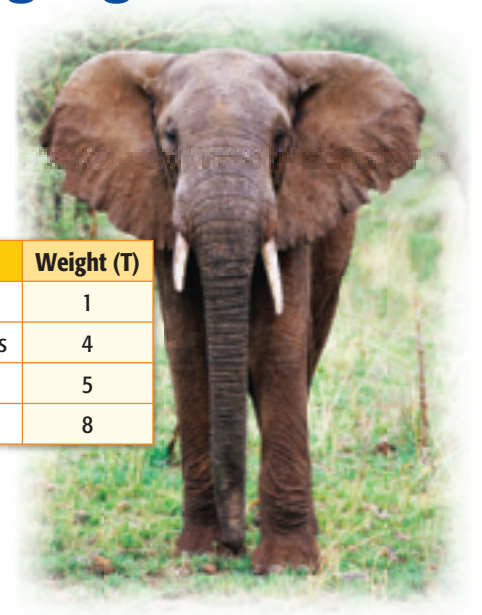


Measurement: Changing Customary Units



MAIN IDEA

Change units in the customary system.

New Vocabulary

unit ratio

Math Online

glencoe.com

- Extra Examples
- Personal Tutor
- Self-Check Quiz

▶ GET READY for the Lesson

ANIMALS The table shows the approximate weights in tons of several large land animals. One ton is equivalent to 2,000 pounds.

Animal	Weight (T)
Grizzly Bear	1
White Rhinoceros	4
Hippopotamus	5
African Elephant	8

You can use a *ratio table*, which have columns filled with ratios that have the same value, to convert each weight from tons to pounds.

1. Copy and complete the ratio table. The first two ratios are done for you.

Tons	1	4	5	8
Pounds	2,000	8,000	■	■

$\times 4$
 $\times 4$

To produce equivalent ratios, multiply the quantities in each row by the same number.

2. Then graph the ordered pairs (tons, pounds) from the table. Label the horizontal axis *Weight in Tons* and the vertical axis *Weight in Pounds*. Connect the points. What do you notice about the graph of these data?

The relationships among the most commonly used customary units of length, weight, and capacity are shown in the table below.

Customary Units			Key Concept
Type of Measure	Larger Unit	→	Smaller Unit
Length	1 foot (ft)	=	12 inches (in.)
	1 yard (yd)	=	3 feet
	1 mile (mi)	=	5,280 feet
Weight	1 pound (lb)	=	16 ounces (oz)
	1 ton (T)	=	2,000 pounds
Capacity	1 cup (c)	=	8 fluid ounces (fl oz)
	1 pint (pt)	=	2 cups
	1 quart (qt)	=	2 pints
	1 gallon (gal)	=	4 quarts

Each of the relationships above can be written as a unit ratio. Like a unit rate, a **unit ratio** is one in which the denominator is 1 unit.

$$\frac{3 \text{ ft}}{1 \text{ yd}} \quad \frac{2,000 \text{ lb}}{1 \text{ T}} \quad \frac{4 \text{ qt}}{1 \text{ gal}}$$

Notice that the numerator and denominator of each fraction above are equivalent, so the value of each ratio is 1. You can multiply by a unit ratio of this type to *convert* or change from larger units to smaller units.

Study Tip

Multiplying by 1
Although the number and units changed in Example 1, because the measure is multiplied by 1, the value of the converted measure is the same as the original.

EXAMPLES Convert Larger Units to Smaller Units

1 Convert 20 feet into inches.

Since 1 foot = 12 inches, the unit ratio is $\frac{12 \text{ in.}}{1 \text{ ft}}$.

$$\begin{aligned} 20 \text{ ft} &= 20 \text{ ft} \cdot \frac{12 \text{ in.}}{1 \text{ ft}} && \text{Multiply by } \frac{12 \text{ in.}}{1 \text{ ft}}. \\ &= 20 \cancel{\text{ft}} \cdot \frac{12 \text{ in.}}{1 \cancel{\text{ft}}} && \text{Divide out common units, leaving} \\ &= 20 \cdot 12 \text{ in. or } 240 \text{ in.} && \text{Multiply.} \end{aligned}$$

So, 20 feet = 240 inches.

2 GARDENING Clarence mixes $\frac{1}{4}$ cup of fertilizer with soil before planting each bulb. How many ounces of fertilizer does he use per bulb?

$$\begin{aligned} \frac{1}{4} \text{ c} &= \frac{1}{4} \cancel{\text{c}} \cdot \frac{8 \text{ fl oz}}{1 \cancel{\text{c}}} && \text{Since 1 cup = 8 fluid ounces, multiply by} \\ &= \frac{1}{4} \cdot 8 \text{ fl oz or } 2 \text{ fl oz} && \frac{8 \text{ fl oz}}{1 \text{ c}}. \text{ Then, divide out common units.} \\ &&& \text{Multiply.} \end{aligned}$$

So, 2 fluid ounces of fertilizer are used per bulb.

CHECK Your Progress

Complete.

a. 36 yd = ft b. $\frac{3}{4}$ T = lb c. $1\frac{1}{2}$ qt = pt

Review Vocabulary

reciprocal The product of a number and its reciprocal is 1; *Example:* The reciprocal of $\frac{3}{5}$ is $\frac{5}{3}$. (Lesson 5-7)

To convert from smaller units to larger units, multiply by the reciprocal of the appropriate unit ratio.

EXAMPLES Convert Smaller Units to Larger Units

3 Convert 15 quarts into gallons.

Since 1 gallon = 4 quarts, the unit ratio is $\frac{4 \text{ qt}}{1 \text{ gal}}$, and its reciprocal is $\frac{1 \text{ gal}}{4 \text{ qt}}$.

$$\begin{aligned} 15 \text{ qt} &= 15 \text{ qt} \cdot \frac{1 \text{ gal}}{4 \text{ qt}} && \text{Multiply by } \frac{1 \text{ gal}}{4 \text{ qt}}. \\ &= 15 \cancel{\text{qt}} \cdot \frac{1 \text{ gal}}{4 \cancel{\text{qt}}} && \text{Divide out common units, leaving} \\ &= 15 \cdot \frac{1}{4} \text{ gal or } 3.75 \text{ gal} && \text{the desired unit, gallons.} \\ &&& \text{Multiplying 15 by } \frac{1}{4} \text{ is the same as} \\ &&& \text{dividing 15 by 4.} \end{aligned}$$

- 4 COSTUMES** Umeka needs $4\frac{1}{2}$ feet of fabric to make a costume for a play. How many yards of fabric does she need?

$$4\frac{1}{2} \text{ ft} = 4\frac{1}{2} \text{ ft} \cdot \frac{1 \text{ yd}}{3 \text{ ft}}$$

Since 1 yard = 3 feet, multiply by $\frac{1 \text{ yd}}{3 \text{ ft}}$.
Then, divide out common units.

$$= \frac{\overset{3}{\cancel{9}}}{2} \cdot \frac{1}{\underset{1}{\cancel{3}}} \text{ yd}$$

Write $4\frac{1}{2}$ as an improper fraction. Then divide out common factors.

$$= \frac{3}{2} \text{ yd or } 1\frac{1}{2} \text{ yd} \quad \text{Multiply.}$$

So Umeka needs $1\frac{1}{2}$ yards of fabric.

CHECK Your Progress

Complete.

d. 2,640 ft = mi

e. 5 pt = qt

f. 100 oz = lb

g. 76c = gal

h. 3 c = pt

i. 18 in. = ft

- j. **FOOD** A 3-pound pork loin can be cut into 10 smaller pork chops of equal weight. How many ounces does each pork chop weigh?

You can also convert from one rate to another by multiplying by a unit rate or its reciprocal.

Real-World EXAMPLE **Convert Rates**

- 5 HELICOPTERS** A helicopter flies at a rate of 158 miles per hour. How many miles per second is this?

Since 1 hour = 3,600 seconds, multiply by $\frac{1 \text{ h}}{3,600 \text{ s}}$.

$$\frac{158 \text{ mi}}{\text{h}} = \frac{158 \text{ mi}}{1 \text{ h}} \times \frac{1 \text{ h}}{3,600 \text{ s}} \quad \text{Multiply by } \frac{1 \text{ h}}{3,600 \text{ s}}$$

$$= \frac{158 \text{ mi}}{1 \cancel{\text{h}}} \times \frac{1 \cancel{\text{h}}}{3,600 \text{ s}} \quad \text{Divide out common units.}$$

$$\approx \frac{0.04 \text{ mi}}{1 \text{ s}} \quad \text{Simplify.}$$

So, a helicopter flies approximately 0.04 mile per second.

CHECK Your Progress

- k. **FISH** A swordfish can swim at a rate of 60 miles per hour. How many feet per hour is this?

- l. **WALKING** Ava walks at a speed of 7 feet per second. How many feet per hour is this?



Real-World Link

A swordfish reaches a maximum size of 14 feet and almost 1,200 pounds.

Source: Sport Fishing Central

CHECK Your Understanding

Examples 1, 2
(p. 299)

Complete.

1. 3 lb = ■ oz
2. $5\frac{1}{3}$ yd = ■ ft
3. 6.5 c = ■ fl oz
4. **FISH** Grouper are members of the sea bass family. A large grouper can weigh $\frac{1}{3}$ ton. About how much does a large grouper weigh to the nearest pound?

Examples 3, 4
(pp. 299–300)

Complete.

5. 12 qt = ■ gal
6. 28 in. = ■ ft
7. 15 pt = ■ qt
8. **VEHICLES** The world's narrowest electric vehicle is about 35 inches wide and is designed to move down narrow aisles in warehouses. About how wide is this vehicle to the nearest foot?

Example 5
(p. 300)

9. **RUNNING** The fastest a human has ever run is about 27 miles per hour. How many miles per minute is this?

Practice and Problem Solving

HOMEWORK **HELP**

For Exercises	See Examples
10–21	1–4
22–23	2
24–25	4
26–27	5


Complete.

10. 18 ft = ■ yd
11. 72 oz = ■ lb
12. 2 lb = ■ oz
13. 4 gal = ■ qt
14. $4\frac{1}{2}$ pt = ■ c
15. 3 c = ■ fl oz
16. 2 mi = ■ ft
17. $1\frac{1}{4}$ mi = ■ ft
18. 5,000 lb = ■ T
19. 13 c = ■ pt
20. $2\frac{3}{4}$ qt = ■ pt
21. $3\frac{3}{8}$ T = ■ lb
22. **PUMPKINS** One of the largest pumpkins ever grown weighed about $\frac{1}{2}$ ton. How many pounds did the pumpkin weigh?
23. **SKIING** Speed skiing takes place on a course that is $\frac{2}{3}$ mile long. How many feet long is the course?
24. **BOATING** A 40-foot power boat is for sale by owner. About how long is this boat to the nearest yard?
25. **BLOOD** A total of 35 pints of blood were collected at a local blood drive. How many quarts of blood is this?
26. **GO-KARTS** A go-kart's top speed is 607,200 feet per hour. How many miles per hour is this?
27. **BIRDS** A peregrine falcon can fly at over 200 miles per hour. How many feet per hour is this?

28. **PUNCH** Will a 2-quart pitcher hold the entire recipe of citrus punch given at the right? Explain your reasoning.

Recipe: Citrus Punch Drink

- 2 cups orange juice
- 2 cups grapefruit juice
- $\frac{1}{4}$ cup apricot nectar
- $\frac{1}{3}$ cup pineapple juice
- 4 cups ginger ale



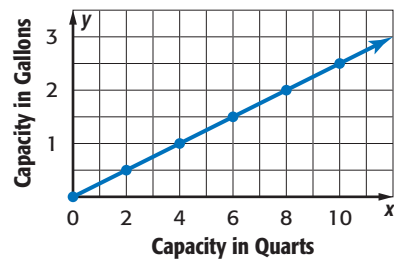
29. **WEATHER** On Monday, it snowed a total of 15 inches. On Tuesday and Wednesday, it snowed an additional $4\frac{1}{2}$ inches and $6\frac{3}{4}$ inches, respectively. A weather forecaster says that over the last three days, it snowed about $2\frac{1}{2}$ feet. Is this a valid claim? Justify your answer.

MEASUREMENT Complete the following statements.

30. If $16\text{ c} = 1\text{ gal}$, then $1\frac{1}{4}\text{ gal} = \blacksquare\text{ c}$
31. If $1,760\text{ yd} = 1\text{ mi}$, then $880\text{ yd} = \blacksquare\text{ mi}$
32. If $36\text{ in.} = 1\text{ yd}$, then $2.3\text{ yd} = \blacksquare\text{ in.}$
33. **ESTIMATION** Cristos is a member of the swim team and trains by swimming an average of 3,000 yards a day. About how many miles would he swim by training at this rate for 5 days, to the nearest half-mile?

MEASUREMENT For Exercises

34–37, use the graph at the right.



34. What does an ordered pair from this graph represent?
35. Find the slope of the line.
36. Use the graph to find the capacity in quarts of a 2.5-gallon container. Explain your reasoning.
37. Use the graph to predict the capacity in gallons of a 12-quart container. Explain your reasoning.

EXTRA PRACTICE

See pages 682, 709.

H.O.T. Problems

38. **OPEN ENDED** Write a problem about a real-world situation in which you would need to convert pints to cups.

REASONING Replace each \bullet with $<$, $>$, or $=$ to make a true sentence. Justify your answers.

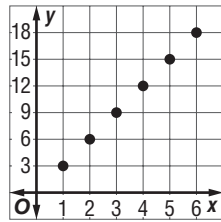
39. $16\text{ in.} \bullet 1\frac{1}{2}\text{ ft}$ 40. $8\frac{3}{4}\text{ gal} \bullet 32\text{ qt}$ 41. $2.7\text{ T} \bullet 86,400\text{ oz}$

42. **CHALLENGE** To whiten fabrics, a certain Web site recommends that you soak them in a mixture of $\frac{3}{4}$ cup vinegar, 2 quarts water, and some salt. Does a mixture that contains 1.5 ounces vinegar and 16 ounces water have the same vinegar-to-water ratio as the recommended mixture? Explain.

43. **WRITING IN MATH** Use multiplication by unit ratios of equivalent measures to convert 5 square feet to square inches. Justify your answer.

TEST PRACTICE

44. Which situation is represented by the graph?



- A conversion of inches to yards
- B conversion of feet to inches
- C conversion of miles to feet
- D conversion of yards to feet

45. How many cups of milk are shown below?



- F $\frac{3}{4}$ c
 - G $1\frac{1}{4}$ c
 - H $2\frac{1}{2}$ c
 - J 10 c
46. How many ounces are in $7\frac{3}{4}$ pounds?
- A 124 oz
 - B 122 oz
 - C 120 oz
 - D 112 oz

Spiral Review

47. Use the information in the table to find the rate of change in dollars per hour. (Lesson 6-3)

Wage (\$)	0	9	18	27
Time (h)	0	1	2	3

48. **GROCERIES** Find the unit price if Anju spent \$2 for six oranges. Round to the nearest cent if necessary. (Lesson 6-2)
49. **MEASUREMENT** By doubling just the length of the rectangular ice skating rink in Will's backyard from 16 to 32 feet, he increased its area from 128 square feet to 256 square feet. Find the width of both rinks. (Lesson 3-6)

ALGEBRA For Exercises 50–52, use the pay stub at the right. (Lesson 3-3)

50. Write and solve an equation to find the regular hourly wage.
51. Write and solve an equation to find the overtime hourly wage.
52. Write and solve an equation to find how many times greater Grace's overtime hourly wage is than her regular hourly wage.

Martin, Grace		Employee #: 4211
Description:	Hours:	Earnings (\$):
Regular hours:	40	300.00
Overtime hours:	2	22.50

▶ GET READY for the Next Lesson

PREREQUISITE SKILL Multiply. (p. 674)

53. 14.5×8.2 54. 7.03×4.6 55. 9.29×15.3 56. 1.84×16.7