

Ratio and Proportion

Student Learning Outcomes

After completing the tasks in this unit, you will be able to:

- 5-1** Define ratio and proportion
- 5-2** Locate and decipher ratios in common health applications such as drug labels
- 5-3** Determine if two ratios are a proportion
- 5-4** Simplify ratios and complex ratios
- 5-5** Apply ratio definitions to express unit rates
- 5-6** Solve for x or an unknown in a proportion
- 5-7** Apply proportions to nutrition labels
- 5-8** Apply proportion to solve dental stone mixtures

Pre-Test

1. One kilogram equals 2.2 pounds. How many pounds equal 24.5 kilograms?
2. Solve for x . $48 : 64 = x : 124$
3. One cup contains 8 ounces. How many full cups are in 138 ounces?
4. Solve for x . $\frac{1}{8} : 3 = \frac{1}{4} : x$
5. Solve for x . $x : 225 = 2 : 5$
6. Write the ratio that represents three registered nurses to twelve certified nursing assistants.

7. The patient's pulse is documented as 73 beats per minute. How many beats will be documented for 5 minutes if the rate remains the same?
8. Two tablespoons of peanut butter are used for each sandwich. One tablespoon has three teaspoons. If 49 sandwiches are made, how many teaspoons of peanut butter are needed to make these sandwiches?
9. Write the medication dosage for the amount on this label. Write it as a ratio. Include the unit of measure.

**hydroxyzine
pamoate**

120 mL
ORAL SUSPENSION

25 mg/5 mL*

For Oral Use Only

Rx only

120 ml | NDC 0069-5440-97

 2418

* Each teaspoonful (5 mL) contains hydroxyzine pamoate equivalent to 25 mg hydroxyzine hydrochloride.

USUAL DAILY DOSAGE:
Adults: 1 to 4 teaspoonfuls 3-4 times daily.
Children: 6 years and over—2 to 4 teaspoonfuls daily in divided doses. Under 6 years—2 teaspoonfuls daily in divided doses.

READ ACCOMPANYING PROFESSIONAL INFORMATION. PROTECT FROM MOISTURE AND HUMIDITY.
 Store below 77°F (25°C)
SHAKE VIGOROUSLY UNTIL PRODUCT IS COMPLETELY RESUSPENDED.
 DYE FREE FORMULA


N 0069-5440-97 7
05-2255-32-6

Practice Label

10. The tapioca recipe calls for $2\frac{1}{2}$ cups of milk to make six servings. How many cups of milk are needed for 15 servings?
11. The dietitian ordered 4 ounces of chicken per patient for a dinner meal. The kitchen served 496 ounces of chicken this evening. How many patients received a 4-ounce portion of chicken?
12. The patient went to the laboratory to have blood drawn by a phlebotomist. Each tube of blood holds 2.5 milliliters of blood. Four tubes of blood were drawn. How many milliliters of blood were drawn?
13. On average, one registered nurse at Valley View uses 62 gloves a day to examine patients. In 5 days, how many gloves will that particular nurse use?
14. Solve for x . $\frac{4}{75} : 15 :: x : 20$
15. How many minutes are in 320 seconds? Your answer should be in minutes and seconds.



Overview

Ratio is a way to show a relationship between two items. We are always counting and comparing items in our daily lives: hours at work versus hours away from work, number of yogurts we have eaten versus the number of yogurts still in the refrigerator, and so on. Ratios simply help us compare two items, objects, or amounts.

Proportion compares two equal ratios in a mathematical equation. We use proportion to either increase or decrease one part of the ratio in the equation so that the unit expressed or found is in the same relationship with the other part of the specific ratio and so that this ratio, when completed, shows the same relationship as the other ratio.

Ratio

REVIEW

A ratio is used to show a relationship between two numbers or a comparison of two items. The numbers are separated by a colon (:) as in $x : y$. For example, three nurses and four medical assistants working a clinic shift can form a ratio. Ratios may be presented in three formats that provide the set-up for solving proportions.

- $3 : 4$ (three nurses to four medical assistants)
- $\frac{3}{4}$ (three nurses to four medical assistants)
- 3 is to 4 (three nurses to four medical assistants)

The relationship can represent something as simple as the $1 : 3$ ratio commonly used to mix frozen juices. We use one can of frozen juice concentrate to three cans of water. Ratios are fractions that represent a part-to-whole relationship. Often when we work with ratios, we use the fraction format to reduce the ratio to its simplest form.

Ratios are always reduced to their lowest form. For example, 8 hours of sleep to 24 hours in a day would be expressed as

$$8 : 24 \rightarrow \frac{8}{24} = \frac{8 \times 1}{8 \times 3} = \frac{1}{3} \quad \text{so the ratio is } 1 : 3.$$

Practice 1

Write the following relationships as ratios using a colon. Reduce to lowest terms, if necessary.

- 6 days out of 7 days _____
- twelve teeth out of thirty-two teeth _____



SET-UP HINT

Writing your ratios in the proper order is important. Follow the order of each number of the ratio in the sentence or problem. It is a good idea to include the units. In that way, you can be sure that you have followed the same pattern in each ratio.

3. 8 students out of 15 students _____
4. 16 scalpels to 45 syringes _____
5. 7 inlays to 14 crowns _____

Simplifying ratios is an important skill. To simplify a ratio, divide the first number by the second.

For example, simplify the following ratio: $4\frac{1}{2} : 6$.

$$4\frac{1}{2} \div 6 \rightarrow \frac{9}{2} \div \frac{6}{1} \rightarrow \frac{9}{2} \times \frac{1}{6} = \frac{9}{12} \rightarrow \frac{3 \times 3}{3 \times 4} = \frac{3}{4}, \text{ which becomes } 3 : 4$$

The answer is 3 : 4.

As another example, simplify the following ratio: $11\frac{1}{4}$. Convert the mixed number into an improper fraction, and then reduce, if necessary.

$$11\frac{1}{4} \rightarrow 11 \times 4 + 1 = 45 \rightarrow \frac{45}{4} = 45 : 4$$

The answer is 45 : 4.

Practice 2

Simplify the following ratios. Write each answer as a ratio.

1. $24 : 3\frac{1}{4} =$ _____

2. $\frac{7}{8} : 14 =$ _____

3. $25 : \frac{5}{6} =$ _____

4. $\frac{1}{3} : 45 =$ _____

5. $0.8 : \frac{2}{5} =$ _____

6. $\frac{1}{2} : \frac{1}{8} =$ _____

7. $4\frac{1}{3} : 7 =$ _____

8. $0.875 : \frac{1}{4} =$ _____

9. $2\frac{1}{2} =$ _____

10. $\frac{2}{3} : 0.33 =$ _____

Ratios in Health Care

Drug labels are another place that ratios may be seen in health care. Careful reading of the drug label will help locate the dosage of medication per tablet or per amount of solution. Notice that each label uses a specific language indicating a ratio. These formats are milligrams/milliliters (mg/mL), micrograms/milligrams (mcg/mg), mg per tablet, milligrams in milliliters (mg in mL), etc. Careful reading will help identify what is in each tablet, each milliliter of medication, etc.

Practice Label

Practice 3

Read the labels and write the ratio of the medication indicated in each label. Write the ratio in simplified form.

1. _____

Practice Label

2.

NDC 0641-0180-25

morphine


Sulfate
Injection, USP

FOR SUBCUTANEOUS, INTRAMUSCULAR OR SLOW INTRAVENOUS USE
 NOT FOR EPIDURAL OR INTRATHECAL USE

WARNING: May be habit forming
 PROTECT FROM LIGHT
 DO NOT USE IF PRECIPITATED

10 mg/mL Rx only

1 mL Vial

 PL Pharmaceuticals

Each mL contains morphine sulfate 10 mg, sodium dihydrogen phosphate 10 mg, disodium hydrogen phosphate 2.8 mg, sodium formaldehyde sulfoxylate 3 mg and phenol 2.5 mg in Water for Injection. Sulfuric acid used to adjust pH to 2.5–6.0. Sealed under nitrogen.

Usual Dose: See package insert for complete prescribing information.
Note: Slight discoloration will not alter efficacy. Discard if markedly discolored.
Caution: Federal law prohibits dispensing without prescription.

Practice Label

3.

cefdinir


100 mL
ORAL SUSPENSION

125 mg per 5 mL

SHAKE WELL BEFORE USING.
 Keep bottle tightly closed. Any unused portion must be discarded 10 days after mixing.

RECONSTITUTE WITH 63 mL WATER
 (when reconstituted)

100 mL | NDC 0074-3771-13


 PL Pharmaceuticals 02-9158

Each 5 mL contains 125 mg cefdinir after reconstitution.

DIRECTIONS FOR RECONSTITUTION
 Prepare suspension at time of dispensing by adding a total of 63 mL water to the bottle. Tap bottle to loosen the powder, then add about half the water, and shake. Add the remaining water and shake to complete suspension. This provides 100 mL of suspension.

USUAL DOSAGE: Children-14 mg/kg/day in a single dose or in two divided doses, depending on age, weight, and type of infection. See package enclosure for full prescribing information. This bottle contains 2.5 g cefdinir. Do not accept if seal over bottle opening is broken or missing.

Keep this and all drugs out of the reach of children. Store dry powder and reconstituted suspension at 25°C (77°F); excursions permitted to 15°–30°C (59°–86°F) [see USP Controlled Room Temperature]. Use within 10 days. **SHAKE WELL BEFORE EACH USE.** Keep bottle tightly closed.

 029158
 3 D074377113 8
 Lot Expiration date of powder. Rx only

Practice Label


4.

LITHIUM
Citrate Syrup, USP
8 mEq/5 mL


NDC 68094-767-59

Sugar-Free
768 R0
6498

Rx only

 PL Pharmaceuticals

Store at 25 °C (77 °F)
Delivers 5 mL
Each 5 mL contains:
8 mEq of Lithium Ion
(Equivalent to 300 mg of Lithium Carbonate per 5 mL)
Alcohol 0.3%



Practice Label


5.

NDC 1123-4567-89

lincomycin hydrochloride

300 mg/mL

10 mL multidose vial

 PL Pharmaceuticals

Practice Label

Unit Rates

Another example of ratio in health care comes from dealing with insurance coverage. There is something called a medical loss ratio, which is used in managed care to measure medical costs as a percentage of premium revenues or income. It is a type of loss ratio used to measure the percentage of premiums paid out in claims rather than expenses. A desirable ratio is 17 : 20 or 85% or less.

In addition, ratios can compare two items. For example, ratios are often used to find the unit rate, which is a rate having 1 as its denominator. Rate is a ratio of two measurements having different units.

$$\text{Example: } \frac{\$4.10 \text{ (a package of gauze strips)}}{24 \text{ (individual number of strips)}}$$

To get the unit rate, divide the bottom number (the denominator) into the top number (the numerator).

$$\$4.10 \div 24 = 0.170833 \text{ or } 17 \text{ cents per sheet of gauze}$$

17 cents : 1 sheet or 17 : 1

Practice 4

Express each as a unit rate.

1. $\frac{\$4182 \text{ room bill for a hospital stay}}{3 \text{ days in the hospital}}$ _____

2. $\frac{120 \text{ pound goal to lose}}{52 \text{ weeks in a year}}$ _____

3. $\frac{24 \text{ ounces}}{3 \text{ cups}}$ _____

4. $\frac{14 \text{ cups of sugar}}{252 \text{ cookies}}$ _____

5. $\frac{14235 \text{ patients}}{365 \text{ days}}$ _____

Proportion

REVIEW

Proportions can be applied to almost every health care profession in one way or another. In addition to on-the-job applications, proportions provide a simple and quick method for solving many everyday math problems such as measurement conversions, recipe conversions for increasing or decreasing the amounts of ingredients, and map mileage.

Proportions are two or more equivalent ratios or fractions in which the terms of the first ratio/fraction have the same part-to-whole relationship as the second ratio/fraction.

Example

If one box of gloves contains 100 gloves, then $4\frac{1}{2}$ boxes will contain how many gloves?

$$\frac{1 \text{ box}}{100 \text{ gloves}} = \frac{4\frac{1}{2} \text{ boxes}}{x \text{ number of gloves}} \quad 4\frac{1}{2} = 4.5 \rightarrow 4.5 \times 100 = 450$$

Once you become well versed in the set-up, you may drop the units. However, labeling the units is very helpful to ensure the proper set-up.

$$\frac{3}{4} = \frac{15}{20} \text{ or } 3 : 4 :: 15 : 20$$

Test the two ratios/fractions to see whether they are equivalent by multiplying diagonally (cross multiply).

$$\frac{3}{4} = \frac{15}{20} \quad 4 \times 15 = 60 \text{ and } 3 \times 20 = 60. \text{ This is a proportion.}$$

If the two numbers that are diagonal result in the same answer when they are multiplied, you are working with a proportion.

Proportions are powerful tools in health care. You can rely on them for solving a majority of your math conversions and problems.

Practice 5

Check to see if the following ratios are proportions.

- | | | |
|-------------------|-----------|----------|
| 1. $5:2 = 4:1$ | _____ Yes | _____ No |
| 2. $16:15 = 8:7$ | _____ Yes | _____ No |
| 3. $40:30 = 4:3$ | _____ Yes | _____ No |
| 4. $10:16 = 5:8$ | _____ Yes | _____ No |
| 5. $100:1 = 50:2$ | _____ Yes | _____ No |



SET-UP HINT

Notice how the terms for each category (boxes and gloves) are across from each other. This is the proper set-up: boxes across from boxes and gloves across from gloves.



MATH SENSE

:: means "is" or =

Solving for x

REVIEW

The ratio and proportion method is used to solve for x . Solving for x uses the known or given information to find what is not known or given. Since a proportion consists of two equal ratios, the relationship between the numerator and denominator

of each fraction is the same for each ratio of the proportion. This is important to know when one must increase or decrease a solution or mixture because the ratio of ingredients must remain constant.

Solving for x is done in two steps.

STEP 1: Set the problems up like fractions. If units of measure such as inches and feet are given, place inches across from inches and feet across from feet. Then cross multiply (diagonally) the two numbers. Set the ratios up like fractions using a vertical line.

$$\frac{3}{4} = \frac{?}{16} \quad 3 \times 16 = 48$$

STEP 2: Divide the answer from step 1 by the remaining number.

$$\begin{array}{r} 12 \\ 4 \overline{)48} \\ \underline{-4} \\ 8 \\ \underline{-8} \\ 0 \end{array}$$

The quotient 12 is the answer to ? or x . This method is an easy way to find the answers for measurement conversions, dosage conversions, and math questions that provide part but not all of the information.

Practice 6

Solve for x or ?

1. $12:45 = x:15$ _____
2. $x:6 = 15:60$ _____
3. $25:45 = 75:x$ _____
4. $7:x = 21:24$ _____
5. $3:9 = ?:81$ _____
6. $13:39 = 1:?$ _____
7. $2:11 = ?:77$ _____
8. $x:125 = 5:25$ _____
9. $2:26 = 4:?$ _____
10. $1:x = 5:200$ _____

Using ratios is often the simplest method of solving other health care math problems, such as dosage calculations and measurement problems.

Example

Zoe weighs 35 pounds. Her doctor prescribed a drug that relates milligrams of medication to kilograms of body weight. The pharmacy technician will need to convert pounds to kilograms. By using the ratio of 1 kilogram to 2.2 pounds, the answer is quickly computed.

$$\frac{\textit{known}}{2.2 \text{ pounds}} = \frac{\textit{unknown}}{35 \text{ pounds}}$$

$$\frac{1 \text{ kilogram}}{2.2 \text{ pounds}} = \frac{? \text{ kilograms}}{35 \text{ pounds}}$$

STEP 1: Multiply the numbers diagonally.

$$1 \times 35 = 35$$

STEP 2: Divide 35 by 2.2. The answer is 15.9 kilograms.

So, 35 pounds equals 15.9 kilograms.

Converting between kilograms and pounds is a common procedure in health care.

Practice 7

Set up and solve these conversions using ratio and proportions. Round to the nearest tenth, if necessary. Use the conversion 1 kilogram = 2.2 pounds.

1. Convert 16.4 kilograms to pounds. _____
2. Convert 125.8 kilograms to pounds. _____
3. Convert 35 kilograms to pounds. _____
4. Convert 75 kilograms to pounds. _____
5. Convert 83.5 kilograms to pounds. _____
6. Convert 16 pounds to kilograms. _____
7. Convert $25\frac{1}{2}$ pounds to kilograms. _____
8. Convert 108 pounds to kilograms. _____
9. Convert 215.6 pounds to kilograms. _____
10. Convert 165 pounds to kilograms. _____

Example

How many pounds are in 24 ounces?

Set the problem up by placing what you know on the left side of the equation and what you do not know on the right side. If you set up all your problems with the known on the left and the unknown on the right, there will be less information for your brain to process because the pattern will be familiar to you.

$$\frac{\textit{known}}{16 \text{ ounces}} = \frac{\textit{unknown}}{24 \text{ ounces}}$$

$$\frac{1 \text{ pound}}{16 \text{ ounces}} = \frac{? \text{ pounds}}{24 \text{ ounces}}$$

STEP 1: $1 \times 24 = 24$

STEP 2: $24 \div 16 = 1.5$

The answer is $1\frac{1}{2}$ pounds or 1.5 pounds.

The answer in a ratio may have a decimal or a fraction in it.

Example

Bob is 176 centimeters (cm) tall. How tall is he in inches? Round the answer to the nearest tenth.

$$\frac{\textit{known}}{2.54 \text{ cm}} = \frac{\textit{unknown}}{176 \text{ cm}}$$

$$\frac{1 \text{ inch}}{2.54 \text{ cm}} = \frac{? \text{ inches}}{176 \text{ cm}}$$

STEP 1: $1 \times 176 = 176$

STEP 2: $176 \div 2.54 = 69.29$

$$\begin{array}{r} 69.29 \\ 254 \overline{)17600} \\ \underline{-1524} \downarrow \\ 2360 \\ \underline{-2286} \downarrow \\ 740 \\ \underline{-508} \downarrow \\ 2320 \\ \underline{-2286} \\ 34 \end{array}$$

So, after the division: $176 \div 2.54 = 69.29$. Rounded to the nearest tenth, the answer is 69.3 inches.

Notice that the units in the metric system are often rounded to the nearest tenth. This is why the division problem above adds a decimal and zeros: to work out the dividend to the hundredths place so that the final answer is rounded to the tenth.


SET-UP HINT

Some basic guidelines need to be followed when formatting answers in measurement conversions:

If the answer is in feet, yards, cups, pints, quarts, gallons, teaspoons, tablespoons, or pounds, use fractions if there is a remainder.

If the answer is in kilograms, milliliters, or money amounts, use decimals. The correct format ensures correct answers, which are often rounded to either the tenth or the hundredth place.

APPROXIMATE EQUIVALENTS

| | | | |
|--------------|--------------------|---------------|--------------------|
| 1 inch | = 2.54 centimeters | 1 cup | = 8 ounces |
| 1 foot | = 12 inches | 1 pint | = 480 milliliters* |
| 1 yard | = 3 feet | 1 quart | = 32 ounces |
| 1 pound | = 16 ounces | 1 quart | = 960 milliliters* |
| 1 kilogram | = 2.2 pounds | 1 pint | = 2 cups |
| 1 tablespoon | = 3 teaspoons | 1 fluid ounce | = 30 milliliters |
| 1 quart | = 2 pints | 1 teaspoon | = 5 milliliters |
| 1 gallon | = 4 quarts | 1 fluid ounce | = 2 tablespoons |

*Certain fields use rounded measures; for example, instead of 480 mL and 960 mL, they use 500 mL and 1000 mL. Check with your instructor.

Notice that the conversions are set up so that the unit (1) elements are all on the left and that these will be placed on the top of the known part of the ratio and proportion equation. This simplifies the learning process, expedites learning, and helps recall of these conversions.

Practice 8

Using the ratio and proportion set-up below, solve the following conversions.

$$\frac{\textit{known}}{\text{_____}} = \frac{\textit{unknown}}{\text{_____}}$$

Set up these conversions using ratios and proportions.

- 23 feet = _____ yards $\rightarrow \frac{1 \text{ yd}}{3 \text{ ft}} = \frac{?}{23 \text{ ft}}$
- 18 quarts = _____ gallons
- 3 quarts = _____ pints
- $2\frac{1}{4}$ pints = _____ cups

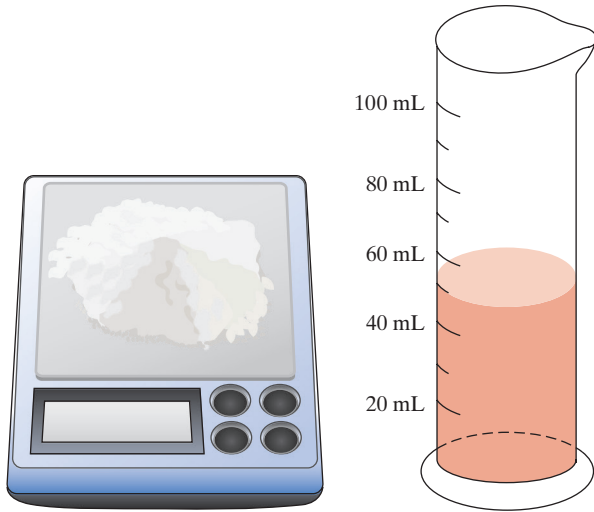

SET-UP HINT

Because inches are rounded to the nearest tenth, go to the hundredths place and stop dividing. At that point, you will have enough information to round to the nearest tenth.

5. 3 tablespoons = _____ teaspoons
6. $2\frac{1}{2}$ quarts = _____ milliliters
7. $\frac{1}{2}$ cup = _____ ounces
8. 1 injection at \$29.50 = 3 injections at _____
9. $3\frac{1}{2}$ pounds = _____ ounces
10. 3 medicine cups = _____ milliliters
(One medicine cup equals 1 fluid ounce.)
11. 12.5 mL = _____ teaspoons
12. 5 fluid ounces = _____ tablespoons
13. _____ tablespoons = 15 teaspoons
14. 64 ounces = _____ cups
15. 750 milliliters = _____ pints
16. 48 inches = _____ feet
17. 5 pounds = _____ ounces
18. _____ quarts = 5000 milliliters
19. _____ kilograms = 11 pounds
20. 15 cups = _____ ounces

Using Proportions and Metric Units to Measure Dental Stone

Sometimes dental assistants need to mix dental stone material for dental molds. The amount of stone and water varies according to the size of the mold needed. A dental assistant learns the importance of mixing a uniform and consistent material for the mold. This task uses the metric system: Dental stone is measured by weight in grams, and room temperature water is measured by volume in milliliters. Knowledge of the metric system coupled with the use of ratio and proportion help maintain the correct ratio of dental stone to water.



The typical ratio of dental stone to water is:

$$\frac{263 \text{ grams of dental stone powder}}{80 \text{ milliliters of room temperature water}}$$

Dental assistants use this ratio as the standard to solve variances in either stone or water to create the proper amount of material for the mold. On occasion, they may be asked to use other ratios of dental stone to water, depending on the type of material or the mold being created.

Example

We will set up the problems as proportions, cross multiply, and then divide by the leftover number. This will solve for the unknown.

If the dentist requests a smaller mold using 35 mL of water, how much stone should be used?

The set-up is:

$$\frac{263 \text{ g}}{80 \text{ mL}} = \frac{? \text{ g}}{35 \text{ mL}}$$

STEP 1: $263 \times 35 = 9205$

STEP 2: $9205 \div 80 = 115.0625$. Round to the nearest whole number.

The final answer is that 115 grams of stone to 35 milliliters of water should be used.

Practice 9

Solve the following using this ratio:

$$\frac{263 \text{ grams dental stone powder}}{80 \text{ milliliters of water}}$$

Round to the nearest whole number.

1. If you use 75 grams of stone, how many milliliters of room temperature water are needed?

2. If you use 125 milliliters of water, how many grams of dental stone are needed?
3. If you use 95 grams of stone, how many milliliters of room temperature water are needed?
4. If you use 75 milliliters of water, how many grams of dental stone are needed?
5. If you use 65 grams of stone, how many milliliters of room temperature water are needed?
6. If you use 55 grams of stone, how many milliliters of room temperature water are needed?
7. If you use 40 milliliters of water, how many grams of dental stone are needed?
8. If you use 35 grams of stone, how many milliliters of room temperature water are needed?
9. If you use 50 grams of stone, how many milliliters of room temperature water are needed?
10. If you use 60 milliliters of water, how many grams of dental stone are needed?



Word Problems Using Proportions

REVIEW

When solving word problems involving proportions, follow these three basic steps.

Example

If 12 eggs cost \$1.49, how much do 18 eggs cost?

$$\frac{\text{Eggs}}{\text{Cost}} = \frac{\text{Eggs}}{\text{Cost}} \rightarrow \frac{12 \text{ eggs}}{\$1.49} = \frac{18 \text{ eggs}}{\$?}$$

STEP 1: Set the problem up so that the same types of elements are directly across from one another.

STEP 2: Multiply the diagonal numbers.

$$\$1.49 \times 18 = 26.82$$

STEP 3: Divide the answer from step 2 by the remaining number in the problem.

$$26.82 \div 12 = \$2.235 \text{ or } \$2.24$$

So, 18 eggs cost \$2.24.

**SET-UP HINT**

Ensure that you understand the story problem, and then place the known information on the left side of the proportion and the unknown information on the right. By doing so, you will not switch the ratio relationships, but instead will rely on the known part-to-whole relationships.

Example

How many milligrams of medication would a nurse administer to a 95-pound child if the prescribed dose was 30 milligrams for every 10 pounds?

STEP 1: $\frac{30 \text{ milligrams}}{10 \text{ pounds}} = \frac{x \text{ milligrams}}{95 \text{ pounds}}$

STEP 2: $30 \times 95 = 2850$

STEP 3: $2850 \div 10 = 285 \text{ milligrams}$

So, the child would receive 285 milligrams of the medication.

Example

The lab mixes a 12% solution for the physician. A 12% solution has a 3 : 25 ratio. This ratio includes 3 grams of powder in 25 milliliters of solution. How many grams of powder will be added to 65 milliliters of solution?

STEP 1:

$$\frac{3 \text{ grams}}{25 \text{ milliliters}} = \frac{x \text{ grams}}{65 \text{ milliliters}}$$

STEP 2: $3 \times 65 = 195$

STEP 3: $195 \div 25 = 7.8 \text{ grams}$

So, 7.8 grams of powder will be used to mix 65 milliliters of the 3 : 25 solution.

Practice 10

Solve the following word problems.

1. A caplet contains 325 milligrams of medication. How many caplets contain 975 milligrams of medication?
2. If a dose of 100 milligrams is contained in 4 milliliters, how many milliliters are in 40 milligrams?
3. If 35 grams of a pure drug are contained in 150 milliliters, how many grams are contained in 75 milliliters?
4. Three tablets of ulcer medication contain 375 milligrams of medication. How many milligrams are in 12 tablets?
5. If 1 kilogram equals 2.2 pounds, how many kilograms are in 61.6 pounds?

Solving for x in More Complex Problems Using Proportion

REVIEW

Decimals and fractions may appear in your proportion problems. Although the numbers may be visually distracting, the *very* same principles apply when solving these proportions.

Example

$$0.25 \text{ mg} : 0.8 \text{ mL} = 0.125 \text{ mg} : x \text{ mL}$$

STEP 1: Place mg across from mg and mL across from mL. Place the known information on the left side of the equation and the unknown information on the right side.

$$\frac{\textit{known}}{0.8 \text{ mL}} = \frac{\textit{unknown}}{x \text{ mL}}$$

$$\frac{0.25 \text{ mg}}{0.8 \text{ mL}} = \frac{0.125 \text{ mg}}{x \text{ mL}}$$

Cross multiply $0.8 \times 0.125 \text{ mg} = 0.1$.

STEP 2: $0.1 \div 0.25 = 0.4 \text{ mL}$

Example

$$\frac{1}{8} : \frac{1}{2} :: 1 : x$$

$$\frac{\frac{1}{8}}{\frac{1}{2}} = \frac{1}{x}$$

STEP 1: Set up and cross multiply. Multiply $\frac{1}{2} \times 1 = \frac{1}{2}$.

STEP 2: Divide $\frac{1}{2}$ by $\frac{1}{8}$.

$$\frac{1}{2} \div \frac{1}{8} \rightarrow \frac{1}{2} \times \frac{8}{1} = \frac{8}{2}, \text{ which is reduced to } 4.$$

Sometimes you will find that medical dosages have both fractions and decimals. Analyze the situation and convert the numbers to the same system format. As a general rule, fractions are always more accurate for calculating than decimals because some decimal numbers have repeating digits, which create variable answers.

Example

$$\frac{1}{16} : 1.6 :: \frac{1}{8} : x$$

This looks like this as a fraction:

$$\frac{\frac{1}{16}}{1\frac{6}{10}} = \frac{\frac{1}{8}}{x}$$

STEP 1: Convert 1.6 into a fraction. So, $1.6 = 1\frac{6}{10}$. Then multiply $1\frac{6}{10} \times \frac{1}{8} = \frac{2}{10}$.

$$\frac{\frac{1}{16}}{1\frac{6}{10}} = \frac{\frac{1}{8}}{x} \quad 1\frac{6}{10} \times \frac{1}{8} = \frac{16}{10} \times \frac{1}{8} = \frac{16}{80} \text{ or } \frac{2}{10}$$

STEP 2: Divide $\frac{2}{10}$ by $\frac{1}{16}$.

$$\frac{2}{10} \div \frac{1}{16} \rightarrow \frac{2}{10} \times \frac{16}{1} = \frac{32}{10}. \text{ Reduced to } 3\frac{2}{10} \rightarrow 3\frac{1}{5}.$$



SET-UP HINT

Tablets can be divided if they are scored; use $\frac{1}{2}$, not 0.5.

Practice 11

Include a unit of measure in your answer. Round any partial unit to the nearest tenth.

1. $2.5 \text{ mg} : 2 \text{ mL} = 4.5 \text{ mg} : x \text{ mL}$ _____
2. $12 \text{ mg} : 2.5 \text{ mL} = 4 \text{ mg} : x \text{ mL}$ _____
3. $7.5 \text{ mg} : 5 \text{ mL} = 24 \text{ mg} : x \text{ mL}$ _____
4. $0.2 \text{ mg} : 1 \text{ tab} = 6 \text{ mg} : x \text{ tabs}$ _____
5. $\frac{1}{4} \text{ grains} : 15 \text{ mg} = ? \text{ grains} : 60 \text{ mg}$ _____
6. $x \text{ mg} : \frac{1}{2} \text{ tab} = 6 \text{ mg} : 4 \text{ tabs}$ _____
7. $\frac{1}{100} \text{ grains} : 2 \text{ mL} = \frac{1}{150} \text{ grains} : x \text{ mL}$ _____
8. $600 \text{ mg} : 1 \text{ cap} = x \text{ mg} : 2 \text{ caps}$ _____
9. $1000 \text{ units} : 1 \text{ mL} = 2400 \text{ units} : x \text{ mL}$ _____
10. $1 \text{ tab} : 0.1 \text{ mg} = x \text{ tabs} : 0.15 \text{ mg}$ _____
11. A drug comes in 100 milligram tablets. If the doctor orders 150 milligrams daily, how many tablets should the patient receive daily?
12. A medical chart states that the patient weighs 78.4 kilograms. What is the patient's weight in pounds? Round to the nearest tenth.



Nutritional Application of Proportions

REVIEW

Carbohydrates, fats, and proteins provide fuel factors for our bodies. These factors are easily applied by using proportions to solve for the unknown.



SET-UP HINT

Carbohydrates → 4 calories per 1 gram

Fats → 9 calories per 1 gram

Proteins → 4 calories per 1 gram

Example

400 carbohydrate calories = _____ grams

$$\begin{array}{ccc} & \textit{known} & \textit{unknown} \\ & 1 \text{ gram} & ? \text{ grams} \\ \frac{1 \text{ gram}}{4 \text{ calories}} & = & \frac{? \text{ grams}}{400 \text{ calories}} \end{array}$$

STEP 1: Multiply diagonally.

$$1 \times 400 = 400$$

STEP 2: Divide answer from step 1 (400) by the remaining number in the equation (4).

$$\begin{array}{r} 100 \\ 4 \overline{)400} \\ \underline{-4} \\ 00 \end{array}$$

So, 400 carbohydrate calories are available in 100 grams of carbohydrates.

Practice 12

Use proportion to solve the following problems.

1. 81 calories of fat = _____ grams
2. 120 calories of protein = _____ grams
3. 36 calories of carbohydrate = _____ grams
4. 145 calories of carbohydrate = _____ grams
5. _____ calories are in 12 grams of protein.
6. _____ calories are in 99 grams of fat.
7. _____ calories are in 328 grams of carbohydrate.
8. _____ calories are in 2450 grams of protein.

Proportion is also useful in solving nutritional problems that involve amounts of sodium, calories, fat, and protein in food or an amount in a drug dosage. The proportion will use the information in a scenario to solve for the unknown quantities of a specific amount.

Example

If one glass of milk contains 280 milligrams of calcium, how much calcium is in $1\frac{1}{2}$ glasses of milk?

$$\frac{1 \text{ glass}}{280 \text{ milligrams}} = \frac{1\frac{1}{2} \text{ glasses}}{? \text{ milligrams}}$$

$$280 \times 1\frac{1}{2} = 420 \text{ mg of calcium}$$

Practice 13

Solve these nutritional problems using ratio and proportion.

1. One-half cup of baked beans contains 430 milligrams of sodium. How many milligrams of sodium are there in $\frac{3}{4}$ cup of baked beans?
2. Baked beans contain 33 grams of carbohydrates in a $\frac{1}{2}$ cup serving. How many milligrams of carbohydrates are in three $\frac{1}{2}$ cup servings?
3. A $\frac{1}{2}$ cup serving of fruit cocktail contains 55 milligrams of potassium. How many milligrams of potassium are in 2 cups of fruit cocktail?
4. If $\frac{1}{2}$ cup of fruit cocktail contains 13 grams of sugar, then $1\frac{1}{4}$ cup of fruit cocktail contains how many grams of sugar?
5. Old-fashioned oatmeal contains 27 grams of carbohydrates per $\frac{1}{2}$ cup of dry oats. How many grams of carbohydrates are available in $2\frac{1}{4}$ cups of the dry oats?


Practice with Food Labels

Knowing how to read food labels is important because patients often need to limit their salt, sugar, and fat intake to help ensure good health. Proportion is useful in figuring out the amounts of these ingredients when portioning—increasing or decreasing portions.

Practice 14

Carefully read the label and then use its information to solve each question.

Albert's Tomato Soup


| Nutrition facts | Amount/serving | %DV* | Amount/serving | %DV* | | |
|--|--|--------|----------------|---------------------|------|----|
| Serving size ½ cup (120 mL) Condensed soup Servings about 2.5 Calories 90 Fat calories 0 | Total fat | 0 g | 0% | Total carbohydrates | 20 g | 7% |
| | Saturated fat | 0 g | 0% | Fiber | 1 g | 4% |
| | Cholesterol | 0 mg | 0% | Sugars | 15 g | |
| | Sodium | 710 mg | 30% | Protein | 2 g | |
| | Vitamin A 12% · Vitamin C 12% · Calcium 0% · Iron 0% | | | | | |

*Percent daily values (%DV) are based on a 2000 calorie diet.

- If $\frac{1}{2}$ cup of soup equals 120 milliliters, then how many milliliters (mL) are in $3\frac{1}{3}$ cups of soup?
- If a can has 2.5 servings, how many cans are needed to serve 10 people?
- One serving contains 90 calories; how many calories are in $4\frac{1}{2}$ servings?
- One gram of fiber constitutes 4% of a daily dietary value. How many grams of fiber would be present in 25% of the daily value?
- How many grams of carbohydrates are present if the portion meets 15% of the daily value of carbohydrates? Round to the nearest tenth.

Use the information from the label to complete these proportions.

Big Al's Organic Sweet and Juicy Dried Plums

| Nutrition facts | | Amount per serving | | | |
|--|-----------------------------|---|---------------------|--------|-----|
| Serving size 1½ oz (40 g in about 5 dried plums) | | Calories 100 | Calories from fat 0 | | |
| Servings per container about 30 | | | | | |
| | %DV* | | %DV* | | |
| Total fat | 0 g | 0% | Potassium | 290 mg | 8% |
| Saturated fat | 0 g | 0% | Total carbohydrates | 24 g | 8% |
| Cholesterol | 0 mg | 0% | Dietary fiber | 3 g | 11% |
| Sodium | 5 mg | 0% | Soluble fiber | 1 g | |
| Vitamin A | 10% (100% as beta carotene) | | Insoluble fiber | 1 g | |
| Vitamin C | 0% | | Sugars | 12 g | |
| Calcium | 2% | | Protein | 1 g | |
| Iron | 2% | <p>Big Al's Organic Sweet and Juicy Dried Plums/Prunes</p>  | | | |
| | | | | | |

*Percent daily values (%DV) are based on a 2000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

6. How many total grams (g) of weight are present in 34 prunes?
7. If 100 calories are consumed with 5 prunes, how many calories are consumed with 12 prunes?
8. If 5 prunes have 290 milligrams (mg) of potassium and that accounts for 8% of percent daily value, how many prunes are needed to equal 15% of the percent daily value? Round to the nearest whole number.
9. If 5 prunes provide 10% of the Vitamin A needed daily, what percent of the daily percent of Vitamin A is present in 20 prunes?
10. If a serving size is $1\frac{1}{2}$ ounces (oz), how many ounces are five servings?

Use the information from the label to complete these proportions.

Jade's Soy Milk

| Nutrition facts | Amount/serving %DV* | Amount/serving %DV* |
|-----------------------------|---|----------------------------|
| Serving size 1 cup (240 mL) | Total fat 4 g 6% | Total Carbohydrates 4 g 1% |
| Servings about 8 per 1.89 L | Saturated fat 0.5 g 3% | Fiber 1 g 4% |
| Calories 80 | Trans fat 0 g | Cholesterol 0 mg 0% |
| Fat calories 35 | Polyunsaturated fat 2.5 g | Sugars 12 g |
| | Monounsaturated fat 1 g | Protein 7 g |
| | Sodium 85 mg 4% | Potassium 300 mg 8% |
| | Vitamin A 10% · Vitamin C 0% · Calcium 30% · Iron 6% | |
| | Vitamin D 10% · Folate 6% · Magnesium 10% · Selenium 8% | |

*Percent daily values (%DV) are based on a 2000 calorie diet.

11. If 1 cup of soy milk contains 4 grams (g) total fat, then how many grams of total fat are in $2\frac{3}{4}$ cups of Jade's Soy Milk?
12. If a cup of soy milk contains 85 milligrams of sodium, and an individual consumes $2\frac{2}{3}$ cups of soy milk per day, what is the sodium intake from soy milk? Round to the nearest whole number.
13. If one serving of Jade's Soy Milk provides 1% of the amount of daily carbohydrates needed, how many milliliters make 5% of the daily carbohydrate intake?
14. One serving contains 80 calories; how many calories are in $3\frac{1}{4}$ servings?
15. If 1 cup of Jade's Soy Milk provides 1 gram of fiber and 4% of the recommended daily fiber intake, how many cups of this soy milk are needed to make up 25% of the dietary fiber?

Unit Review

Critical Thinking with Ratio and Proportion

1. Use ratio and proportion to find x . $\frac{\frac{1}{8}}{\frac{3}{4}} = \frac{12}{x}$
2. The physician ordered Valium 3.5 milligrams intramuscularly every 6 hours as needed for anxiety. The pharmacist has Valium in his pharmacy in the following supply: 10 milligrams per 2 milliliters. How many milliliters will the patient receive in each dose for this drug order?
3. Using the information from problem 2, what would be a full dosage of medication, in milliliters, given on schedule for one day?
4. The average human heart beats 4320 times every 60 minutes. Express this as a unit rate.
5. Write 450 calories in three servings as a unit rate.
6. Mixing infant formula is an important task. For every 2 ounces of instant infant formula, Mary needs 6 ounces of tepid, sterilized water. If the can of instant infant formula contains 8 ounces, how many ounces of sterilized water are needed?
7. At Valley View Center, there are three part-time employees for every two full-time employees. If there are 48 full-time employees, how many part-time employees are there?
8. The exercise pool at Care Vista has a pump that can drain 5500 gallons of treated water from the pool in 90 minutes. How many gallons can it drain in two and a half hours? Round to the nearest whole number.
9. Greek yogurt has 140 calories in 6 ounces. What is the unit rate of calories in each ounce? Round to the nearest whole number.
10. There are 14 grams of protein in a 6-ounce container of Greek yogurt. What is the per-unit rate of grams of protein per ounce? Round to the nearest whole number.



11. In 12.5 hours, the patient had an even distribution of 750 milligrams of medication via intravenous solution. How many milligrams of medication did the patient receive per hour?
12. Write the following ratio as a decimal: 1 : 25.
13. The dental assistant is to mix the modeling mix for a dental model. She has learned that she should use 50 milliliters of water for 100 milligrams of the modeling mix. How many milligrams of modeling mix are used with 75 milliliters of water?
14. The lab technician is working on a special research project. She can prepare 45 pipettes every hour for the project. If she works consistently at this rate, how many pipettes will she have ready in 45 minutes? Round to the nearest whole number.
15. A disinfectant solution has 10 grams of disinfectant powder to 100 milliliters of hot water. Keeping the ratio at 1 : 10, how many grams of disinfectant powder are used for 330 milliliters of hot water?

Professional Expertise

- Always reduce ratios to their simplest form.
- Similar units in ratios should be across from each other when setting up two fractions as a proportion.
- Read the problem carefully to find out if you are solving for a ratio, a unit rate, or a proportion.

Ratio and Proportion Post-Test

Show all your work.

1. Write a definition for proportion. Provide one health profession application or example.
2. $30 : 120 = ? : 12$
3. One glass contains 8 ounces. How many full glasses are in 78 ounces?
4. $\frac{1}{2} : 4 = \frac{1}{3} : x$

5. $x : 625 = 1 : 5$
6. If 10 milligrams are contained in 2 milliliters, how many milligrams are contained in 28 milliliters?
7. A tablet contains 30 milligrams of medication. How many tablets will be needed to provide Ms. Smith with 240 milligrams of medication?
8. 100 micrograms of a drug are contained in 2 milliliters. How many milliliters are contained in 15 micrograms?
9. $\frac{1}{100} : 6 = ? : 8$
10. $0.04 : 0.5 = 0.12 : ?$
11. How many minutes are in 130 seconds? Your answer will have both minutes and seconds. Show your set-up.
12. Four out of every six dental patients request fluoride treatment after their dental cleaning treatments. If 120 patients have dental cleanings this week, how many will choose to have fluoride treatments as well?
13. If the doctor's office uses 128 disposal thermometer covers each day, how many covers will be used in a 5-day workweek?
14. Solve: $\frac{1}{125} : 3 :: \underline{\hspace{2cm}} : 12$
15. If the doctor ordered 6 ounces of cranberry juice four times a day for 4 days, how many total ounces would be served to the patient?

