CHAPTER 6

Concentrations and Dilutions

Learning Objectives

After completing this chapter, you should be able to:

- Calculate weight/weight percent concentrations.
- Calculate weight/volume percent concentrations.
- Calculate volume/volume percent concentrations.
- Calculate dilutions of stock solutions.

INTRODUCTION

Concentrations of many pharmaceutical preparations are expressed as a percent strength. This is an important concept to understand. Percent strength represents how many grams of active ingredient are in 100 mL. In the case of solids such as ointment, percent strength would represent the number of grams contained in 100 g. Percent strength can be reduced to a fraction or to a decimal, which may be useful in solving these calculations. It is best to convert any ratio strengths to a percent. We assume that 1 g of solute displaces exactly 1 mL of liquid. Therefore, you will notice that grams and milliliters are used interchangeably depending on whether you are working with solids in grams or liquids in milliliters.

Concentrations

WEIGHT/WEIGHT

Percent concentrations for solids such as ointments or creams are expressed as % w/w. You can determine these by establishing a proportion and then converting it into a percentage, as discussed in Chapter 4.

Calculating weight/weight concentrations can be easily and accurately performed by following these steps:

1. Set up a proportion with the amount of active ingredient listed over the total quantity, as grams over grams.
2. Convert the proportion to a decimal (by dividing the numerator by the denominator).
3. Multiply the converted number by 100 to express the final concentration as a percentage.

EXAMPLE 6.1 1 g of active ingredient powder is mixed with 99 g of white petrolatum. What is the final concentration [w/w]?

Let's look at the information that has been provided and is critical to solving the calculation:

1 g active ingredient	amount of active
99 g white petrolatum	amount of base
100 g*	total quantity (1 g of active + 99 g of the base)

*It is important to be careful in determining the amount for the total quantity. If you do not add both the active and base quantities for the total quantity, if not listed, the calculation will be set up incorrectly from the very start!

The first step is to set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{1 \text{ g (active)}}{100 \text{ g (total)}}$$

Next, convert the proportion to a decimal by dividing the numerator by the denominator.

$$1 \text{ g} \div 100 \text{ g} = 0.01$$

Now, multiply the converted number by 100 to express the final concentration as a percentage.

$$0.01 \times 100 = 1\%$$

So, the final weight/weight concentration is 1%.

EXAMPLE 6.2 12 g of active ingredient powder is in a 120 g compounded cream. What is the concentration [w/w]?

Let's look at the information that has been provided and is critical to solving the calculation:

12 g active ingredient	amount of active
not provided	amount of base
120 g*	total quantity

*In this example, we are not provided with the amount of base, but only the amount of active ingredient and the total quantity.

First set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{12 \text{ g (active)}}{120 \text{ g (total)}}$$

Now, convert the proportion to a decimal by dividing the numerator by the denominator.

$$12 \text{ g} \div 120 \text{ g} = 0.1$$

Finally, multiply the converted number by 100 to express the final concentration as a percentage.

$$0.1 \times 100 = 10\%$$

Therefore, the final weight/weight concentration of the compounded cream is 10%.

EXAMPLE 6.3 30 g of a compounded ointment contains 105 mg of neomycin sulfate. What is the final concentration [w/w]?

Let's look at the information that has been provided and is critical to solving the calculation:

0.105 g* active ingredient	amount of active
not provided	amount of base
30 g	total quantity

*To accurately perform concentration calculations, the proportion must be set up as grams over grams. In this example, the problem provides the amount of active ingredient in milligrams, which must be converted to grams.

Set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{0.105 \text{ g (active)}}{30 \text{ g (total)}}$$

Then, convert the proportion to a decimal by dividing the numerator by the denominator.

$$0.105 \text{ g} \div 30 \text{ g} = 0.0035$$

Now, multiply the converted number by 100 to express the final concentration as a percentage.

$$0.0035 \times 100 = 0.35\%$$

The final weight/weight concentration is 0.35%.

EXAMPLE 6.4 If you add 3 g of salicylic acid to 97 g of an ointment base, what is the final concentration [w/w] of the product?

Let's look at the information that has been provided and is critical to solving the calculation:

3 g active ingredient	amount of active
97 g	amount of base
100 g	total quantity (3 g + 97 g)

Set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{3 \text{ g (active)}}{100 \text{ g (total)}}$$

Now, convert the proportion to a decimal by dividing the numerator by the denominator.

$$3 \text{ g} \div 100 \text{ g} = 0.03$$

Multiply the converted number by 100 to express the final concentration as a percentage.

$$0.03 \times 100 = 3\%$$

The final weight/weight concentration of the ointment is 3%.

EXAMPLE 6.5 How much oxiconazole nitrate powder is required to prepare this order?

Rx—1% Oxiconazole Nitrate Ointment

Disp. 45 g

Let's look at the information that has been provided . . . and what is missing.

not provided	amount of active
not provided	amount of base
45 g	total quantity
1%	final

Now this problem has given us the final concentration, and we are being asked to determine the amount of active ingredient needed. Notice that, in essence, the previous examples could be solved by using the formula below.

$$\frac{\text{g Active}}{\text{g Total Qty}} \times 100 = \text{Final \% Strength}$$

Up until this point, we have been able to solve for the final % strength by filling in the other amounts and solving. This is the same approach that we will take to solving this problem; the only difference is that we will be solving for the number of grams of active ingredient.

Using the information we know and the formula above, let's fill in everything we can.

$$\frac{x \text{ g (active)}}{45 \text{ g (total)}} \times 100 = 1\%$$

To solve for x, the unknown quantity of active ingredient, we can divide both sides of the equation by 100 . . . which will cancel it out on the left side and create a fraction on the right side.

$$\frac{x \text{ g (active)}}{45 \text{ g (total)}} \times \frac{\cancel{100}}{\cancel{100}} = \frac{1}{100}$$

Now, we have a ratio and proportion, which can be solved by cross multiplication and solving for x.

$$\frac{x \text{ g (active)}}{45 \text{ g (total)}} = \frac{1}{100}$$

Cross-multiply.

$$x \times 100 = 100x$$
$$1 \times 45 = 45$$

So . . .

$$100x = 45$$

Now, we can divide both sides by 100 to solve for x (the quantity of active ingredient needed).

$$\frac{\cancel{100}x}{\cancel{100}} = \frac{45}{100}$$
$$x = 0.45$$

So, 0.45 g or 450 mg of oxiconazole nitrate powder is needed for this order.

EXAMPLE 6.6 How much fluorouracil powder is in 5% Efudex® cream 25 g?

Let's look at the information that has been provided.

not provided	amount of active
not provided	amount of base
25 g	total quantity
5%	final

Again, this problem has given us the final concentration, and we are being asked to determine the amount of active ingredient needed.

Using the information known and the formula, fill in everything you can.

$$\frac{x \text{ g (active)}}{25 \text{ g (total)}} \times 100 = 5\%$$

Divide both sides of the equation by 100 to set up a ratio and proportion which can be solved.

$$\frac{x \text{ g (active)}}{25 \text{ g (total)}} \times \cancel{100} = \frac{5}{100}$$

Now, we have a ratio and proportion, which can be solved by cross multiplication and solving for x.

$$\frac{x \text{ g (active)}}{25 \text{ g (total)}} = \frac{5}{100}$$

Cross-multiply.

$$x \times 100 = 100x$$
$$5 \times 25 = 125$$

So . . .

$$100x = 125$$

Now, divide both sides by 100 to solve for x (the quantity of active ingredient needed).

$$\frac{\cancel{100}x}{\cancel{100}} = \frac{125}{100}$$
$$x = 1.25$$

So, 1.25 g of fluorouracil powder is contained in 25 g of 5% Efudex® cream.

PRACTICE PROBLEMS 6.1

1. 3 g of Zovirax® ointment contains 150 mg of acyclovir. What is concentration of this product?_____
2. 15 g of Tinactin® contains 0.15 g of tolnaftate powder. What is the % strength of this cream? _____
3. Bactroban® ointment contains 0.6 g of mupirocin per 30 g tube. What is the % strength? _____

4. Zonalon® cream contains 1.5 g of dosepin HCl with 28.5 g of a cream base. What is the concentration of Zonalon®? _____
5. To prepare a topical cream, you add 150 mg of metronidazole with 14.85 g of a cream base. What is the final percent strength of the cream? _____
6. 6 g of azelaic acid is added to 24 g of cream base to produce Azelex® cream. What is the concentration of this product? _____
7. Hytone® contains 500 mg of hydrocortisone powder with 19.5 g of emollient base. What is the percentage strength of Hytone®? _____
8. How much boric acid is contained in 30 g of a 10% boric acid ointment? _____
9. How much sulfur is contained in 120 g of 5% Plexion SCT® cream? _____
10. Vaniqa® cream contains 13.9% eflornithine HCl. How many grams of active ingredient is contained in 30 grams? _____

WEIGHT/VOLUME

Percent concentrations for liquids in which an active ingredient starting out as a powder is dissolved in a liquid, such as distilled water or normal saline, are expressed as % w/v. Again, you can determine these by establishing a proportion and then converting it into a percentage. Calculating weight/volume concentrations can be easily and accurately performed by following these steps:

1. Set up a proportion with the amount of active ingredient listed over the total quantity, as grams over milliliters.
2. Convert the proportion to a decimal (by dividing the numerator by the denominator).
3. Multiply the converted number by 100 to express the final concentration as a percentage.

EXAMPLE 6.7 100 g of active ingredient powder is mixed with 500 mL normal saline. What is the final concentration [w/v]?

Let's look at the information that has been provided and is critical to solving the calculation:

100 g active ingredient	amount of active
500 mL normal saline	amount of base
500 mL*	total quantity

*When mixing powders with liquids, the liquid (base) quantity is considered the total quantity, since the powder will either dissolve or suspend within the base liquid.

The first step is to set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{100 \text{ g (active)}}{500 \text{ mL (total)}}$$

Next, convert the proportion to a decimal by dividing the numerator by the denominator.

$$100 \text{ g} \div 500 \text{ mL} = 0.2$$

Now, multiply the converted number by 100 to express the final concentration as a percentage.

$$0.2 \times 100 = 20\%$$

So, the final weight/volume concentration is 20%.

EXAMPLE 6.8 25 g of active ingredient powder is mixed with 250 mL of distilled water. What is the final percent strength [w/v]?

Let's look at the information that has been provided and is critical to solving the calculation:

25 g active ingredient	amount of active
250 mL	total quantity

First, set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{25 \text{ g (active)}}{250 \text{ mL (total)}}$$

Next, convert the proportion to a decimal by dividing the numerator by the denominator.

$$25 \text{ g} \div 250 \text{ mL} = 0.1$$

Now, multiply the converted number by 100 to express the final concentration as a percentage.

$$0.1 \times 100 = 10\%$$

So, the final weight/volume percent strength is 10%.

EXAMPLE 6.9 9 g of sodium chloride is diluted in 1 L of SWFI (sterile water for injection). What is the final percent strength [w/v]?

Let's look at the information that has been provided and is critical to solving the calculation:

9 g active ingredient	amount of active
1000 mL*	total quantity

*Remember that the total quantity must be expressed as milliliters, so the 1 L is converted to 1000 mL.

Set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{9 \text{ g (active)}}{1000 \text{ mL (total)}}$$

Next, convert the proportion to a decimal by dividing the numerator by the denominator.

$$9 \text{ g} \div 1000 \text{ mL} = 0.009$$

Now, multiply the converted number by 100 to express the final concentration as a percentage.

$$0.009 \times 100 = 0.9\%$$

So, the final weight/volume percent strength is 0.9%.
(This is the formula for normal saline)

EXAMPLE 6.10 30 mL of Xylocaine® liquid contains 1.5 g of lidocaine HCl. What is the final concentration [w/v]?

Let's look at the information that has been provided and is critical to solving the calculation:

1.5 g active ingredient	amount of active
30 mL	total quantity

Set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{1.5 \text{ g (active)}}{30 \text{ mL (total)}}$$

Now, convert the proportion to a decimal by dividing the numerator by the denominator.

$$1.5 \text{ g} \div 30 \text{ mL} = 0.05$$

Finally, multiply the converted number by 100 to express the final concentration as a percentage.

$$0.05 \times 100 = 5\%$$

So, the final weight/volume concentration is 5%.

EXAMPLE 6.11 Melanex® solution contains 0.9 g of hydroquinone in every 1 oz. bottle. What is the final percent strength [w/v]?

Let's look at the information that has been provided and is critical to solving the calculation:

0.9 g active ingredient	amount of active
30 mL*	total quantity

*Remember that the total quantity must be expressed as milliliters, so the 1 oz. is converted to 30 mL.

Set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{0.9 \text{ g (active)}}{30 \text{ mL (total)}}$$

Next, convert the proportion to a decimal by dividing the numerator by the denominator.

$$0.9 \text{ g} \div 30 \text{ mL} = 0.03$$

Now, multiply the converted number by 100 to express the final concentration as a percentage.

$$0.03 \times 100 = 3\%$$

So, the final weight/volume percent strength is 3%.

EXAMPLE 6.12 Rogaine® Extra Strength is a 5% solution of minoxidil in alcohol. How much active ingredient is in a 60 mL bottle?

Let's look at the information that has been provided . . . and what is missing.

not provided	amount of active
60 mL	total quantity
5%	final strength

Now this problem has given us the final concentration and we are being asked to determine the amount of active ingredient needed. Notice that, in essence, the previous examples could be solved by using the formula below.

$$\frac{\text{g Active}}{\text{mL Total Qty}} \times 100 = \text{Final \% Strength}$$

Using the information we know and the formula above, let's fill in everything we can.

$$\frac{x \text{ g (active)}}{60 \text{ mL (total)}} \times 100 = 5\%$$

To solve for x, the unknown quantity of active ingredient, we can divide both sides of the equation by 100 . . . which will cancel it out on the left side and create a fraction on the right side.

$$\frac{x \text{ g (active)}}{60 \text{ mL (total)}} \times \frac{\cancel{100}}{\cancel{100}} = \frac{5}{100}$$

Now, we have a ratio and proportion, which can be solved by cross multiplication and solving for x.

$$\frac{x \text{ g (active)}}{60 \text{ mL (total)}} = \frac{5}{100}$$

Cross-multiply.

$$x \times 100 = 100x$$

$$60 \times 5 = 300$$

So . . .

$$100x = 300$$

Now, we can divide both sides by 100 to solve for x (the quantity of active ingredient needed).

$$\frac{\cancel{100}x}{\cancel{100}} = \frac{300}{100}$$

$$x = 3$$

So, a 60 mL bottle of 5% Rogaine® Extra Strength contains 3 g of minoxidil powder.

PRACTICE PROBLEMS 6.2

1. Betagan Liquifilm® contains 25 mg of levobunolol HCl in 10 mL of solution. What is the percentage strength?

   _____

2. 50 g of dextrose is added to 1 L of SWFI. What is the final concentration? _____
3. Cleocin T® contains 10 mg of clindamycin phosphate per mL of solution. What percentage strength is this product?

   _____

4. Pred Forte® contains 0.15 g of prednisilone in 15 mL of ophthalmic suspension. What is the concentration? _____
5. How much sodium chloride powder is needed to prepare 500 mL of a 0.45% NaCl solution? _____
6. How much phenylephrine HCl would be needed to prepare 20 mL of a 5% ophthalmic solution? _____
7. Sebizon® lotion contains 8.5 g sulfacetamide sodium in 85 mL. What is the final concentration of this product? _____
8. How much silver nitrate is needed to prepare one ounce of a 35% silver nitrate solution? _____
9. How much albuterol sulfate is needed to compound 120 unit dose vials (3 mL) of 0.042% albuterol for nebulization?

   _____

10. Drysol® contains 7.5 g of aluminum chloride hexahydrate in 37.5 mL of an alcohol base. What is the final percent strength of Drysol®?

    _____

VOLUME/VOLUME

Percent concentrations that dissolve a liquid into a liquid are considered % v/v. The percentage indicates the number of milliliters of active ingredient contained in the total volume of the solution. As before, you can determine these by establishing a proportion and then converting it into a percentage, as discussed in Chapter 4.

Calculating volume/volume concentrations can be easily and accurately performed by following these steps:

1. Set up a proportion with the amount of active ingredient listed over the total quantity, as milliliters over milliliters.
2. Convert the proportion to a decimal (by dividing the numerator by the denominator).
3. Multiply the converted number by 100 to express the final concentration as a percentage.

EXAMPLE 6.13 10 mL of active ingredient is mixed with distilled water to total 200 mL. What is the final concentration [v/v]?

Let's look at the information that has been provided and is critical to solving the calculation:

10 mL active ingredient	amount of active
200 mL*	total quantity

The first step is to set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{10 \text{ mL (active)}}{200 \text{ mL (total)}}$$

Next, convert the proportion to a decimal by dividing the numerator by the denominator.

$$10 \text{ mL} \div 200 \text{ mL} = 0.05$$

Now, multiply the converted number by 100 to express the final concentration as a percentage.

$$0.05 \times 100 = 5\%$$

So, the final volume/volume concentration is 5%.

EXAMPLE 6.14 180 mL of active ingredient is added to 820 mL of an alcohol-based solution. What is the final strength [v/v]?

Let's look at the information that has been provided and is critical to solving the calculation:

180 mL active ingredient	amount of active
820 mL	amount of base
1000 mL*	total quantity

*It is important to be careful in determining the amount for the total quantity. If you do not add both the active and base quantities for the total quantity, if not listed, the calculation will be set up incorrectly from the very start!

The first step is to set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{180 \text{ mL (active)}}{1000 \text{ mL (total)}}$$

Next, convert the proportion to a decimal by dividing the numerator by the denominator.

$$180 \text{ mL} \div 1000 \text{ mL} = 0.18$$

Now, multiply the converted number by 100 to express the final concentration as a percentage.

$$0.18 \times 100 = 18\%$$

So, the final volume/volume strength is 18%.

EXAMPLE 6.15 36 mL of bezoin tincture is combined with 84 mL of an 80% alcohol solution. What is the final strength [v/v]?

Let's look at the information that has been provided and is critical to solving the calculation:

36 mL active ingredient	amount of active
84 mL	amount of base
120 mL	total quantity

*Be careful. 80% is not a factor in solving this problem . . . it is simply describing the base product.

The first step is to set up a proportion with the amount of active ingredient listed over the total quantity.

$$\frac{36 \text{ mL (active)}}{120 \text{ mL (total)}}$$

Next, convert the proportion to a decimal by dividing the numerator by the denominator.

$$36 \text{ mL} \div 120 \text{ mL} = 0.3$$

Now, multiply the converted number by 100 to express the final concentration as a percentage.

$$0.3 \times 100 = 30\%$$

So, the final volume/volume strength is 30%.

EXAMPLE 6.16 How many mL of active ingredient must be added to distilled water to produce 60 mL of a 25% solution [v/v]?

Let's look at the information that has been provided . . . and what is missing.

not provided	amount of active
60 mL	total quantity
25%	final strength

Now this problem has given us the final concentration, and we are being asked to determine the amount of active ingredient needed. Notice that, in essence, the previous examples could be solved by using the formula below.

$$\frac{\text{mL Active}}{\text{mL Total Qty}} \times 100 = \text{Final \% Strength}$$

Using the information we know and the formula above, let's fill in everything we can.

$$\frac{x \text{ mL (active)}}{60 \text{ mL (total)}} \times 100 = 25\%$$

To solve for x, the unknown quantity of active ingredient, we can divide both sides of the equation by 100—which will cancel it out on the left side and create a fraction on the right side.

$$\frac{x \text{ mL (active)}}{60 \text{ mL (total)}} \times \frac{\cancel{100}}{\cancel{100}} = \frac{25}{100}$$

Now, we have a ratio and proportion, which can be solved by cross multiplication and solving for x.

$$\frac{x \text{ mL (active)}}{60 \text{ mL (total)}} = \frac{25}{100}$$

Cross-multiply.

$$x \times 100 = 100x$$

$$60 \times 25 = 1500$$

So . . .

$$100x = 1500$$

Now, we can divide both sides by 100 to solve for x (the quantity of active ingredient needed).

$$\frac{\cancel{100}x}{\cancel{100}} = \frac{1500}{100}$$

$$x = 15$$

So, 15 mL of active ingredient is necessary to produce 60 mL of a 25% solution.

PRACTICE PROBLEMS 6.3

1. 10 mL of alcohol combined with 90 mL of distilled water would yield what % v/v? _____
2. 150 mL of active ingredient is combined with 350 mL of normal saline. What is the final strength? _____

3. Two tablespoons of extract are mixed with 120 mL of oral suspension base. What is the final concentration of the suspension?
_____
4. 5 mL of medicated tincture is combined with simple syrup to total 2 ounces. What is the final strength of the product? _____
5. 48 mL of lidocaine is mixed with 552 mL of a suspension base. What is the final percentage v/v? _____
6. How many milliliters of active ingredient are required to be added to produce 250 mL of normal saline to produce a 15% solution?
_____
7. How much gentian violet should be added to produce 1 L of a 10% solution? _____
8. How much active ingredient is needed to be added to distilled water to produce 20 mL of a 70% solution? _____
9. 20 mL of butyl stearate is mixed with 380 mL of alcohol. What is the final percentage strength? _____
10. 35 mL of artificial flavor concentrate is mixed with 105 mL of SWFI. What is the final concentration? _____

Dilutions

Stock solutions are stronger solutions that you can later dilute to the desired strength ordered. The larger volume that you mix with the stock solution is called the diluent. You can use the following formula to calculate dilutions:

FORMULA **Dilutions**

$$Q1 \times C1 = Q2 \times C2$$

The equation may also be shown this way as a ratio and proportion:

$$\frac{Q1}{Q2} :: \frac{C2}{C1}$$

Notice that quantity is shown on one side and concentration is shown on the other. Note also that the initial values are diagonal to each other and the final values are on the opposite diagonal.

You should solve the equation shown in the box algebraically versus the second option of setting up a ratio and proportion. Both options will work. The secret is to place the provided elements appropriately before solving.

Where Q represents *quantity* expressed in milliliters or grams and C represents *concentration* in percent strength:

- Q1 = initial quantity (volume)
- C1 = initial concentration expressed as a percentage (stock solution)
- Q2 = final quantity (volume)
- C2 = final concentration expressed as a percentage (final solution)

Notice that Q1 and C1 on the left side of the equation represent the initial quantity and strength, and Q2 and C2 on the right side of the equation represent the final quantity and final strength. This should help you remember the equation.

In the following questions, three of the four elements will be listed; you should place them appropriately in the formula, then solve for x.

EXAMPLE 6.17 How much stock solution of hydrogen peroxide 12% solution will you need to make 480 mL of hydrogen peroxide 3% solution?

$$\begin{aligned} Q1 &= x \\ C1 &= 12\% \\ Q2 &= 480 \text{ mL} \\ C2 &= 3\% \end{aligned}$$

Use the formula by plugging in the known elements:

$$\begin{aligned} x \times 12 &= 480 \times 3 \\ 12x &= 1440 \end{aligned}$$

To solve for x, divide both sides by 12:

$$\begin{aligned} \frac{12x}{12} &= \frac{1440}{12} \\ x &= 120 \text{ mL} \end{aligned}$$

So we will measure 120 mL of the 12% solution and add diluent qs to 480 mL. This will yield the desired quantity and strength. (*qs* means *quantity sufficient*, or as much as is needed to yield the final amount.)

Solids, such as ointments and creams, can also be diluted. If you are starting out with an active ingredient that is a powder, consider the beginning concentration to be 100%.

EXAMPLE 6.18 Rx salicylic acid 40% ointment 15 g

You have salicylic acid powder and white petrolatum. You are starting with 100% powder, which you will dilute by adding the white petrolatum.

$$\begin{aligned} Q1 &= x \\ C1 &= 100\% \\ Q2 &= 15 \text{ g} \\ C2 &= 40\% \end{aligned}$$

Use the formula by plugging in the known elements:

$$\begin{aligned} x \times 100 &= 15 \times 40 \\ 100x &= 600 \end{aligned}$$

Solve for x:

$$\begin{aligned} \frac{100x}{100} &= \frac{600}{100} \\ x &= 6 \text{ g} \end{aligned}$$

So you will need 6 g of salicylic acid powder.

EXAMPLE 6.19 You had 60 g of a 20% coal tar solution, which you diluted to produce 100 g. What is the strength of the final product?

$$Q1 = 60 \text{ g}$$
$$C1 = 20\%$$
$$Q2 = 100 \text{ g}$$
$$C2 = x$$

Use the formula by plugging in the known elements:

$$60 \times 20 = 100 \times x$$
$$1200 = 100x$$

To solve for x, divide both sides by 100.

$$\frac{12}{12} = \frac{\cancel{100}x}{\cancel{100}}$$
$$x = 12$$

So the final product is a 12% coal tar solution.

EXAMPLE 6.20 If you diluted 90 mL of an 8% benzocaine lotion to 6%, how much could you produce?

$$Q1 = 90 \text{ mL}$$
$$C1 = 8\%$$
$$Q2 = x\text{X}$$
$$C2 = 6\%$$

Use the formula by plugging in the known elements:

$$90 \times 8 = x \times 6$$
$$720 = 6x$$

To solve for x, divide both sides by 6.

$$\frac{720}{6} = \frac{6x}{6}$$
$$x = 120$$

So, you would be able to produce 120 mL of the diluted 6% lotion.

PRACTICE PROBLEMS 6.4

Calculate the following dilutions.

1. How much of a 10% solution will you need to produce 150 mL of a 6% solution?_____
2. How much 50% silver nitrate solution do you need to produce one ounce of a 10% silver nitrate solution? _____
3. How much 8% solution can you make by diluting 500 mL of a 20% solution? _____

4. Rx cephazolin 2% ophthalmic drops 10 mL

   To make this order, use cephazolin injection 500 mg/10 mL vial. How many milliliters from the vial of cephazolin will be in the final preparation? _____

   (Note: Compounded ophthalmic drops must be prepared using aseptic technique in a clean room. The appropriate amount of stock solution is combined with enough sterile tear drops to make the final volume.)

5. Rx benzalkonium chloride 1:200 solution 1 L

   How many milliliters can be made from 120 mL of a 12% stock solution? _____

6. Rx morphine sulfate 30 mg/mL oral solution 240 mL

   You have four 50-mL vials of morphine sulfate 50 mg/mL injectable. How many milliliters of product can be made using three of the stock vials? _____

7. Rx aluminum acetate solution 1:13 dilution 480 mL

   You have a box of domeboro packets with directions stating that three packets mixed into 16 oz. of water will yield a 1:13 dilution that will contain aluminum acetate 0.48%. If the patient dilutes 1 cup of the solution by placing it in an empty gallon jug and filling with water, what ratio strength will result? _____

8. Rx prostaglandin 20 mcg/cc 10 cc

   You have a stock solution that contains 50 mcg/mL. How much of the stock solution will you need to prepare the order?

   _____

9. Rx doxepin 25 mg/5 mL 240 mL

   How much doxepin 10 mg/mL concentrate should you dilute to prepare the order? _____

10. Rx povidone iodine 1% soaking solution 1 L

    How much povidone iodine 12% solution should you dilute to prepare the order? _____

11. Rx lidocaine HCl 1% nasal spray 30 mL

    You have a stock solution of lidocaine HCl 4% solution. How much of the stock solution do you need to prepare the order?

    _____

12. Rx hydrochloric acid 1% solution 120 mL

    You have a stock solution of hydrochloric acid 50%. How much of the stock solution will you use to prepare the order?_____

13. Rx hydroxycobalamine 5,000 mcg/mL 30 mL

    You have a stock solution of hydroxycobalamine 10 mg/mL. How much of the stock solution do you need to prepare the order?

    _____

14. Rx histamine phosphate 1:1000 solution 30 mL

    You have a stock solution of histamine phosphate 1:10. How much of the stock solution will you need to prepare the order?

    _____

15. Rx vancomycin 50 mg/100 mL 10 mL

    You have vials that contain 50 mg/100 mL. How many milliliters of stock solution will you need to prepare the order? _____

PRACTICE PROBLEMS 6.5

Determine how much active ingredient is needed.

1. How much minoxidil powder would be required to compound 60 mL of a 2% solution? _____
2. Rx silver nitrate 0.25% soaking solution 2 L

   How much silver nitrate do you need to prepare the order?_____
3. Rx thymol 4% in alcohol 30 mL

   How much active ingredient do you need to prepare the order?_____
4. Rx azothioprine 1% suspension 150 mL

   (Note: Once tablets are triturated to a powder, the beginning strength is 100 percent.)

   a. If the dose is 1 tsp, how many doses are in 150 mL?_____

   b. How many 50-mg tablets will you need to prepare the order?

   _____
5. Rx taurine 50 mg/mL 45 mL

   How much taurine powder should you weigh out to prepare the order?

   _____

SUMMARY

Concentrations and dilutions, which can appear overwhelming and intimidating, are nothing more than a series of ratios and proportions. You will use concentrations and dilutions in a variety of pharmacy practice settings, so it is important that you master this skill.

CHAPTER 6

CHAPTER REVIEW QUESTIONS

MULTIPLE CHOICE

1. 50% w/w contains how many grams of active ingredient? _____
   a. 50 g
   b. 25 g
   c. 100 g
   d. 5 g

2. How many milligrams of active ingredient will you need to prepare 120 mL of a product to contain 4 mg/mL of active ingredient?
   _____
   a. 120 mg
   b. 4 mg
   c. 480 mg
   d. 400 mg

3. What is the percent strength of clemastine fumerate syrup 0.5 mg/5 mL?
   _____
   a. 0.05%
   b. 0.01%
   c. 0.025%
   d. 0.5%

4. Which of the following has the highest concentration? _____
   a. 4 mg/mL
   b. 4%
   c. 2 mg/mL
   d. 2%

5. What is the final volume when diluting 10 mL of a lidocaine 6% nasal spray to a lidocaine 2% nasal spray? _____
   a. 10 mL
   b. 12 mL
   c. 15 mL
   d. 30 mL

6. How many milliliters of gentian violet 2% solution will you need to make 500 mL of a 0.025% solution? _____
   a. 6.25 mL
   b. 20 mL
   c. 50 mL
   d. 250 mL

7. What is the final strength when diluting 25 mL of a 12% solution with 100 mL water?
   _____
   a. 5.0%
   b. 2.0%
   c. 2.4%
   d. 3.0%

8. What is the resulting ratio strength when you dilute 12 mL of liquid coal tar to make 240 mL of coal tar lotion? _____
   a. 1:5
   b. 1:10
   c. 1:12
   d. 1:20

9. How many grams of thymol should you dilute to make 30 mL of a 4% thymol in alcohol topical nail solution? _____
   a. 0.12 g
   b. 1.2 g
   c. 4.0 g
   d. 7.5 g

10. What is the final volume when diluting 100 mL of sorbitol 50% solution to a 20% solution?
    _____
    a. 120 mL
    b. 150 mL
    c. 250 mL
    d. 300 mL

TRUE OR FALSE

11. A solution that has a concentration of 25% contains 25 mg in 100 mL. _____
    a. true
    b. false

12. 4 mg/mL is more concentrated than 4%.
    _____
    a. true
    b. false

13. One gram of solute displaces 1 mL of liquid. _____
    a. true
    b. false

14. When using the formula Q1 × C1 = Q2 × C2, C represents concentration and should be stated as a percentage. _____

a. true **b.** false

15. To convert a percentage to a decimal, move the decimal point two places to the left. _____

a. true **b.** false

SHORT ANSWER

16. Describe the formula for calculating percent strength._____
17. Explain the difference between % w/w and % w/v._____
18. Write the formula used to calculate dilutions. _____
19. What is the diluent? _____
20. What is normal saline? _____