Preparation 3.7-W
Medical Dosages

(1) Ben has $75 in his savings account. He plans to deposit $35 per week to build his account balance.

(a) Complete the following equation to represent the amount of money (A) Ben will have in his account after any number of weeks. Use x as your input variable.

A =

(b) What does your variable represent in this problem?

(c) Which of the following values could be the value of the variable in this context? There may be more than one correct answer.

(i) -5

(ii) 3

(iii) 4.2

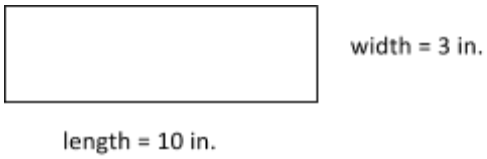
(iv) 18

(d) Ben wants to use his savings to buy a computer for $740. Use your algebraic expression to determine the number of weeks it will take him to save enough money to buy the computer.

Proportionality

Length-to-width and width-to-length ratios

The dimensions of a figure can be written as a ratio. Imagine a rectangle with a length of ten inches and a width of three inches.



You can say that the ratio of the length to width is 10:3 or 10/3. It is also correct to say that the ratio of the width to length is 3:10 or 3/10. In Collaboration 3.7, when we compare multiple figures using their respective ratios, it will be important to be consistent.

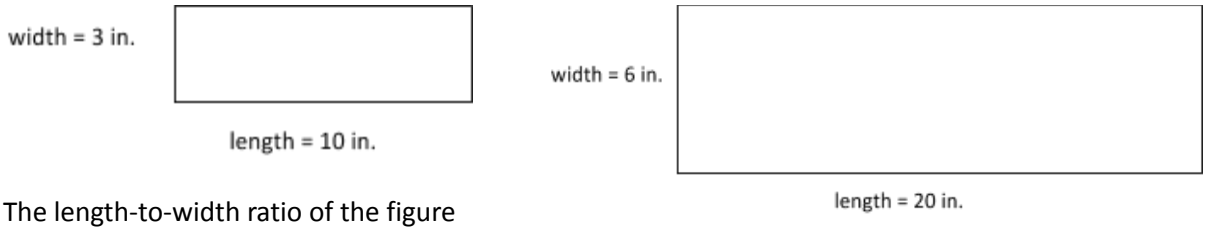
Equivalent Fractions (review)

As you recall from Unit 3.1, equivalent fractions (ratios) can be written in many equivalent forms. For example, all of the following fractions simplify to $\frac{10}{3}$ in lowest terms:

$$\frac{10}{3} = \frac{20}{6} = \frac{30}{9} = \frac{100}{30}$$

Proportional Figures

Now, we can define what it means for two figures to be proportional. Consider the following figures and compare them using their length-to-width ratios.

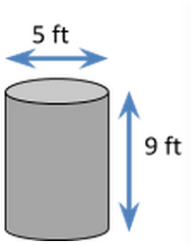


The length-to-width ratio of the figure on the left is $\frac{10}{3}$.

The length-to-width ratio of the figure on the right is $\frac{20}{6} = \frac{10}{3}$ in lowest terms. Note that $\frac{10}{3}$ and $\frac{20}{6}$ are equivalent fractions.

While these figures are not *equivalent*, they are *proportional* to each other because their dimensions have the same ratio.

(2) Use the figure below to answer the following questions.



(a) Write the ratio of the dimensions of the cylinder shown above in the form of diameter to height.

(b) Give the dimensions of a cylinder that would be proportional to the one shown.

Diameter:

Height:

(3) Which of the following fractions has a ratio of 4:3? There may be more than one correct answer.

(i) $\frac{24}{18}$

(ii) $\frac{16}{9}$

(iii) $\frac{9}{12}$

(iv) $\frac{20}{15}$

(v) $\frac{8.8}{6.6}$

After Preparation 3.7 (survey)

You should be able to do the following things for the next collaboration. Rate how confident you are on a scale of 1–5 (1 = not confident and 5 = very confident).

Before beginning Collaboration 3.7, you should understand the concepts and demonstrate the skills listed below.

Skill or Concept: I can …	**Rating from 1 to 5**
interpret the meaning of ratios, including when written as fractions.	
understand the use of a variable to represent an unknown.	
solve a two-step equation such as $2x + 9 = 13$.	

3.7-W: Medical Dosages
Health Care

INTRODUCTION

Lucas Fuel Treatment is formulated for both gasoline and diesel engines. It gives your fuel system what it really needs – a blend of super slick oils and additives with a high detergent action that allows the engine to operate at maximum efficiency. Also, it cleans and lubricates the carburetor and injectors and causes the fuel to burn more thoroughly for increased power and less fuel consumption.

KEY BENEFITS

- A great tune-up in a bottle
- Cleans and lubricates the fuel system
- Neutralizes low sulfur fuel problems
- Increases power and miles per gallon by burning excess exhaust emissions
- Increases the life of pumps and injectors

DIRECTIONS FOR USE

The recommended dosage is 2-3 ounces of Fuel Treatment for every 10 gallons of gasoline or diesel fuel. Pour Lucas Fuel Treatment directly into fuel tank. Exceeding the recommended dosage is not harmful to your vehicle.

5.25oz Bottle - One bottle treats up to 25 gallons of fuel.

1 Quart/32oz Bottle - One bottle treats up to 100 gallons of fuel.

1 Gallon/128oz Bottle - One bottle treats up to 400 gallons of fuel.

In your group, use the information from the image to answer the following two questions:

- What is the recommended dosage of Fuel Treatment per 50 gallons of fuel?

- What is the recommended dosage of Fuel Treatment per 37 gallons of fuel?

Completing the CaS Chart

You can use the Comprehension and Synthesis (CaS) Chart in this collaboration. Remember, using the CaS Chart will help you have a deeper understanding of the problem situation. CaS Charts help you understand the main issue(s) that need(s) to be resolved, and will help you to recognize the quantitative information that is available in the problem situation that can help you to solve the problem. You will use CaS Charts in some of the Quantway lessons to "unpack" problem situations and support problem-solving.

Read through the steps for completing the CaS Chart below. As you read the problem situation, complete the CaS Chart. You may wish to return to these steps as you complete the CaS Chart.
Read through the problem situation below, **Problem Situation: Medical Dosages in Hospitals**. As you are reading:

- Complete Column A. Hint: What issues in the problem situation do you need to understand in order to solve the problem? Is there contextual information that you need to know in order to understand the problem situation?
- Complete Column B. Hint: What quantitative information is provided in the problem situation that will help you solve the problem? Hint: Quantitative information is often a number, but also could be a number word, like "two".
- Complete Column C. Hint: It is not necessary to solve the problem or use calculations right now. In this column, brainstorm ways you might address the issues presented in the problem situation (Column A) using the quantitative information in Column B. There are no wrong answers.

Column A	Column B	Column C
What is/are the main issue(s) in this problem situation?	**What is the key quantitative information you need to solve the issue(s) in the problem situation?**	**Describe in writing how the information in Column B will help you address the issue(s) in Column A later in the lesson.**

SPECIFIC OBJECTIVES

By the end of this collaboration, you should understand that

- proportional relationships are based on a constant ratio.
- rules for solving equations can be applied in unfamiliar situations.

By the end of this collaboration, you should be able to

- set up a proportion based on a contextual situation.
- solve a proportion with algebraic methods.

SPECIFIC LANGUAGE AND LITERACY OBJECTIVES

By the end of this collaboration, you should be able to

- read and comprehend the problem situation about medical dosages.
- complete the Comprehension and Synthesis (CaS) Chart with contextual and quantitative information from the problem situation about medical dosages.
- demonstrate an understanding of mathematics by writing complete and correct responses to questions.
- demonstrate the ability to interpret, predict, analyze, and revise answers about the medical dosages.
- use appropriate quantitative and health care vocabulary to discuss mathematics in this collaboration.

PROBLEM SITUATION 1: MEDICAL DOSAGES IN HOSPITALS

Michael is a night nurse at Central County Hospital. He is responsible for administering medicines to three patients. This is his first night on the job. He wants to be very careful about the medicine he administers, because of a new study.

This study has shown that medical errors in hospitals are the third leading cause of the death in the U.S. As many as 440,000 people in the U.S. die from medical errors each year.[1] If there is a medication error, it is most commonly the result of calculation errors by the nurse or doctor.[2]

Nurses must work with many different types of medicines. Drugs are generally measured according to:

- weight of the drug (for example, grams or milligrams),
- volume of the drug (for example, liters or milliliters), or
- strength of the drug when dissolved in liquid, for example, milligrams per milliliter (also called concentration).

Often the doctor prescribes a medicine using one type of measurement, but the medicine is available to nurses in a different measurement.

Michael's first patient, Viola, has been diagnosed with pneumonia and prescribed amoxicillin. Aiyana, his second patient, has tonsillitis and was prescribed penicillin. His third patient, Thomas, was prescribed colchicine to treat the gout in his hands.

[1] http://www.npr.org/blogs/health/2013/09/20/224507654/how-many-die-from-medical-mistakes-in-u-s-hospitals
[2] http://www.nursingtimes.net/how-to-ensure-patient-safety-in-drug-dose-calculation/5050561.article

Below are the prescriptions and availability of medicine for Michael's first three patients. How can Michael calculate the correct dosage for each patient?

Patient Name: Viola Shore

Prescription: 80 mg Amoxicillin

The vial of medicine at Central County Hospital is labeled 100 mg/mL.

Patient Name: Aiyana Jones

Prescription: 100,000 units penicillin.

The label for the penicillin on hand is 250,000 units/mL.

Patient Name: Thomas Grady

Prescription: 0.6 mg colchicine

The colchicine in the hospital medicine room is labeled 250 mcg/mL.

* 1 mg= 1,000 mcg

(1) What is the correct dosage for each patient?

(a) Patient One (Viola):

(b) Patient Two (Aiyana):

(c) Patient Three (Thomas):

(2) These three examples show how proportions are useful in assigning correct dosages to patients. In each case, the problem required knowing the *concentration* of the drug. Why is it necessary to know the concentration of a drug before you can prescribe the drug's dosage? Explain your reasoning **in two or three complete sentences**.

PROBLEM SITUATION 2: YOLANDA, THE PEDIATRIC NURSE

In the same hospital, one floor above, Yolanda is a pediatric nurse. Pediatric nurses work with infants and children. It is essential that the pediatric nurses calculate the correct dosage of medicine, because children and infants weigh much less than adults. If children or infants are given the wrong dose of medicine, it could result in severe illness or even death. Medications for infants and children are commonly prescribed by body weight to ensure that patients are receiving the exact dose for their size.

Medicines are often prescribed in milligrams (mg) or micrograms (mcg) per kilogram (kg) of body weight. This is different from the U.S. common measurement of weight (i.e., pounds). At Central County hospital, patients are weighed using scales that measure in pounds. So, Yolanda must first convert the patient's weight in pounds to kilograms before calculating patient dosage. Here is the conversion rate for 1 kg:

1 kg = 2.2 lbs

(3) A 20-pound child is given the following prescription: Solu-Medrol 1.5 mg/kg. Solu-Medrol is one drug prescribed as a treatment for leukemia. How much Solu-Medrol should the child receive? (**Hint**: Remember, you must first convert kg to lbs.)

(4) Anthony is a 5-year-old boy who weighs 40 lbs. He is in the hospital with meningitis. The doctor prescribed 100 mg/kg/day of ceftriaxone administered through an IV once daily. The drug is already pre-diluted in a concentration of 40 mg/mL. How many mL of ceftriaxone should Anthony receive each day?

(5) In this collaboration, you have learned about the importance of proportions in helping nurses make decisions about how much medicine an infant, child or adult patient should receive.

   (a) In your own words, first explain why there is often a mismatch between the amount of medicine that doctors prescribe and the amount of medicine that nurses give to patients.

(b) Now explain why knowing how to do dimensional analysis calculations helps nurses give patients the correct dosages of medicine.

FURTHER APPLICATIONS

Nurses are required to determine whether children's prescribed dosages are in the safe range. This "safe range" change ensures that the doctor prescribes the appropriate dosage, and that the nurse makes the correct calculations to administer the correct dose. This requirement is important because administering the wrong dose to an infant or small child could result in long-term damage or death.

(6) Determine whether a dosage of 400 mg of Phenytoin is safe for a 55 lb child. The "safe range" is 15-20 mg/kg.

(7) Sometimes there is a 24-hour safe range for a medicine. In this case, the nurse must also determine how many doses of the medicine it is safe to give a patient within a 24-hour period.

For an infant who weighs 11 lbs, a doctor ordered 18 mg/kg every 6 hours. The maximum daily dose for this medicine is 40 mg/kg/day. Does the doctor's prescription exceed the maximum daily dose? Why or why not?

MAKING CONNECTIONS

Record the important mathematical ideas from the discussion.

Exercise 3.7-W
Medical Dosages

MAKING CONNECTIONS TO THE COLLABORATION

(1) Which of the following was one of the main *mathematical* ideas of the collaboration?

(i) Nurses have to be very aware of proportionality and know how to solve proportions.

(ii) The rules for solving equations are the same for all types of equations.

(iii) The rules for solving equations depend on the type of equation.

(iv) To solve for a variable in the denominator of a fraction, multiply both sides of the equation by the variable.

(2) In Module 1, you learned that a statement such as "30% of voters support Candidate A" can be interpreted as 30 out of 100.

(a) How many voters out of 1,000 support Candidate A?

(b) How many voters out of 1,500 support Candidate A?

(c) Is this a proportional relationship? Explain your answer.

DEVELOPING SKILLS AND UNDERSTANDING

(3) The tables below each give the dimensions of four different rectangles. Write in the blank if the four rectangles in each set are "Proportional" or "Not Proportional".

(a) _____

	Width	Length
Rectangle 1	17	110.5
Rectangle 2	23.4	152.1
Rectangle 3	33	214.5
Rectangle 4	52.2	339.3

(b) _____

	Width	Length
Rectangle 1	7.4	15.5
Rectangle 2	17	40.8
Rectangle 3	23.4	68.5
Rectangle 4	33	72.6

(4) A marine biologist would like to feed some dolphins a mix of fish that consists of 9 parts cod to 4 parts mackerel. List a combination that would be an acceptable mixture of these fish.

(5) Identify the proportions that have the same solution as the one below. There may be one more correct answer.

$$\frac{3}{x}=\frac{24}{56}$$

(i) $\frac{x}{3}=\frac{24}{56}$

(ii) $\frac{3}{24}=\frac{x}{56}$

(iii) $\frac{24}{3}=\frac{56}{x}$

(iv) $\frac{x}{24}=\frac{3}{56}$

(v) $\frac{x}{3}=\frac{56}{24}$

(6) Solve the following proportions (round to one decimal place):

(a) $\frac{x}{5} = \frac{10}{13}$

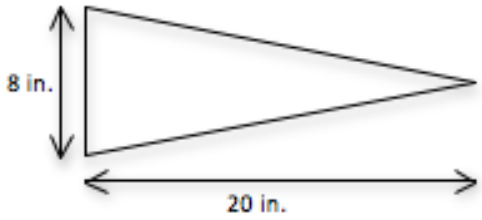
(b) $\frac{3}{4} = \frac{15}{2x}$

(7) Erica would like to bake an 8-pound roast for a family gathering. The cookbook tells her to bake a 5-pound roast for 135 minutes. Create and solve a proportion that would allow Erica to cook her 8-pound roast.

(8) Cefaclor is a medication used for infections. It is often given in liquid form by mixing the powdered medication with a fluid. A pharmacist is mixing a dosage for a child. The instructions indicate that 125 mg of the medication should be mixed with 5 mL of fluid. If the child only requires a dosage of 100 mg of Cefaclor, how much fluid should the pharmacist use?

MAKING CONNECTIONS ACROSS THE COURSE

(9) A company is making pennants or flags for a sports team. The team wants small versions for fans and large versions that will fly over the stadium. The dimensions of the small version are shown below.

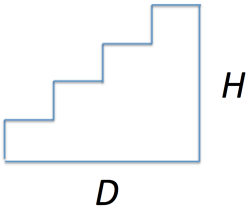


(a) The large version needs to be 12.5 feet across the base (the short side of the triangle). How long should it be?

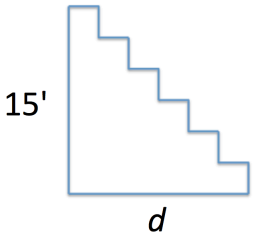
(b) How much material will be used for the large version of the flag? Round up to the nearest tenth of a square foot to ensure the company has enough material.

(10) A staircase is made up of individual steps that should be consistent in height and width. The height of each step is called the *rise*, and the width of the step is called the *run*.

(a) The staircase below is made up of four steps each with a rise of 6.5" and a run of 8.25". Find the height (*H*) and depth (*D*) of the entire staircase.



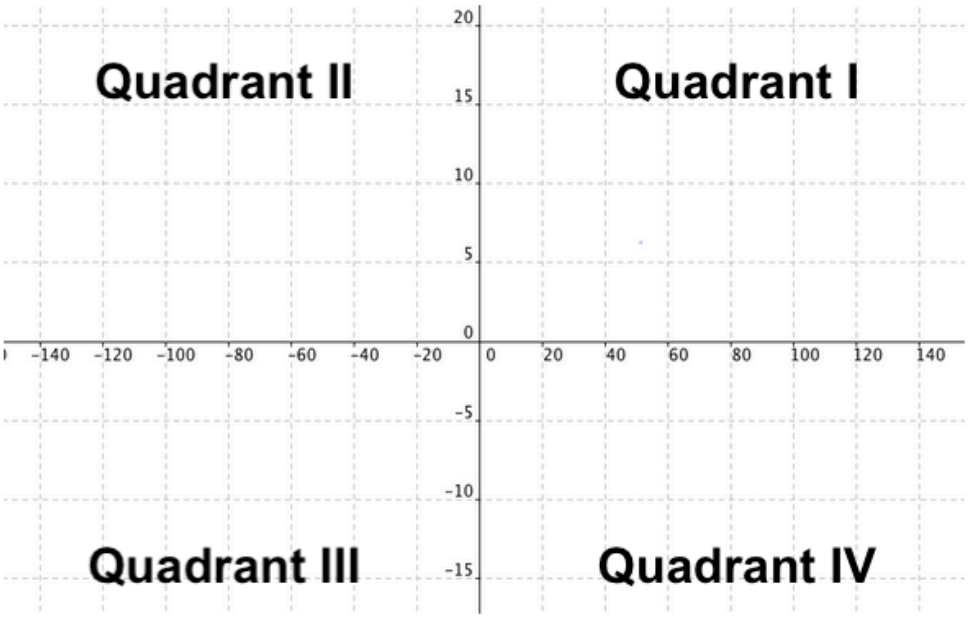
(b) Builders have to follow guidelines on the rise and run of stairs when building a staircase. One acceptable ratio is a rise of 7-3/4 inches for a run of 9-3/4 inches. If a builder is using this ratio to build a staircase that is 15 feet high, how deep will the staircase need to be (*d* in the drawing below)? Note that the drawing does *not* show the correct number of steps. Round to the nearest tenth of a foot.

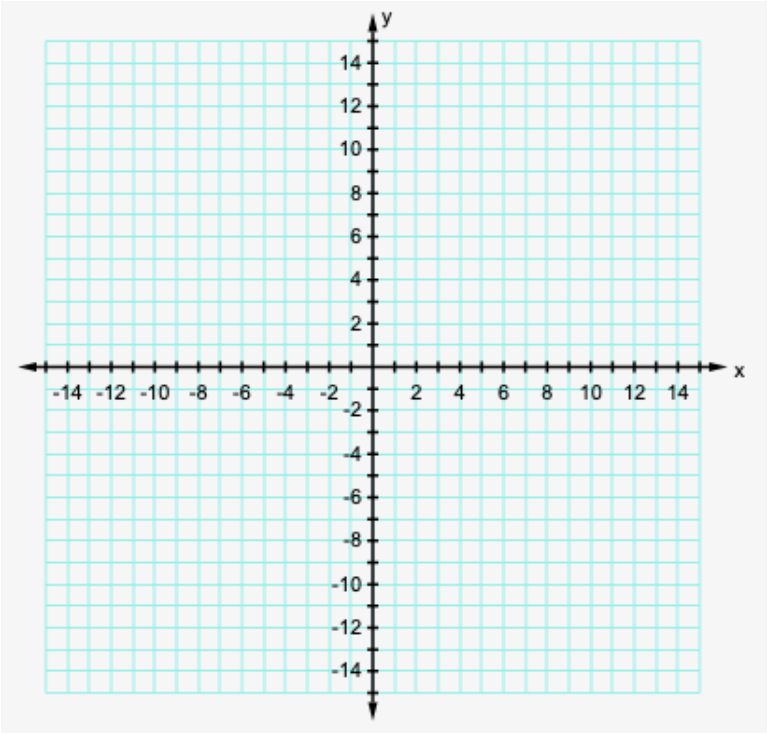


GRAPHING ON A COORDINATE PLANE

Now, you will once again return to graphing on a coordinate plane. You may have noticed that the two axes split the coordinate plane into four sections. These are called **quadrants** and are numbered using Roman numerals as shown below.

For practical reasons, only a small part of the coordinate plane can be shown, but understand that the axes can go on infinitely in all four directions. The **scale** of the grid tells you which numbers are included in the portion of the plane that is shown. You can change the scale to make graphs with very large or very small numbers. The scale on a single axis must be consistent. In other words, if the distance between the gridlines represents five units on one part of the horizontal axis, then that same distance must always represent five units on that axis. However, the vertical and horizontal axes can have different scales as in the example below. As you have seen with other types of graphs, it is important to pay close attention to the scale.





(11) Place the following points on the graph above. Label each with its ordered pair.

(a) (–90, 7)

(b) (0, 19)

(c) (63, –16)

(12) Indicate if each statement is true or false.

(a) The point (–7, –5) is in Quadrant II.

i) True ii) False

(b) The point (0, 5) lies on the vertical axis.

i) True ii) False

(c) All the points in Quadrant IV have a positive horizontal coordinate and a negative vertical coordinate.

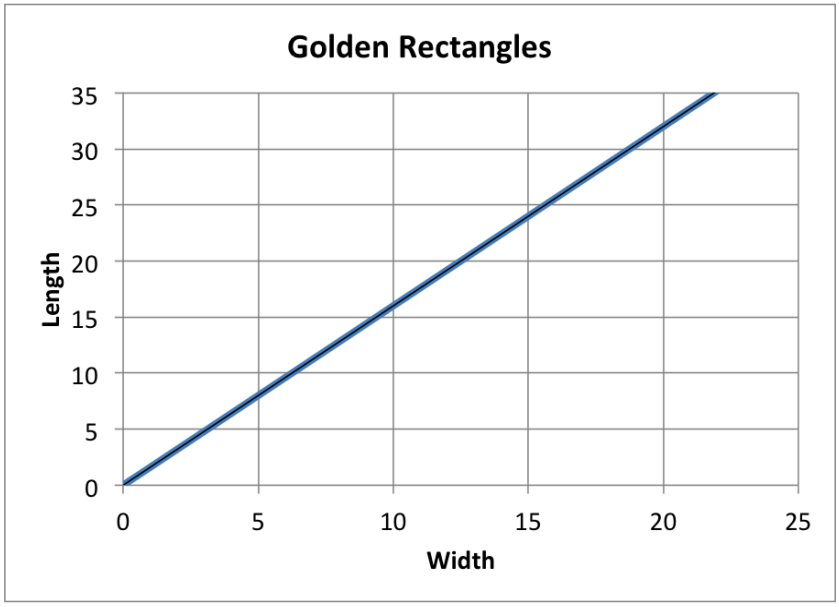
i) True ii) False

(d) The points (20, 12) and (20, 200) lie on the same horizontal line.

i) True ii) False

Many applications use only positive numbers. In these cases, only Quadrant I of the graph is usually shown because that is the only quadrant that is used. An example of this is given below.

(13) You learned about the *golden ratio* in Exercise 3.5. A rectangle whose dimensions match the golden ratio is called a *golden* rectangle. The graph below shows the widths and lengths of golden rectangles.



(a) Based on the graph, is a rectangle with a width of 17 inches and a length of 30 inches a golden rectangle?

i) Yes ii) No

(b) Use the graph to complete the table of values below. Estimate to the nearest whole number.

Width	Length
5	(i)
8	(ii)
(iii)	20
(iv)	31