL of solution

$$\frac{10,000 \text{ (mL)}}{500 \text{ (mL)}} = \frac{1 \text{ (g)}}{x \text{ (g)}}, \quad x = 0.050 \text{ g, or } 50 \text{ mg, answer.}$$



- 1 **How many milligrams of hexachlorophene should be used in compounding the following prescription?**

Hexachlorophene 1:400

Hydrophilic Ointment ad 10 g

Sig. Apply.

1 1:400 = 0.25%

1 10 (g) X 0.0025 = 0.025 g or 25 mg, answer.

- 1 Or,

1 1:400 means 1 g in 400 g of ointment

$$\frac{400 \text{ (mL)}}{10 \text{ (mL)}} = \frac{1 \text{ (g)}}{x \text{ (g)}}, \quad x = 0.025 \text{ g, or } 25 \text{ mg, answer.}$$



SIMPLE CONVERSIONS OF CONCENTRATION TO "mg/mL"



- In patient care settings, need to convert rapidly product concentrations expressed as percentage strength, ratio strength, or as grams per liter (as in IV infusions) to milligrams per milliliter (mg/mL).



CALCULATIONS CAPSULE

Ratio Strength

The concentrations of very weak pharmaceutical preparations (usually weight-in-volume solutions) often are expressed in terms of their ratio strengths.

Ratio strength is another way of expressing percentage strength. For example, a 1% w/v solution and a ratio strength of 1:100 w/v are equivalent.

The preferable style of a ratio strength is to have the numeric value of the solute as 1. This is accomplished when calculating a ratio strength, by setting up a proportion from the data as:

$$\frac{\text{g (given solute)}}{\text{mL (given solution)}} = \frac{1}{x}; \text{ then, 1/value of } x, \text{ answer.}$$

In using a ratio strength in a calculations problem, there are two options: (1) convert it to a percentage strength and perform calculations in the usual manner, or (2) use the ratio strength directly in a problem-solving proportion.

- (a) To convert a ratio strength to a percentage strength; for example, 1:10,000 w/v:

$$\frac{1 \text{ g}}{10,000 \text{ mL}} = \frac{x \text{ (g)}}{100 \text{ mL}}$$

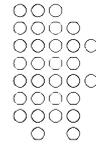
Solving for x yields percent, by definition (parts per hundred).

- (b) Problem-solving proportion, for example:

$$\frac{1 \text{ g}}{10,000 \text{ mL}} = \frac{x \text{ g}}{\text{(given quantity, mL)}}; x = \text{g in given mL}$$



To convert product percentage strengths to mg/mL, multiply the percentage strength, expressed as a whole number, by 10.



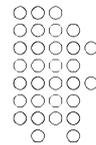
┆ Example: *Convert 4% (w/v) to mg/mL.*

┆ $4 \times 10 = 40$ mg/mL, answer.

┆ Proof or alternate method:

$$\begin{aligned} 4\% \text{ (w/v)} &= 4 \text{ g/100 mL} \\ &= 4000 \text{ mg/100 mL} \\ &= 40 \text{ mg/mL} \end{aligned}$$

To convert product ratio strengths to mg/mL, divide the ratio strength by 1000.



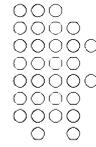
┆ Example: *Convert 1:10000 (w/v) to mg/mL.*

┆ $10000 \div 1000 = 1$ mg/10 mL, answer.

┆ Proof or alternate method:

$$\begin{aligned} 1:10000 \text{ (w/v)} &= 1 \text{ g/10000 mL} \\ &= 1000 \text{ mg/10000 mL} \\ &= 1 \text{ mg/10 mL} \end{aligned}$$

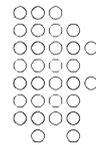
To convert product strengths expressed as grams per milliliter (g/mL) to mg/mL



- | convert the numerator to milligrams
- | divide by the number of milliliters in the denominator.
- | Example: *Convert a product concentration of 1 g per 250 mL to mg/mL.*

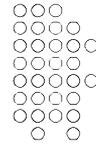
- | 1 g=1000 mg
- | $1000 \div 250 = 4 \text{ mg/mL}$, answer.
- | Proof or alternate method:
$$1 \text{ g}/250 \text{ mL} = 1000 \text{ mg}/250 \text{ mL}$$
$$= 4 \text{ mg/mL}$$

MILLIGRAMS PERCENT (mg%)



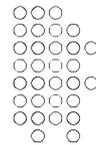
- | expresses the number of milligrams of substance in 100 mL of liquid.
- | is used frequently to denote the concentration of a drug or natural substance in a biologic fluid, as in the blood.
- | the concentration of nonprotein nitrogen in the blood is 30 mg% means that each 100 mL of blood contains 30 mg of nonprotein nitrogen.
- | As noted in the following section, "*Expressing Clinical Laboratory Test Values*," quantities of substances present in biologic fluids also commonly are stated in terms of milligrams per deciliter (mg/dL) of fluid.

PARTS PER MILLION (PPM) AND PARTS PER BILLION (PPB)



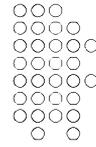
- | The strengths of very dilute solutions are commonly expressed in terms of parts per million (ppm) or parts per billion (ppb),
 - | i.e., the number of parts of the agent per 1 million or 1 billion parts of the whole.
 - | fluoridated drinking water, used to reduce dental caries, often contains 1 part of fluoride per million parts of drinking water (1:1,000,000).

PARTS PER MILLION (PPM) AND PARTS PER BILLION (PPB)



- | may be used to describe the quantities of trace impurities in chemical samples and trace elements in biologic samples.
- | Depending on the physical forms of the trace substituent and the final product, a concentration expressed in ppm or ppb could, in theory, be calculated on a weight-in-volume, volume-in-volume, or weight-in-weight basis.
- | For all practical purposes, the unit-terms of the solute and solution are generally considered like units (i.e., the same type of "parts").

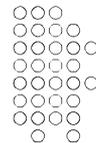
Equivalent Values of Percent Strength, Ratio Strength, and Parts per Million or Parts per Billion.



- Example: *Express 5 ppm of iron in water in percent strength and ratio strength.*

5 ppm = 5 parts in 1,000,000 parts
= 1:200,000, ratio strength,
= 0.0005%, percent strength, answers.

Using Parts per Million or Parts per Billion in Calculations.



- Example: *The concentration of a drug additive in an animal feed is 12.5 ppm. How many milligrams of the drug should be used in preparing 5.2 kg of feed?*
- 12.5 ppm = 12.5 g (drug) in 1,000,000 g (feed)
- Thus,

$$\frac{1,000,000(g)}{12.5(g)} = \frac{5200(g)}{x(g)}, \quad x = 0.065 \text{ g} = 65 \text{ mg, answer.}$$

! Thanks!

