Pharmaceutical Calculations

13th Edition

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This textbook is intended to provide the *underpinnings of the methods* used in pharmaceutical calculations. The drugs, drug products, formulas, equations, uses, and doses are included in this textbook for the sole purpose of providing examples in the types of calculations described. The information *is not intended* for use in any practice or clinical application, nor should it be considered or construed as specific for any individual patient nor as a substitute for current drug package inserts. The author, editors, and publisher make no warranty, express or implied, with regard to the contents and use of this publication and are not responsible, as a matter of product liability, negligence, or otherwise, for any injury resulting from any material contained herein.

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The authors, editors, and publisher have exerted every effort to ensure that drug selection and dosage set forth in this text are in accordance with the current recommendations and practice at the time of publication. However, in view of ongoing research, changes in government regulations, and the constant flow of information relating to drug therapy and drug reactions, the reader is urged to check the package insert for each drug for any change in indications and dosage and for added warnings and precautions. This is particularly important when the recommended agent is a new or frequently employed drug.

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

Special Considerations in Percentage Calculations

In general, the nature of the ingredients in a pharmaceutical preparation determines the basis of the calculation. That is, a powdered substance dissolved or suspended in a liquid vehicle would generally be calculated on a *weight-in-volume* basis; and a powdered substance mixed with a solid or semisolid, such as an ointment base, would generally be calculated on a *weight-in-weight* basis; and, a liquid component in a liquid preparation would be calculated on a *volume-in-volume* basis. *Based on these considerations, if the designation of the term of a calculation (e.g., w/v, w/w, or v/v) is not included in a problem, the appropriate assumption must be made*. Table 6.1 presents examples of the usual basis for calculations of concentration for some dosage forms.

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 ingredient (ATI) is not specific. 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). However, 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. 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 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

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

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 100 parts),* the percentage of a liquid preparation (e.g., solution, suspension, lotion) would represent the *grams* of solute or constituent in *100 g* of the liquid preparation. However, in practice, the pharmacist most frequently uses a different definition of percentage for solutions and for other liquid preparations, one in which the *parts* of the percentage represent *grams* of a solute or constituent in *100 mL* of solution or liquid preparation.

Indeed, in weight-in-volume expressions, 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. 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.* It is on this assumption that 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).

Taking water to represent any solvent or vehicle, we may prepare weight-in-volume percentage solutions or liquid preparations by the SI 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. *The volume, in milliliters, represents the weight in grams of the solution or liquid preparation as if it were pure water.*

Volume (mL, representing grams) × % (expressed as a decimal) = grams (g) of solute or constituent

Examples of Weight-in-Volume Calculations

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

4000 mL represents 4000 g of solution
5% = 0.05
4000 g × 0.05 = 200 g, *answer.*

Or, solving by dimensional analysis:

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

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.	

250 mL represents 250 g of solution
0.02% = 0.0002
250 g × 0.0002 = 0.05 g, *answer.*