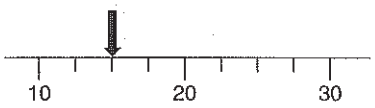
Measurement

Reading a Scale

A number line on a measurement tool is called a **scale**. To use a simple scale such as a ruler, follow these steps:

- Line up one end of the object you are measuring with the zero.
- Find the number that lines up with the other end of the object.
- Check your work by measuring the object again.

Sometimes a scale skips numbers. In that situation, you can estimate the measurement shown on the scale. The pointer is about halfway between 10 and 20, so the measurement shown on the scale is about 15.



PRACTICE

Find each measurement below.

1. The pointer on a scale is about halfway between 18 and 20. What number is halfway between 18 and 20? _____

2. The pointer on a scale is about halfway between 90 and 100. What number is halfway between 90 and 100? _____

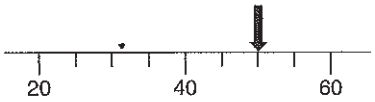
3. The pointer on a scale is about halfway between 60 and 80. What number is halfway between 60 and 80? _____

4. The pointer on a scale is about $\frac{1}{4}$ of the way from 60 to 80. What measurement is shown? _____

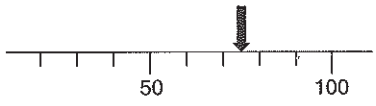
5. The pointer on a scale is about $\frac{1}{4}$ of the way from 0 to 100. What measurement is shown? _____

6. The pointer on a scale is about $\frac{1}{3}$ of the way from 60 to 90. What measurement is shown? _____

7. What measurement is shown on this scale? _____

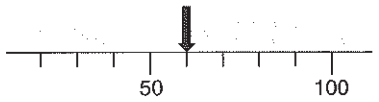


8. What measurement is shown on this scale? _____



Reading a Scale (continued)

If a scale has tick marks, count the number of equal spaces formed between numbers. Divide the difference between the numbers by the number of spaces to find the value of a tick mark. In the scale shown, there are 5 equal spaces between 50 and 100. $100 - 50 = 50$, and $50 \div 5 = 10$. Each tick mark represents 10 units.



The arrow is one tick mark beyond 50, so the reading is $50 + 10$, or 60 units.

PRACTICE

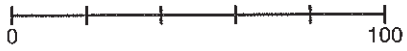
Identify the number of units represented by a tick mark for each scale described in Numbers 9–14.

9. The interval between 30 and 40 is divided into 5 equal parts. Each tick mark represents _____.

10. The interval between 60 and 80 is divided into 10 equal parts. Each tick mark represents _____.

11. The interval between 75 and 100 is divided into 5 equal parts. Each tick mark represents _____.

12. The interval between 100 and 200 is divided into 5 equal parts. Each tick mark represents _____.

13. 

Each tick mark represents _____.

14. 

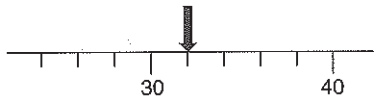
Each tick mark represents _____.

For Numbers 15–18, identify the value of each tick mark and the reading on the scale.

15. 

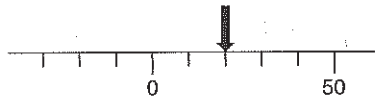
Each tick mark represents _____.

The reading on the scale is _____.

16. 

Each tick mark represents _____.

The reading on the scale is _____.

17. 

Each tick mark represents _____.

The reading on the scale is _____.

18. 

Each tick mark represents _____.

The reading on the scale is _____.

Using a Customary Ruler

In the **customary system**, most standard rulers, yardsticks, and tape measures are not as simple as the scales on the previous pages. The inch ruler shown here uses several different types of tick marks.

- The longest tick marks divide the ruler into inches.
- The next longest tick marks divide each inch into half inches.
- The half inches are divided into fourths by slightly shorter tick marks.
- The fourths are divided into eighths by even shorter tick marks.
- The shortest tick marks may be eighths of an inch or sixteenths of an inch.

PRACTICE

Use a ruler marked in inches. Measure each line below to the nearest $\frac{1}{2}$ inch. Some answers will be whole numbers.

1. _____
   _____ inches
2. _____
   _____ inches
3. _____
   _____ inch
4. _____
   _____ inches
5. _____
   _____ inch
6. _____
   _____ inches
7. _____
   _____ inch

Measure the lines below to the nearest $\frac{1}{4}$ inch.

8. _____
   _____ inch
9. _____
   _____ inch
10. _____
    _____ inches
11. _____
    _____ inch
12. _____
    _____ inches
13. _____
    _____ inches
14. _____
    _____ inches

Measuring to a Fraction of an Inch

When you measure with a ruler, make sure you line up one end of the object with 0. Then find the tick mark that lines up with the other end of the object. To complete the items on this page, you will measure objects in your home or your classroom using a customary ruler.

PRACTICE

Find the height and width of at least *two* of the objects listed below. Give your answers to the nearest fourth of an inch.

1. a VCR tape _____ by _____
2. a new #2 pencil _____ by _____
3. a standard index card _____ by _____
4. the front of this book _____ by _____

The objects listed below are difficult to measure because they have rounded shapes. Measure the widest and tallest part of each object. Give your answers to the nearest half of an inch.

5. a 12-oz soda can _____ by _____
6. a 2-liter soda bottle _____ by _____

Measure the height and width of at least *two* of the objects listed below. Give your answers to the nearest eighth of an inch.

7. a can of Campbell's® condensed soup _____ by _____
8. a computer disk _____ by _____
9. a dollar bill _____ by _____
10. a 9-volt battery _____ by _____

Circle the letter for the most reasonable measurement of each object.

11. the width of a dime

A $\frac{11}{16}$ inch C $\frac{1}{2}$ inch

B $\frac{3}{4}$ inch D $\frac{7}{8}$ inch

12. the width of a penny

F $\frac{4}{8}$ inch H $\frac{3}{4}$ inch

G $\frac{7}{8}$ inch J $\frac{14}{16}$ inch

13. the width of a nickel

A 1 inch C $\frac{1}{4}$ inch

B $\frac{5}{8}$ inch D $\frac{13}{16}$ inch

Circle the letter for the most accurate measurement of each line below.

14. —

F $\frac{1}{2}$ inch H $\frac{1}{16}$ inch

G $\frac{5}{16}$ inch J $\frac{3}{16}$ inch

15. ——

A $\frac{3}{4}$ inch C $\frac{3}{8}$ inch

B $\frac{7}{16}$ inch D $\frac{5}{8}$ inch

16. ————————

F $\frac{3}{4}$ inch H $1\frac{3}{8}$ inches

G 1 inch J $\frac{1}{2}$ inch

Reviewing Customary Units of Measure

The customary system of measurement is the one most commonly used in the United States.

Customary System Units of Measure

Temperature degrees Fahrenheit (°F)	Normal body temperature is 98.6°F. Water boils at 212°F. Water freezes at 32°F.
Length 12 inches (in.) = 1 foot (ft) 3 feet = 1 yard (yd) 5,280 feet = 1 mile (mi)	An inch is about the length of a straight pin. A foot is about the length of a man's foot. A yard is about the length of your arm. A mile is 8 to 10 city blocks.
Weight 1 pound (lb) = 16 ounces (oz) 1 ton (T) = 2,000 lb	A pencil weighs about 1 ounce. An eggplant weighs about 1 pound. A car weighs about 1 ton.
Capacity 1 pint = 2 cups 1 quart = 4 cups (or 2 pints) 1 gallon = 4 quarts (or 16 cups)	An ice cream dish holds about 1 cup. A mug holds about 1 pint. A narrow milk carton holds 1 quart. A large plastic milk jug holds 1 gallon.

Time
1 minute (min) = 60 seconds (sec)
1 hour (hr) = 60 min
1 day = 24 hr

PRACTICE

Circle the letter for the most reasonable estimate for each measurement.

1. the temperature in a refrigerator
   - **A** 70°F
   - **B** 25°F
   - **C** 40°F

2. the width of a dime
   - **F** 3 inches
   - **G** $\frac{1}{2}$ inch
   - **H** 6 inches

3. the weight of a dinner roll
   - **A** 1 pound
   - **B** 1 ounce
   - **C** $\frac{1}{2}$ pound

4. the capacity of a soup can
   - **F** $1\frac{1}{2}$ cups
   - **G** 1 gallon
   - **H** 1 quart

Circle the *greater* measurement in each pair.

5. 15 inches 1 foot
6. 5 feet 2 yards
7. 12 ounces 1 pound
8. 22 ounces 1 pound
9. 3 cups 1 pint
10. 3 cups 1 quart
11. 1 gallon 12 cups
12. 90 minutes 2 hours

Converting Units Within the Customary System

In order to convert from one unit of measurement to another, you need to know the exchange rate. For example, in changing from feet to inches, you need to know that 1 foot = 12 inches. You can use the table on the previous page as a reference.

One way to convert between units is to set up a proportion. Be sure to place like units in the numerator and like units in the denominator.

Example Change 15 feet to yards.
To make this conversion, you need to know that 3 feet = 1 yard.

- Set up a proportion. $\frac{\text{feet}}{\text{yards}}$ $\frac{3}{1} = \frac{15}{n}$
- Cross multiply. $3n = 15$
- Divide both sides by 3. $\frac{\cancel{3}^{1}n}{\cancel{3}_{1}} = \frac{\cancel{15}^{5}}{\cancel{3}_{1}}$

15 feet = 5 yards $n = 5$

Another way to convert between units is to use multiplication or division.
- Multiply to change larger units to smaller units.

Example 1 foot = 12 inches To convert from feet to inches, multiply each foot by 12.

- Divide to change smaller units to larger units.

Example 3 feet = 1 yard To convert from feet to yards, divide the number of feet by 3.

PRACTICE

Convert each measurement below to the given unit.

1. 9 ft = _____ yd
2. 24 in. = _____ ft
3. 36 in. = _____ yd
4. $\frac{1}{2}$ ft = _____ in.
5. $\frac{1}{3}$ yd = _____ ft
6. $1\frac{1}{2}$ feet = _____ in.
7. $1\frac{2}{3}$ yd = _____ ft
8. 3 lb = _____ oz
9. $\frac{1}{2}$ lb = _____ oz
10. 32 oz = _____ lb
11. 2 tons = _____ lb
12. 360 min = _____ hr
13. $1\frac{1}{2}$ hr = _____ min
14. $\frac{1}{4}$ hour = _____ min
15. 1 ft 2 in. = _____ in. (Convert 1 foot into inches and then add 2 in.)
16. 11 ft = _____ yd _____ ft (Divide 11 by 3 and give the remainder in feet.)
17. 23 oz = _____ lb _____ oz (Divide 23 by 16 and give the remainder in ounces.)

Reviewing Metric Units of Measure

Most countries around the world use the metric system of measurement.

Metric Units of Measure

Temperature degrees Celsius (°C)	Water boils at 100°C. Water freezes at 0°C. Normal body temperature is 37°C.
Length – basic unit is the meter 1 meter (m) = 1,000 millimeters (mm) = 100 centimeters (cm) 1 cm = 10 mm 1 kilometer (km) = 1,000 m	A needle is about 1 millimeter wide. A kindergarten student is about 1 meter tall. Your little finger is about 1 centimeter wide.
Mass (Weight) – basic unit is the gram 1 gram (g) = 1,000 milligrams (mg) 1 kilogram (kg) = 1,000 g	A needle weighs about 1 milligram. A peanut weighs about 1 gram. A city telephone book weighs about 1 kg.
Capacity – basic unit is the liter 1 liter (L) = 1,000 milliliters (mL) 1 kiloliter (kL) = 1,000 L	A large plastic soda bottle holds 2 liters. A dose of cough medicine is about 10 mL. A septic tank holds about 2 kiloliters.

The rate of exchange for the metric system corresponds to that of our decimal place-value system. When you get 10 units, you regroup. Prefixes identify amounts less than or greater than the basic units. The most frequently used prefixes and their abbreviations are shown below.

1,000	100	10	1	0.1 *or* $\frac{1}{10}$	0.01 *or* $\frac{1}{100}$	0.001 *or* $\frac{1}{1,000}$
kilo (k)	hecto (h)	deka (dk)	basic unit	deci (d)	centi (c)	milli (m)
km	hm	dkm	meter (m)	dm	cm	mm
kL	hL	dkL	liter (L)	dL	cL	mL
kg	hg	dkg	gram (g)	dg	cg	mg

PRACTICE

Circle the letter of the most reasonable measure.

1. The capacity of a coffee mug	**A**	2.5 kL	**B**	25 L	**C**	250 mL
2. The oil needed to fry an egg	**D**	5 L	**E**	5 dL	**F**	5 mL
3. The length of a new pencil	**G**	14 cm	**H**	14 mm	**J**	14 km
4. The mass of a cat	**A**	20 g	**B**	200 dg	**C**	2 kg
5. The length of a baseball bat	**D**	1 dkm	**E**	1 m	**F**	1 dm
6. The mass of a wristwatch	**G**	30 mg	**H**	30 g	**J**	30 kg

Converting Units Within the Metric System

As with customary units, you can use a proportion to convert between units within the metric system. You must use the rate of exchange between the units to set up the proportion. In the metric system, the converted units should be expressed as decimals rather than fractions.

Example 24 cg = _____ g

- Set up a proportion. $\frac{\text{cg}}{\text{g}}$ $\frac{100}{1} = \frac{24}{n}$
- Cross multiply. $100 \times n = 24 \times 1$
- Divide both sides by 100. $\frac{100n}{100} = \frac{24}{100} = 0.24$

24 cg = 0.24 g

Another way to convert between units is to use multiplication or division. You can use a place-value chart to help. (See the place-value chart on page 135.)

- Multiply to convert larger units to smaller units.

Example 5 hm = _____ dm

Find the **hecto**meters in the chart. **Deci**meters are three columns to the right. Each column has ten times the value of the column immediately to its right. When you move to the right, multiply. For three columns to the right, multiply by 10 × 10 × 10, or 1,000. To convert hectometers to decimeters, multiply the number of hectometers by 1,000.

5 × 1,000 = 5,000 5 hm = 5,000 dm

- Divide to convert smaller units to larger units.

Example 14 dL = _____ kL

Find the **deci**liters column in the chart. **Kilo**liters are four columns to the left. For each column to the left, divide. For four columns to the left, divide by 10 × 10 × 10 × 10, or 10,000. Remember that in the metric system, units are always expressed as decimals.

14 ÷ 10,000 = 0.0014 14 dL = 0.0014 kL

PRACTICE

Fill in each blank.

1. $\frac{1}{2}$ kg = _____ g
2. 2 L = _____ mL
3. 3,000 mL = _____ L
4. $1\frac{1}{2}$ m = _____ mm
5. 3,500 mm = _____ m
6. 10 cm = _____ mm
7. $2\frac{1}{2}$ kL = _____ L
8. 150 cm = _____ m
9. 3 m 15 cm = _____ cm
10. 1 kg 450 g = _____ g
11. 3 L 15 mL = _____ mL
12. 1,515 g = ____ kg ____ g

Comparing Customary and Metric Units

The chart below compares some customary units with metric units of measurement. The symbol ≈ indicates that the measurements are approximately equal.

Length	Mass/Weight	Capacity
1 in. ≈ 2.5 cm	1 kg ≈ 2.2 lb	1 L ≈ 1.1 qt
1 m ≈ 1.1 yd	1 oz ≈ 28 g	1 kL ≈ 275 gal
1 km ≈ 0.6 mi		

You can use a proportion to convert a measurement from one system to the other. Use the exchange rates shown in the chart above to set up the proportion.

Example 40 cm ≈ _____ in.

- Set up the ratio. $\frac{\text{cm}}{\text{in.}}$ $\frac{2.5}{1} \approx \frac{40}{n}$
- Cross multiply. $2.5n \approx 40$
- Divide both sides by 2.5 $\frac{2.5n}{2.5} \approx \frac{40}{2.5}$

$n \approx 16$

40 cm ≈ 16 in.

PRACTICE

Circle the greater measurement in each pair.

1. 1 in. 1 cm
2. 1 g 1 oz
3. 1 qt 1 L
4. 1 yd 1 m
5. 1 mi 1 km

Convert units as indicated. Round all answers to the nearest tenth.

6. 20 yd ≈ _____ m
7. 40 g ≈ _____ oz
8. 15 mi ≈ _____ km
9. 10 L ≈ _____ qt
10. 3 m ≈ _____ yd
11. 15 lb ≈ _____ kg
12. 100 cm ≈ _____ in.
13. 150 gal ≈ _____ kL
14. 12 in. ≈ _____ cm
15. 4 km ≈ _____ mi

Adding and Subtracting Mixed Measurements

To add or subtract mixed measurements, start computing with the smallest unit, and then add or subtract the next greatest unit. You may need to regroup. When that happens, be sure you use the exchange rate that corresponds to the units of measure you are working with. Simplify answers.

Examples

Add 1 hour 15 minutes and 2 hours 50 minutes.

- Add minutes first.
- Then add hours.

$$\begin{array}{rr} 1 \text{ hour} & 15 \text{ minutes} \\ +\ 2 \text{ hours} & 50 \text{ minutes} \\ \hline 3 \text{ hours} & 65 \text{ minutes} \end{array}$$

- Simplify. Regroup minutes to hours. Remmeber 60 minutes = 1 hour.

$$\begin{aligned} 3 \text{ hours} + 65 \text{ minutes} &= 3 \text{ hours} + 60 \text{ minutes} + 5 \text{ minutes} \\ &= 3 \text{ hours} + 1 \text{ hour} + 5 \text{ minutes} \\ &= 4 \text{ hours } 5 \text{ minutes} \end{aligned}$$

Subtract 1 foot 9 inches from 3 feet 3 inches.

- Subtract inches first.
- Continue subtracting.

$$\begin{array}{rr} {}^{2}\not{3} \text{ feet} & {}^{15}\not{3} \text{ inches} \\ -\ 1 \text{ foot} & 9 \text{ inches} \\ \hline 1 \text{ foot} & 6 \text{ inches} \end{array}$$

Since 9 inches is greater than 3 inches, change 1 foot to 12 inches and add to the 3 inches.

PRACTICE

Add or subtract. Then simplify your answer. You can use the table on page 133.

1. $\begin{array}{rr} 2 \text{ hours} & 45 \text{ minutes} \\ +\ 1 \text{ hour} & 15 \text{ minutes} \\ \hline \end{array}$

2. $\begin{array}{rr} 4 \text{ pounds} & 10 \text{ ounces} \\ +\ 5 \text{ pounds} & 7 \text{ ounces} \\ \hline \end{array}$

3. $\begin{array}{rr} 5 \text{ yards} & 2 \text{ feet} \\ +\ 2 \text{ yards} & 2 \text{ feet} \\ \hline \end{array}$

4. $\begin{array}{rr} 12 \text{ feet} & 10 \text{ inches} \\ +\ 3 \text{ feet} & 7 \text{ inches} \\ \hline \end{array}$

5. $\begin{array}{rr} 1 \text{ hour} & 15 \text{ minutes} \\ + & 50 \text{ minutes} \\ \hline \end{array}$

6. $\begin{array}{rr} 1 \text{ quart} & 3 \text{ cups} \\ +\ 1 \text{ quart} & 2 \text{ cups} \\ \hline \end{array}$

7. $\begin{array}{rr} 12 \text{ pounds} & 10 \text{ ounces} \\ -\ 5 \text{ pounds} & 7 \text{ ounces} \\ \hline \end{array}$

8. $\begin{array}{rr} 3 \text{ yards} & 2 \text{ feet} \\ -\ 2 \text{ yards} & 1 \text{ foot} \\ \hline \end{array}$

9. $\begin{array}{rr} 9 \text{ feet} & 4 \text{ inches} \\ -\ 5 \text{ feet} & 8 \text{ inches} \\ \hline \end{array}$

10. $\begin{array}{rr} 1 \text{ gallon} & 1 \text{ quart} \\ - & 3 \text{ quarts} \\ \hline \end{array}$

11. $\begin{array}{rr} 4 \text{ hours} & 15 \text{ minutes} \\ -\ 1 \text{ hour} & 45 \text{ minutes} \\ \hline \end{array}$

12. $\begin{array}{rr} 4 \text{ pints} & \\ -\ 1 \text{ pint} & 1 \text{ cup} \\ \hline \end{array}$

Calculating Time

Sometimes you need to figure out when to start a task in order to complete it by a certain time. Or you might need to know what time you will finish a task if you start it at a certain time. To calculate this, first count the complete number of hours, then count the number of minutes.

Examples

It takes 1 hour 15 minutes to drive to the doctor's office. You have a 10:00 appointment. If you allow an additional 15 minutes for traffic problems, what time should you leave?

Hint: You need time before 10:00, so count back from 10:00.

- Count the hours. 1 hour before 10:00 is 9:00.
- Count the minutes. 15 minutes plus 15 additional minutes equals 30 minutes. 30 minutes before 9:00 is 8:30.

You should leave at 8:30.

Wendi put a cake into the oven at 8:15. The cake is supposed to bake for 40 minutes. What time should the cake be ready to come out of the oven?

- Count the hours. There are only minutes to count.
- Count the minutes. 15 minutes plus 40 minutes equals 55 minutes. Add the minutes to the hours. 8 hours + 55 minutes = 8:55

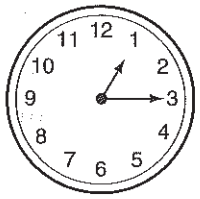
The cake should be ready at 8:55.

Pay close attention to any mention of A.M. (morning) and P.M. (afternoon and evening). From 9:00 A.M. to 10:00 A.M. is 1 hour, but from 9:00 A.M. to 10:00 P.M. is 13 hours.

PRACTICE

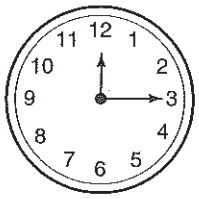
Fill in the blank for each problem.

1. What time is it 3 hours *before* 1:15?



_____

2. It will take $3\frac{1}{2}$ hours to make dinner rolls. You plan to eat at 12:15 P.M. What time should you start making the rolls?



_____

3. You need to work $5\frac{1}{2}$ hours today. If you start at 11:15, what time will you finish? _____

4. Your night class starts at 6:55 and ends at 7:35. How long is the class? _____

5. It takes you 20 minutes to clean 1 room, and there are 3 rooms in your apartment. If you start cleaning at 8:10, what time will you finish? _____

Finding Elapsed Time

Elapsed time is the amount of time that passes from the start of an event or activity to the end of that event or activity.

Example

Will started painting the kitchen at 2:30 in the afternoon. He finished at 9:15 that evening. How long did it take Will to paint the kitchen?

One method to solve is to subtract.

- Begin with the finish time and subtract the start time.
- Regroup as needed.

$$\begin{array}{r} {}^{8}\not{9}\text{ hr }{}^{75}\not{15}\text{ min} \\ -\ 2\text{ hr }30\text{ min} \\ \hline 6\text{ hr }45\text{ min} \end{array}$$

Another method is to count forward.

- Begin with the start time and count the hours to the finish time.
- Adjust for the minutes.

  Subtract 30 minutes for the time from 2 to 2:30.

  Add on 15 minutes for the time from 9 to 9:15.

From 2 to 9 is 7 hours.

$$\begin{array}{r} 6\text{ hr }60\text{ min} \\ -\ \ 30\text{ min} \\ \hline 6\text{ hr }30\text{ min} \\ +\ \ 15\text{ min} \\ \hline 6\text{ hr }45\text{ min} \end{array}$$

PRACTICE

Find the elapsed time for each situation.

1. When Clyde's train left the station, it was 5:17 A.M. When the train arrived at his destination, it was 6:39 A.M. How long was Clyde's train ride? _____

2. Jennifer got back from lunch at 1:45. When she left for lunch, it was 11:20. How much time did Jennifer take for lunch? _____

3. The concert started at 8:30 P.M. and ended at 10:10 P.M. How long did the concert last? _____

4. Paul started working on his model plane at 10:30 A.M. At 3:15 P.M. he stopped working to have lunch. How long had Paul been working on his model? _____

5. Celine ran in the marathon. The race began at 9:00 A.M. Celine crossed the finish line at 1:15. How long did Celine's run last? _____

6. The inspection crew started at 11:30 A.M. and completed their work at 2:20 P.M. How long did the job take? _____

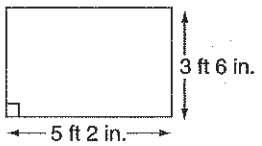
7. Brian's flight left Chicago at 10:00 A.M. and arrived in New York at 1:09 P.M. How long was the flight? *Hint:* Adjust for the time difference. New York is one hour later than Chicago. _____

8. The first guest arrived for Connie's party at 8:00 P.M. The last guest left at 2:30 A.M. How long did the party last? _____

Finding Perimeter

Perimeter is a measure of the distance around the outside edge of a figure. To find the perimeter, add the lengths of the figure's sides together. A capital letter P is used to represent perimeter.

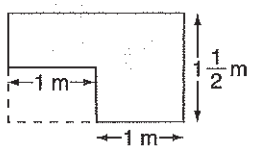
Opposite sides of a rectangle are the same length. To find the perimeter of a rectangle, add the lengths of the four sides.



5 ft 2 in.
3 ft 6 in.
5 ft 2 in.
+ 3 ft 6 in.
16 ft 16 in.

P = 17 ft 4 in.

The dashed lines in the figure at the right show that the figure fits inside a rectangle. The top and bottom of the rectangle are each 2 m. The right side is $1\frac{1}{2}$ m, and the sum of the two sides along the left is also $1\frac{1}{2}$ m.

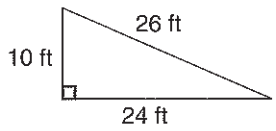


2 m
$1\frac{1}{2}$ m
2 m
+ $1\frac{1}{2}$ m
$P = 6\frac{2}{2}$ m = 7m

PRACTICE

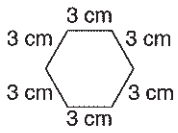
Find the perimeter of each shape.

1.



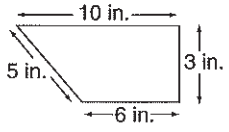
P = _____

2.



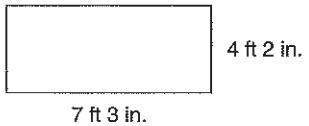
P = _____

3.



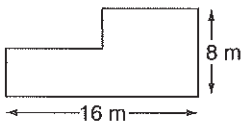
P = _____

4.



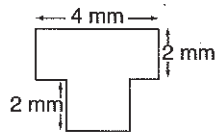
P = _____

5.



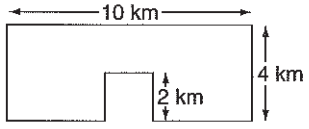
P = _____

6.



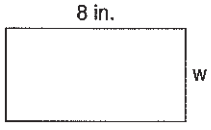
P = _____

7.



P = _____

8.



P = 24 in.

w = _____

9. What is the perimeter of a room 15 ft long and 12.5 ft wide?

P = _____

10. How much fencing is needed to enclose a 6 × 8 foot garden?

P = _____

11. If the perimeter of a square is 16 inches, how long is each side of the square?

P = _____

12. If the perimeter of an equilateral triangle is 54 cm, how long is each side of the triangle?

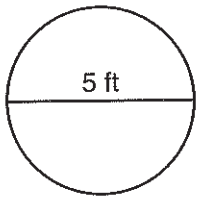
P = _____

Finding Circumference

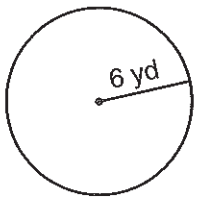
The perimeter of a circle is called the **circumference.**
A capital letter C is used to represent circumference.

The circumference of any circle is approximately 3 times its diameter (d).

- The diameter (d) of the circle at the right is 5 ft.
  $C \approx 3 \times 5$ ft, or ≈ 15 ft



- The radius (r) of the circle at the right is 6 yd. The diameter is double the radius, or 12 yd.
  $C \approx 3 \times 12$ yd, or ≈ 36 yd



To find a more exact measure of a circumference, instead of saying "it is about 3 times the diameter," you can multiply the diameter by the Greek symbol π, which represents 3.1416 or $\frac{22}{7}$.

Examples

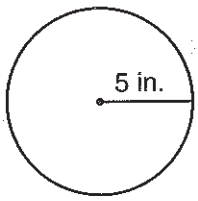
Find the circumference of a circle with a radius of 4 cm. Use $\pi = 3.14$.
$C = \pi \times d$
$r = 4$ cm, so $d = 8$ cm
$C = 3.14 \times 8$ cm $= 25.12$
$C = 25.12$ cm

Find the circumference of a circle with a diameter of 28 ft. Use $\pi = \frac{22}{7}$
$C = \pi \times d$
$d = 28$ ft
$C = \frac{22}{\cancel{7}} \times \frac{\cancel{28}^{4}}{1} = 88$
$C = 88$ ft

PRACTICE

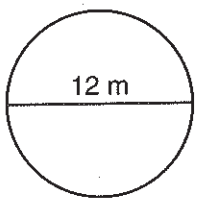
Find the circumference of each circle.
Use $\pi = 3.14$ for Questions 1–3. Use $\pi = \frac{22}{7}$ for Questions 4–6.

1.



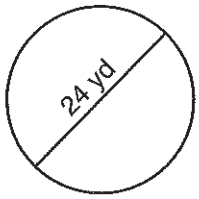
$C =$ _____

2.



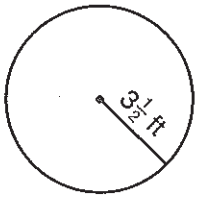
$C =$ _____

3.



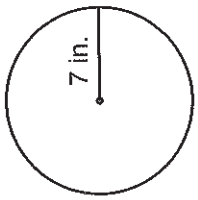
$C =$ _____

4.



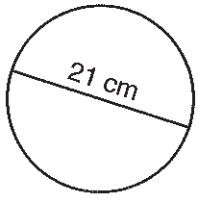
$C =$ _____

5.



$C =$ _____

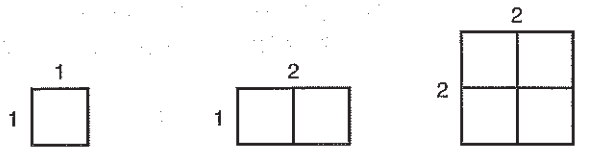
6.



$C =$ _____

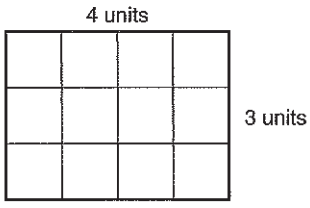
Finding Area of Squares and Rectangles

Area is the measure of the surface within a given region. Area is measured in **square units**. A capital letter *A* is used to represent area.



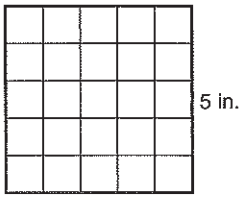
A = 1 square unit A = 2 square units A = 4 square units

A rectangle with a length of 4 units and a width of 3 units can be divided to form 3 rows with 4 squares in each row, making a total of 12 squares. Each square measures 1 unit on a side. The area of the rectangle is 12 square units, or 12 units^2.



A = 12 sq. units or 12 units^2

A square with a length of 5 inches on each side can be divided to form 5 rows of 5 squares, or 25 squares that measure 1 inch on each side. The area of the square is 25 square inches, or 25 in.^{2}

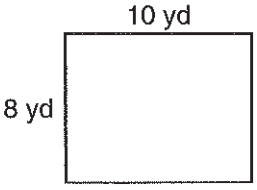


A = 25 sq. in. or 25 in.^{2}

A shortcut for finding the area of a rectangle or square is to multiply the length by the width. You can use the formula $A = lw$, where l represents length, and w represents width.

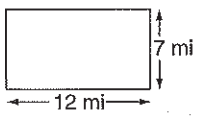
Example Find the area of a rectangle that measures 8 yd by 10 yd.

- Write the formula. $A = lw$
  length = 10 yd, width = 8 yd
- Replace variables with numbers. $A = 10 \text{ yd} \times 8 \text{ yd}$
- Multiply. $A = 80$ square yards, or 80 yd^2



PRACTICE

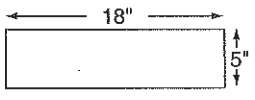
Find each area. Be sure to label the answer as square units. *Hint*: Divide the figures in Numbers 5 and 6 into two rectangles.

1. 

A = _____

2. a square patio that measures 5 m by 5 m

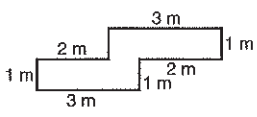
A = _____

3. 

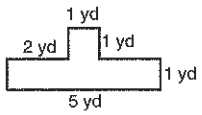
A = _____

4. a floor that is 12 ft by 15 ft

A = _____

5. 

A = _____

6. 

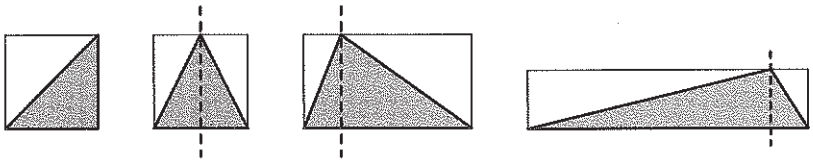
A = _____

Finding the Area of a Triangle

There are different types of triangles, but no matter what the type of triangle, you can find its area by taking half of the area of the rectangle the triangle "lives in."

In the examples below, a rectangle has been drawn around each triangle. You can see that a line that is perpendicular to the base of the triangle, and that passes through the triangle's vertex, creates two rectangles. Half of each smaller rectangle is shaded, so each triangle equals half of the larger rectangle.

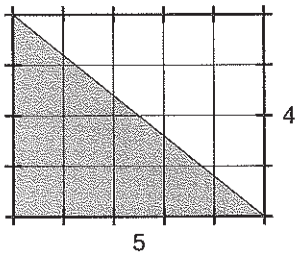
Examples



PRACTICE

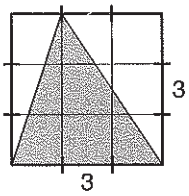
Find the area of each triangle. Label each answer as square units.

1.



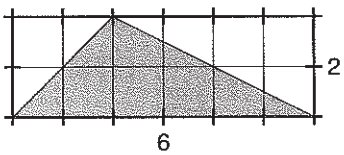
$A =$ _____

2.



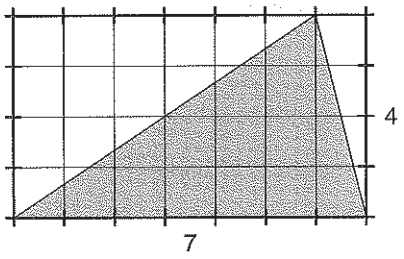
$A =$ _____

3.



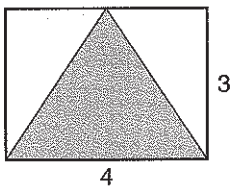
$A =$ _____

4.



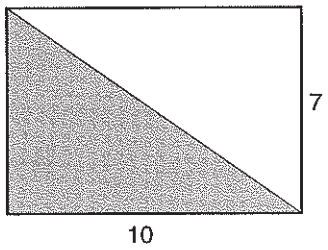
$A =$ _____

5.



$A =$ _____

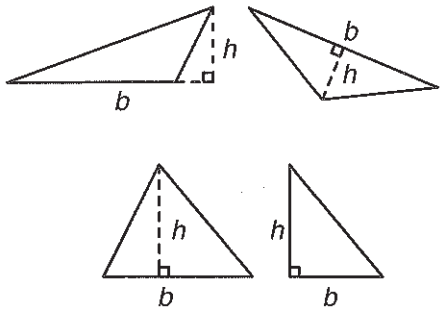
6.



$A =$ _____

Since a triangle is always half of the rectangle it lives in, you can use a formula to find the area of a triangle. The formula for finding the area of a triangle is $A = \frac{1}{2}bh$, where b represents the base of the triangle, and h represents the height of the triangle.

- The base is usually at the bottom of the triangle, but it doesn't have to be.
- The height is the distance between the base and the vertex directly opposite it. This distance must be at a right angle to the base. The height may be shown outside the triangle.

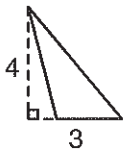


To use the formula, replace b and h with the values they represent in the triangle, and then multiply.

Example Find the area of this triangle.

- Write the formula.
- Replace variables with numbers.
- Multiply.

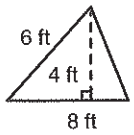
$A = 6$ square units *or* 6 units^2



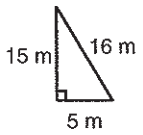
$$A = \frac{1}{2}bh$$
$$b = 3,\ h = 4$$
$$A = \frac{1}{\cancel{2}} \times \frac{3}{1} \times \frac{\cancel{4}^{2}}{1} = \frac{6}{1} = 6$$

PRACTICE

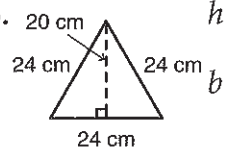
Find the area of each triangle. Use the formula $A = \frac{1}{2}bh$. Round your answers to the nearest tenth. Be sure to label your answers with square units.

1. 

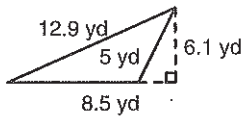
$h =$ _____
$b =$ _____
$A =$ _____

2. 

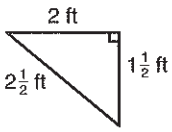
$h =$ _____
$b =$ _____
$A =$ _____

3. 

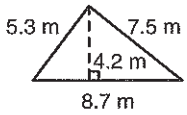
$h =$ _____
$b =$ _____
$A =$ _____

4. 

$A =$ _____

5. 

$A =$ _____

6. 

$A =$ _____

7. $h = 3\frac{1}{2}$ in., $b = 6\frac{1}{4}$ in.

$A =$ _____

8. $h = 4.5$ m, $b = 7.3$ m

$A =$ _____

9. $h = 4$ cm, $b = 5.35$ cm

$A =$ _____

Finding the Area of a Circle

The area of a circle is the number of square units contained within the circumference of the circle. You can use a formula $A = \pi r^2$ to find the area of a circle, where A stands for area, π is either 3.14 or $\frac{22}{7}$, and r^2 represents the radius squared, which means *radius* × *radius*.

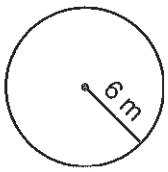
Example Find the area of a circle that has a radius of 12 inches. Use $\pi = 3.14$.

- Start by writing the formula. $A = \pi r^2$
- Determine the values to use. $\pi = 3.14$ $r = 12$ in. $r^2 = 12$ in. × 12 in. $= 144$ in.^{2}
- Replace variables with values. $A = 3.14 \times 144$ in.$^2 = 452.16$ in.^{2}

$A = 452.16$ in.^{2} for a circle with a radius of 12 inches.

PRACTICE

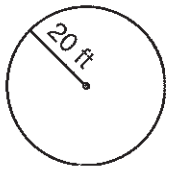
Write the formula and the values to use to find the area of each circle. Use $\pi = 3.14$ to find the area. Be sure to label your answer with square units.

1. 

Formula _____

$r =$ _____ $r^2 =$ _____

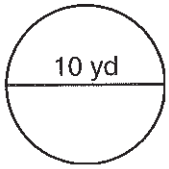
$A =$ _____

2. 

Formula _____

$r =$ _____ $r^2 =$ _____

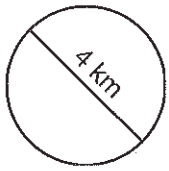
$A =$ _____

3. 

Formula _____

$r =$ _____ $r^2 =$ _____

$A =$ _____

4. 

Formula _____

$r =$ _____ $r^2 =$ _____

$A =$ _____

Write the formula and the values to use to find the area of each circle. Use $\pi = \frac{22}{7}$ to find the area. Be sure to label your answer with square units.

5. circle with radius of 14 in.

Formula _____

$r =$ _____ $r^2 =$ _____

$A =$ _____

6. circle with a diameter of 14 m

Formula _____

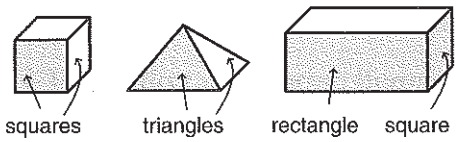
$r =$ _____ $r^2 =$ _____

$A =$ _____

Finding Surface Area

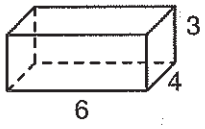
Squares, rectangles, and triangles are examples of two-dimensional figures. They are flat shapes that have two dimensions; length or height, and width.

The faces of geometric solids such as cubes and pyramids, which are three-dimensional figures, are made up of two-dimensional shapes such as squares, rectangles, and triangles.



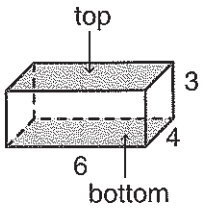
When you find **surface area (SA)**, you find the area of each face of a geometric solid, and then add those areas together to find the total.

Example Find the surface area (*SA*) of the figure.
This figure has 6 rectangular faces. Opposite faces are congruent, so you can find the area of one and then double it.



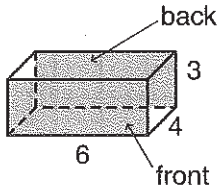
- Find the area of each face.

Top and bottom are each 4 by 6.



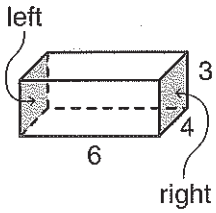
$A = lw = 4 \times 6 = 24$ sq. units
2×24 sq. units $= 48$ sq. units

Front and back are each 3 by 6.



$A = lw = 3 \times 6 = 18$ sq. units
2×18 sq. units $= 36$ sq. units

Right and left sides are each 3 by 4.

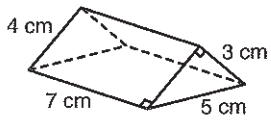


$A = lw = 3 \times 4 = 12$ sq. units
2×12 sq. units $= 24$ sq. units

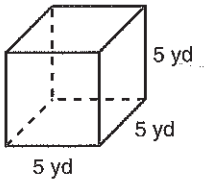
- Add the areas. $SA = 48 + 36 + 24 = 108$ sq. units

PRACTICE

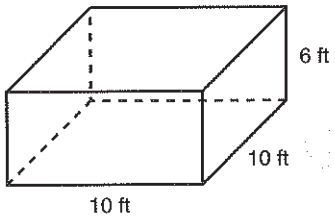
Find the surface area of each figure.

1. 

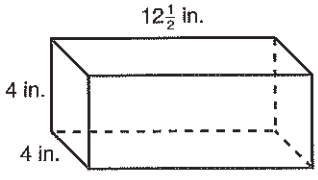
$SA =$ _____

2. 

$SA =$ _____

3. 

$SA =$ _____

4. 

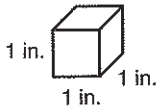
$SA =$ _____

Finding Volume

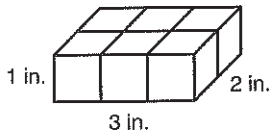
Volume is the space occupied by — or the space inside — a solid, measured in cubes called cubic units. The capital letter V is used to represent volume.

Each edge of the small cube measures 1 inch.

The small cube has a volume of 1 cubic inch, which can also be written 1 in.^{3}



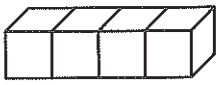
It takes 6 small cubes to make this larger shape, so this larger shape has a volume of 6 cubic inches or 6 in.^{3}



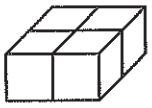
A cubic inch is a cube that is 1 inch long on each side. Similarly, a cubic foot is a cube that is 1 foot long on each side, a cubic meter is a cube that is 1 meter long on each side, and so on.

PRACTICE

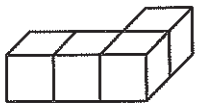
Find the volume of each shape if each cube is equal to 1 cm^3.

1. 

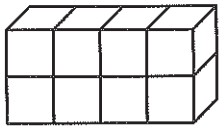
   $V =$ _____

2. 

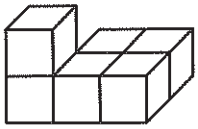
   $V =$ _____

3. 

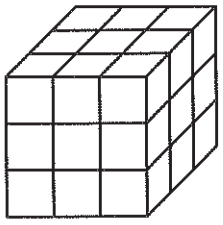
   $V =$ _____

4. 

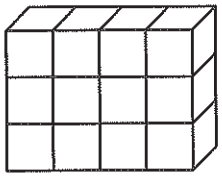
   $V =$ _____

5. 

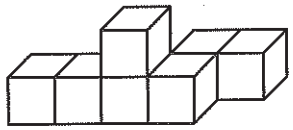
   $V =$ _____

6. 

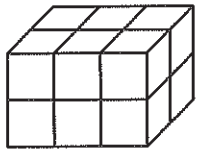
   $V =$ _____

7. 

   $V =$ _____

8. 

   $V =$ _____

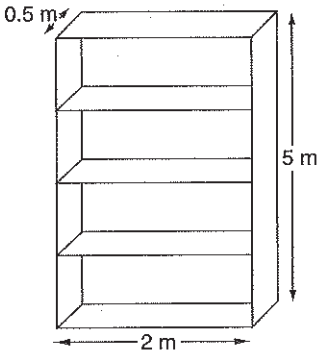
9. 

   $V =$ _____

Measurement Skills Checkup

Circle the letter for the correct answer to each question.

This diagram shows the plans for building a bookcase. Study the diagram. Then do Numbers 1–5.



1. Each shelf on the bookcase will be 0.5 (or $\frac{1}{2}$) meter deep. Which of these is another way to describe the depth of each shelf?

   A 5 cm
   B 20 cm
   C 50 cm
   D 95 cm

2. The top of each shelf in the bookcase will be covered with a special adhesive-backed paper. How much of the paper is needed to cover 4 shelves?

   F 1 sq m
   G 4 sq m
   H 8 sq m
   J 10 sq m

3. According to the plans, each shelf of this bookcase can hold 110 kilograms. How many pounds can each shelf hold? (1 kg ≈ 2.2 lbs)

   A 5 **C** 41
   B 242 **D** 24.2

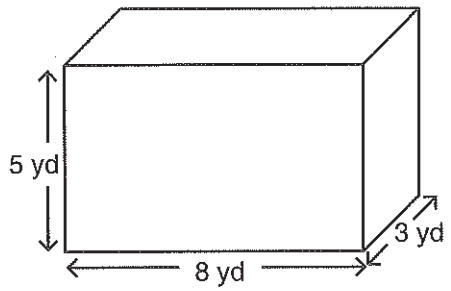
4. Akira needs $\frac{1}{2}$ gallon of shellac to finish the bookcase, but the shellac comes only in 1-quart cans. How many 1-quart cans does he need?

   F 1 **H** 5
   G 4 **J** 2

5. Akira estimates that it will take him $7\frac{1}{2}$ hours to build this bookcase. If he works for 90 minutes a day, how many days will it take him to finish?

   A 4 days **C** 5 days
   B 6 days **D** 9 days

Use the figure shown for Numbers 6 and 7.



6. What is the volume of the above figure?

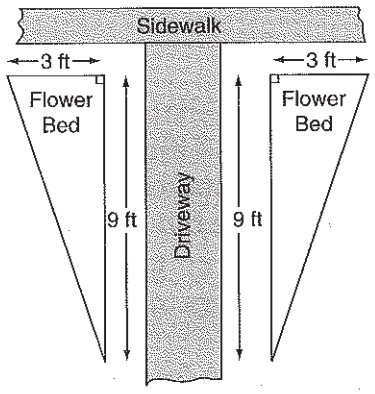
   F 120 cubic yd
   G 140 cubic yd
   H 160 cubic yd
   J 180 cubic yd

7. What is the surface area (*SA*) of the figure?

   A 79 sq yd
   B 120 sq yd
   C 136 sq yd
   D 158 sq yd

Measurement Skills Checkup (continued)

This diagram shows plans for two flower beds that Helio is going to put along the sides of his driveway. Study the diagram. Then do Numbers 8–12.



8. Helio wants to put cedar planks around the outside edges of each flower bed. To figure out how much planking he needs for each flower bed, what should he find?

   F the perimeter
   G the area
   H the volume
   J the depth

9. Helio uses an ounce of fertilizer for each square foot of area. How much fertilizer does he need to cover both flower beds?

   A 18 ounces **C** 27 ounces
   B 54 ounces **D** 108 ounces

10. Helio buys $\frac{1}{4}$ of a pound of fertilizer. How many ounces is that?

    F 25 **H** 5
    G 4 **J** 8

11. It takes 20 minutes for Helio to plant half of one flower bed. At that rate, how long will it take him to plant all the *remaining* portions of the flower beds?

    A 1 hour 15 minutes
    B 1 hour 20 minutes
    C 2 hours
    D 1 hour

12. Helio began planting at 8:25 a.m. but he was interrupted. He finished at 2:15 p.m. How much time elapsed between his starting and finishing times?

    F 5 hours 50 minutes
    G 6 hours 50 minutes
    H 5 hours 90 minutes
    J 5 hours 10 minutes

13. What is the circumference of a circle with a radius of 4 ft? Use $\pi = 3.14$.

    A 12.56 ft **C** 25.12 ft
    B 50.24 ft **D** 66.24 ft

14. Which is the best estimate of the capacity of a bathtub?

    F 40 milliliters
    G 40 centiliters
    H 40 liters
    J 40 kiloliters

15. Which measurement is equivalent to $3\frac{1}{2}$ yards?

    A 12 ft **C** 10 ft
    B $10\frac{1}{2}$ ft **D** $9\frac{1}{2}$ ft

Page 118

1. 50°, isosceles and acute
2. 50°, scalene and acute
3. 60°, equilateral and acute
4. 48°, scalene and right
5. A
6. H
7. B
8. H

Page 119

hexagon:
3, 4, $4 \times 180° = 720°$
octagon:
8, 5, 6, $6 \times 180° = 1{,}080°$

1. 108°
2. 120°
3. 135°

Page 120

1. A
2. G
3. line B
4. circumference
5. 2 in.; 4 in.
6. 3 mm, 6mm
7. cannot tell
   cannot tell

Page 121

1. C
2. G
3. B
4. G
5. C and D or A and E
6. & 7. Figures should be drawn correctly.

Page 122

rectangular prism: 6, 12, 8
cube: 6, 12, 8
square pyramid: 5, 8, 5
triangular pyramid: 4, 6, 4
triangular prism: 5, 9, 6

Page 123

1. cylinder
2. cone
3. rectangular prism
4. sphere
5. triangular prism
6. rectangular prism
7. rectangular prism
8. triangular pyramid
9. triangular prism
10. cube

Pages 124–125

1. C
2. F
3. B
4. G
5. A
6. H
7. 90º
8. 360º
9. 180º
10. C
11. J
12. C

Page 126

1. *Y*
2. *B*
3. *N*
4. *E*
5. *S*
6. *H*
7. $(2, {}^{-}2)$
8. (4, 6)
9. (1, 0)
10. (2, 7)
11. $(5, {}^{-}3)$
12. (0, 3)

Geometry Skills Checkup

Page 127-128

1. A
2. H
3. C
4. J
5. C
6. G
7. B
8. F
9. H
10. B
11. J
12. A
13. J
14. D
15. H
16. C
17. F

Measurement

Page 129

1. 19
2. 95
3. 70
4. 65
5. 25
6. 70
7. 50
8. 75

Page 130

9. 2
10. 2
11. 5
12. 20
13. 20
14. 4
15. 25, 75
16. 2, 32
17. 10, 20
18. 1, 43

Page 131

1. $1\frac{1}{2}$
2. 2
3. $\frac{1}{2}$
4. $2\frac{1}{2}$

5. 1
6. $1\frac{1}{2}$
7. $\frac{1}{2}$
8. $\frac{1}{4}$
9. $\frac{3}{4}$
10. $1\frac{1}{4}$
11. $\frac{1}{2}$
12. $1\frac{3}{4}$
13. 1
14. 2

Page 132

1. 4 by $7\frac{1}{2}$ in.
2. $\frac{1}{4}$ by $7\frac{1}{2}$ in.
3. 3 by 5 in.
4. 8 by 11 in.
5. $2\frac{1}{2}$ by $4\frac{1}{2}$ in.
6. 4 by 12 in.
7. $2\frac{5}{8}$ by 4 in.
8. $3\frac{1}{2}$ by $3\frac{5}{8}$ in.
9. $2\frac{5}{8}$ by $6\frac{1}{8}$ in.
10. 1 by $1\frac{3}{4}$ in.
11. A
12. H
13. D
14. J
15. B
16. H

Page 133

1. C
2. G
3. B
4. F
5. 15 inches
6. 2 yards
7. 1 pound
8. 22 ounces
9. 3 cups
10. 1 quart
11. 1 gallon
12. 2 hours

Page 134

1. 3
2. 2
3. 1
4. 6
5. 1
6. 18
7. 5
8. 48
9. 8
10. 2
11. 4,000
12. 6
13. 90
14. 15
15. 14
16. 3, 2
17. 1, 7

Page 135

1. C
2. F
3. G
4. C
5. E
6. H

Page 136

1. 500
2. 2,000
3. 3
4. 1,500
5. 3.5
6. 100
7. 2,500
8. 1.5
9. 315
10. 1,450
11. 3,015
12. 1 kg 515 g

Page 137

1. 1 in.
2. 1 oz
3. 1 L
4. 1 m
5. 1 mi
6. 18.2
7. 1.4
8. 25
9. 11
10. 3.3
11. 6.8
12. 40
13. 0.5
14. 30
15. 2.4

Page 138

1. 4 hr
2. 2 lb 1 oz
3. 8 yd 1 ft
4. 16 ft 5 in.
5. 2 hr 5 min
6. 3 qt 1 c
7. 7 lb 3 oz
8. 1 yd 1 ft
9. 3 ft 8 in.
10. 2 qt
11. 2 hr 30 min
12. 2 pt 1 c

Page 139

1. 10:15
2. 8:45 A.M.
3. 4:45
4. 40 min
5. 9:10

Page 140

1. 1 hr 22 min
2. 2 hr 25 min
3. 1 hr 40 min
4. 4 hr 45 min
5. 4 hr 15 min
6. 2 hr 50 min
7. 2 hr 9 min
8. 6 hr 30 min

Page 141

1. 60 ft
2. 18 cm
3. 24 in.
4. 22 ft 10 in.
5. 48 m
6. 16 mm
7. 32 km
8. 4 in.
9. 55 ft
10. 28 ft
11. 4 in.
12. 18 cm

Page 142

1. 31.4 in.
2. 37.68 m
3. 75.36 yd
4. 22 ft
5. 44 in.
6. 66 cm

Page 143

1. 84 mi^2
2. 25m^2
3. 90 $in.^2$
4. 180 ft^2
5. 6 m^2
6. 6 yd^2

Page 144

1. 10 $units^2$
2. $4\frac{1}{2}$ $units^2$
3. 6 $units^2$
4. 14 $units^2$
5. 6 $units^2$
6. 35 $units^2$

Page 145

1. 4 ft, 8 ft; 16 ft^2
2. 15 m, 5 m, 37.5 m^2
3. 20 cm, 24 cm; 240 cm^2
4. 25.9 yd^2
5. $1\frac{1}{2}$ ft^2
6. 18.3 m^2
7. 10.9 $in.^2$
8. 16.4 m^2
9. 10.7 cm^2

Page 146

1. 6 m, 36 m; 113.04 m^2
2. 20 ft, 400 ft; 1,256 ft^2
3. 5 yd, 25 yd; 78.5 yd^2
4. 2 km, 4 km: 12.56 km^2
5. 14 in., 196 in; 616 $in.^2$
6. 7 m, 49 m; 154 m^2

Page 147

1. 93 cm^2
2. 150 yd^2
3. 440 ft^2
4. 232 $in.^2$

Page 148

1. 4 cm^3
2. 4 cm^3
3. 4 cm^3
4. 8 cm^3
5. 6 cm^3
6. 27 cm^3
7. 12 cm^3
8. 7 cm^3
9. 12 cm^3

Measurement Skills Checkup

Pages 149–150

1. C
2. G
3. B
4. J
5. C
6. F
7. D
8. F
9. C
10. G
11. D
12. F
13. C
14. H
15. B

Probability, Data, and Statistics

Page 152

1. D
2. H
3. B
4. A
5. C
6. J
7. D
8. F

Page 153

1. D
2. J
3. C

Page 154

1. B
2. Nov. 21, 1980
3. 30,190,300
4. M*A*S*H*, Dallas, and Roots
5. M*A*S*H*
6. Jan. 30, 1977
7. M*A*S*H*