



Chapter 7

Measurement

There are two main systems for measuring distance, weight, and liquid capacity. The United States and parts of the former British Empire use **customary**, or **standard**, units of measure. This system includes inches, feet, and miles for distance, and ounces, pounds, and tons for weight. Most countries use the **metric** system. The metric system includes meters and kilometers for distance, and grams and kilograms for weight.

Customary Measures

The table below shows customary units of measure for length, weight, and liquid measure as well as units of time. Take the time to memorize any of the units and equivalents that you do not know.

In the chart the larger unit of measurement is on the left of the = sign. On the right of the = sign is the equivalent in smaller units. Abbreviations are in parentheses. You may see these abbreviations with or without periods at the end.

Customary Units of Measure	
Measures of Length	
1 foot (ft)	= 12 inches (in.)
1 yard (yd)	= 36 inches
1 yard	= 3 feet
1 mile (mi)	= 5280 feet
1 mile	= 1760 yards
Measures of Weight	
1 pound (lb)	= 16 ounces (oz)
1 ton (T)	= 2000 pounds
Liquid Measures	
1 pint (pt)	= 16 ounces (oz)
1 cup	= 8 ounces
1 pint	= 2 cups
1 quart (qt)	= 2 pints
1 gallon (gal)	= 4 quarts
Measures of Time	
1 minute (min)	= 60 seconds (sec)
1 hour (hr)	= 60 minutes
1 day	= 24 hours
1 week (wk)	= 7 days
1 year (yr)	= 365 days

It is often convenient to change, or **convert**, from one unit of measure to another. For example, inches are appropriate units for measuring short distances such as the width of a table. Feet are appropriate for longer distances, such as the dimensions of a room. The distance between cities is usually measured in miles.

R U L E

To change from a smaller unit to a larger unit, you need to divide.

When you change from a smaller unit to a larger unit, you want *fewer* of the larger units.

Example 1 Change 8 ounces to pounds.

Step 1 Remember that the fraction bar means to divide. $\frac{8}{16} = \frac{1}{2}$ lb
Write 8 as the numerator and 16, the number of ounces in one pound, as the denominator.

Step 2 Reduce. 8 ounces = $\frac{1}{2}$ pound

R U L E

To change from a larger unit to a smaller unit, you need to multiply.

When you change from a larger unit to a smaller unit, you want *more* of the smaller units.

Example 2 Change 10 feet to inches.

Multiply 10 by 12, the number of inches in one foot. $10 \times 12 = 120$ in.
10 feet = 120 inches

When you **convert** from one unit of measure to another, there is often more than one way to express the answer.

Example 3 Change 6 quarts to gallons.

Step 1 Divide 6 by 4, the number of quarts in one gallon.

Step 2 Express the remainder as a fraction and reduce. $1\frac{2}{4} = 1\frac{1}{2}$ gal
6 quarts = $1\frac{1}{2}$ gallons

Example 4 Change 6 quarts to gallons and quarts.

Step 1 Divide 6 by 4, the number of quarts in one gallon. 1 gal 2 qt
 $4 \overline{)6}$

Step 2 Express the remainder as 2 quarts.
6 quarts = 1 gallon 2 quarts

The answers to Examples 3 and 4 are both acceptable.

EXERCISE 1

Directions: For problems 1–6, change each measurement to a fraction of the new unit that follows.

- | | |
|----------------------------|-------------------------|
| 1. 18 inches = _____ yard | 8 hours = _____ day |
| 2. 40 minutes = _____ hour | 12 ounces = _____ pound |
| 3. 9 inches = _____ foot | 2 quarts = _____ gallon |
| 4. 500 pounds = _____ ton | 528 feet = _____ mile |
| 5. 1 cup = _____ pint | 5 minutes = _____ hour |
| 6. 5 days = _____ week | 8 inches = _____ foot |

For problems 7–10, change each measurement to the smaller unit that follows.

- | | |
|---------------------------------------|--------------------------|
| 7. 3 pounds = _____ ounces | 4 feet = _____ inches |
| 8. 5 minutes = _____ seconds | 2 yards = _____ feet |
| 9. 3 tons = _____ pounds | 4 days = _____ hours |
| 10. $1\frac{1}{2}$ miles = _____ feet | 5 gallons = _____ quarts |

Solve problems 11–15.

11. A group of neighbors cooked 130 quarts of tomatoes. They wanted to can them in gallon jars. How many gallon jars did they need for canning?
12. Pieter and his son went camping for 3 whole days. Altogether, how many hours did they camp?
13. Latisha's car was double-parked for 45 minutes. For what fraction of an hour was her car double-parked?
14. Kwan climbed a mountain that is 10,560 feet high. Find the mountain's height in miles.
15. Frank has to carry 3 tons of cement. If his truck carries a maximum of 500 pounds at a time, how many trips will Frank have to make?

Metric Measures

In the metric system, units of measure are multiples of 10, 100, and 1000. In other words, metric units of measure rely on decimals.

In the metric system, the basic unit length is the **meter**. A meter is a little longer than one yard. The basic unit of liquid measure is the **liter**. A liter is about the same size as a quart. The basic unit of weight is the **gram**. A gram is a very small unit of weight such as the weight of a couple of aspirin tablets. A **kilogram**, which is the metric unit used to weigh people, is a little more than 2 pounds.

These prefixes are used in metric measurements. Learn their meanings before you go on.

kilo-	hecto-	deca-	base unit	deci-	centi-	milli-
1000×	100×	10×	liter meter gram	0.1×	0.01×	0.001×

- Examples** one kilometer = 1000 meters
one milliliter = 0.001 liter or $\frac{1}{1000}$ liter
one deciliter = 0.1 liter or $\frac{1}{10}$ liter
one centimeter = 0.01 meter or $\frac{1}{100}$ meter

Below are the most common metric measures and their abbreviations. Take the time now to learn these units before you go on.

Metric Units of Measure	
Measures of Length	
1 meter (m)	= 1000 millimeters (mm)
1 meter	= 100 centimeters (cm)
1 kilometer (km)	= 1000 meters
1 decimeter (dm)	= $\frac{1}{10}$ meter
Measures of Weight	
1 gram (g)	= 1000 milligrams (mg)
1 kilogram (kg)	= 1000 grams
Liquid Measures	
1 liter (L)	= 1000 milliliters (mL)
1 deciliter (dL)	= $\frac{1}{10}$ liter

To change from one unit to another, simply move the decimal point.

R U L E

To change from a larger unit to a smaller unit, you need to multiply. You will be moving the decimal point to the right.

Example 1 Change 1.5 meters to centimeters.

Multiply 1.5 by 100. Move the decimal point two places to the right.
1.5 meters = 150 cm

$$1.5 \times 100 = 150$$

R U L E

To change from a smaller unit to a larger unit, you need to divide. You will be moving the decimal point to the left.

Example 2 Change 165 milliliters to liters.

Divide 165 by 1000. Move the decimal point three places to the left.
165 mL = 0.165 L

$$165 \div 1000 = 0.165 \text{ L}$$

Review the shortcuts for multiplying and dividing by 10, 100, and 1000 on pages 86 and 89.

EXERCISE 2

Directions: For problems 1–3, answer each question.

1. One kilogram is equal to how many grams?
2. One centimeter is equal to what fraction of a meter?
3. One milliliter is equal to what fraction of a liter?

For problems 4–8, change each metric measurement to the unit that follows.

4. 1.65 kilograms = _____ grams 9 meters = _____ centimeters
5. 3.2 liters = _____ milliliters 4 kilometers = _____ meters
6. 0.6 kilograms = _____ grams 0.25 liter = _____ milliliters
7. 80 centimeters = _____ meter 795 grams = _____ kilogram
8. 500 meters = _____ kilometer 380 milliliters = _____ liter

Answers are on page 412.

Converting Measurements

Using Proportion to Convert Measurements

You can use proportion to change one unit of measure to another. Remember that the parts of a proportion must correspond.

Example 1 Use a proportion to change 3 pounds to ounces.

- Step 1** Write a proportion with the ratio of 1 pound to 16 ounces on the left. Write 3 in the pound position. Let x represent the missing ounces. $\frac{1 \text{ lb}}{16 \text{ oz}} = \frac{3}{x}$
- Step 2** Find the cross products. $1x = 48$
- Step 3** Divide by 1.
3 pounds = 48 ounces $x = 48$

Example 2 Use a proportion to change 10 quarts to gallons.

- Step 1** Write a proportion with the ratio of 1 gallon to 4 quarts on the left. Write 10 in the quart position. Let x represent the missing gallons. $\frac{1 \text{ gal}}{4 \text{ qt}} = \frac{x}{10}$
- Step 2** Find the cross products. $4x = 10$
- Step 3** Divide by 4.
10 quarts = $2\frac{1}{2}$ gallons $x = 2\frac{1}{2}$

Example 3 Use a proportion to change 9.6 meters to centimeters.

- Step 1** Write a proportion with the ratio of 1 meter to 100 centimeters on the left. Write 9.6 in the meter position. Let x represent the missing centimeters. $\frac{1 \text{ m}}{100 \text{ cm}} = \frac{9.6}{x}$
- Step 2** Find the cross products. $1x = 960$
- Step 3** Divide by 1.
9.6 meters = 960 centimeters $x = 960$

EXERCISE 3

Directions: Use a proportion to solve each of the following problems.

1. Change 20 ounces to pounds.
2. Change 35 centimeters to meters.
3. Change 150 minutes to hours.
4. Change 75 inches to feet.
5. Change 850 milliliters to liters.
6. Change 9 quarts to pints.
7. Change $1\frac{3}{4}$ pounds to ounces.
8. Change 400 pounds to tons.

For more practice, use proportion to solve the measures in Exercises 1 and 2.

Answers are on page 412.

Interchanging Measures

On the GED Mathematics Test you will not have to convert between customary units of measure and metric units. However, to get an idea of how the systems compare, use the following chart.

Units of Length	
1 inch = 2.54 centimeters	1 centimeter = 0.3937 inch
1 foot = 0.3048 meter	1 meter = 39.37 inches
1 mile \approx 1.6 kilometers	1 kilometer \approx 0.62 mile
Units of Weight	
1 pound \approx 0.453 kilogram	1 kilogram \approx 2.2 pounds

Example

Max drives 6 miles to work every weekday morning. What is his driving distance in kilometers?

Multiply 6 miles by 1.6, the approximate equivalent in kilometers.

Max drives 9.6 kilometers to work.

$$6 \times 1.6 = 9.6 \text{ km}$$

EXERCISE 4

Directions: Use the chart of equivalents on page 189 to solve each problem. Round each answer to the nearest unit.

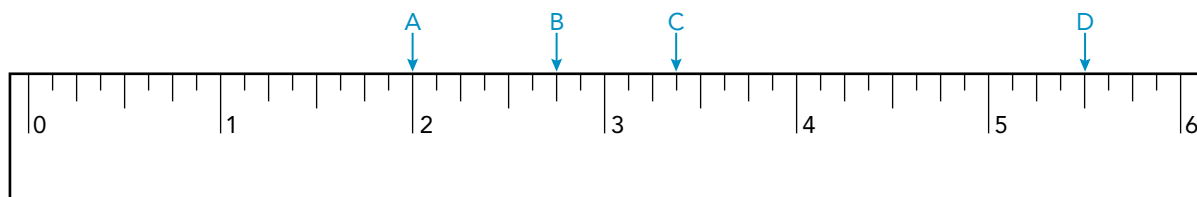
1. Sam weighs 180 pounds. What is his weight in kilograms?
2. Maria weighs 55 kilograms. What is her weight in pounds?
3. Mary is 5 feet 6 inches tall. What is her height in centimeters? (Hint: First change her height to inches.)
4. The driving distance between Cleveland and Boston is 632 miles. What is this distance in kilometers?
5. The air travel distance between Paris and Berlin is 540 kilometers. What is this distance in miles?
6. A standard sheet of copy paper in the U.S. is $8\frac{1}{2}$ inches wide and 11 inches high. What are these measurements in centimeters?

Answers are on page 412.

Scales, Meters, and Gauges

A ruler is a tool for measuring short distances. With customary measures, rulers are marked in inches and feet. With metric measures, rulers are marked in centimeters and meters. Gauges are tools for measuring mileage, temperature, speed, electrical current, blood pressure, and so on.

Below is a 6-inch ruler.



The longest lines on the ruler are inch lines. They are numbered 1, 2, 3, and so on. The second-longest lines are $\frac{1}{2}$ -inch lines. The next longest lines are $\frac{1}{4}$ -inch lines. The shortest lines are $\frac{1}{8}$ -inch lines. Many rulers include even smaller $\frac{1}{16}$ -inch lines.

To read a length on a ruler, decide how far a point is to the right of zero.

Example 1

Tell how far to the right of zero the points labeled A, B, C, and D on the ruler are.

Point A is 2 inches.

Point A is at the line labeled 2.

Point B is $2\frac{3}{4}$ inches.

Point B is between 2 and 3 inches.
Point B is at the third $\frac{1}{4}$ -inch line between 2 and 3.

Point C is $3\frac{3}{8}$ inches.

Point C is between 3 and 4 inches.
Point C is at the third $\frac{1}{8}$ -inch line between 3 and 4.

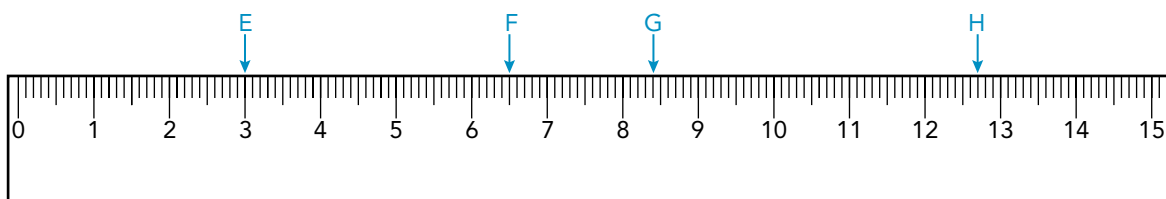
Point D is $5\frac{1}{2}$ inches.

Point D is between 5 and 6 inches.
Point D is at the $\frac{1}{2}$ -inch line between 5 and 6.

Notice that distances on the 6-inch ruler were given in fractions.

The next illustration shows a metric scale that is 15 centimeters long. The longest lines on the metric scale are the centimeter lines, labeled 1, 2, 3, and so on. The next longest lines are the $\frac{1}{2}$ -centimeter lines, or 0.5-centimeter lines. The shortest lines are millimeter lines, or 0.1-centimeter lines.

Notice in the next example that all distances on the metric scale are given in decimals.

**Example 2**

Tell how far to the right of zero the points labeled E, F, G, and H on the ruler are.

Point E is 3 centimeters.

Point E is at the line labeled 3.

Point F is 6.5 centimeters.

Point F is between 6 and 7 centimeters.
Point F is at the middle line, which is 0.5 centimeter.

Point G is 8.4 centimeters.

Point G is between 8 and 9 centimeters.
Point G is at the fourth millimeter, or 0.4-centimeter line.

Point H is 12.7 centimeters.

Point H is between 12 and 13 centimeters.
Point H is at the seventh millimeter, or 0.7-centimeter line.

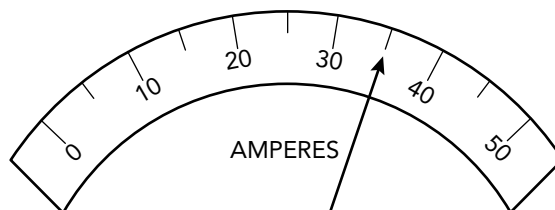
Example 3 What is the distance from point F to point G?

Point G (the farther point) is 8.4 centimeters.

Point F (the point closer to zero) is 6.5 centimeters.

Subtract to find the difference. $8.4 - 6.5 = 1.9$ centimeters

The diagram at the right shows the dial of an instrument that measures **amperes**. An ampere is a unit of electric current. The dial is labeled from 0 to 50 with a small mark halfway between each number.



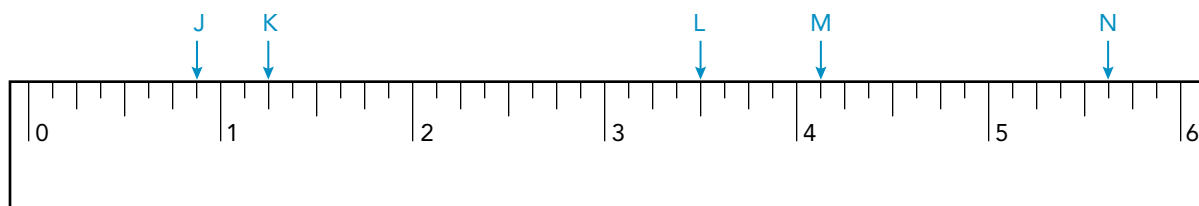
Example 4 What is the reading, in amperes, on the gauge shown above?

The arrow is halfway between 30 and 40.

The reading on the gauge is 35 amperes.

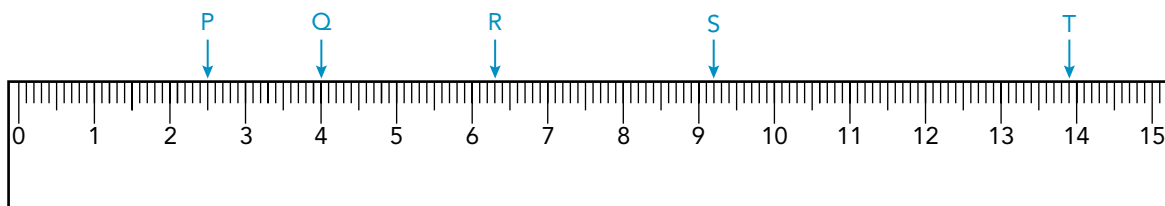
EXERCISE 5

Directions: For problems 1–5, tell the distance in inches from 0 of each labeled point on the ruler below.



1. Point J
2. Point K
3. Point L
4. Point M
5. Point N
6. What is the distance from point K to point N?

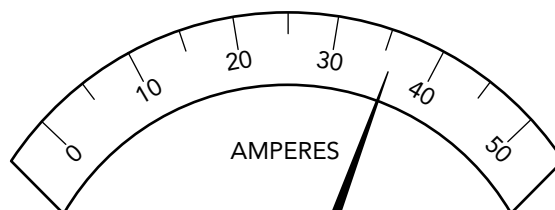
For problems 7–11, tell the distance in centimeters from 0 of each labeled point on the ruler below.



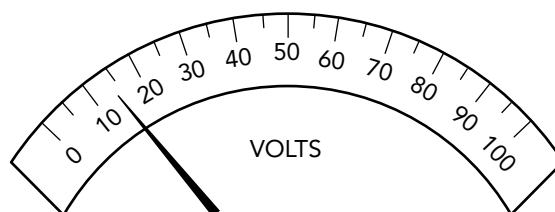
7. Point P
8. Point Q
9. Point R
10. Point S
11. Point T
12. What is the distance from point P to point S?

For problems 13–15, use the diagram to the right of each question.

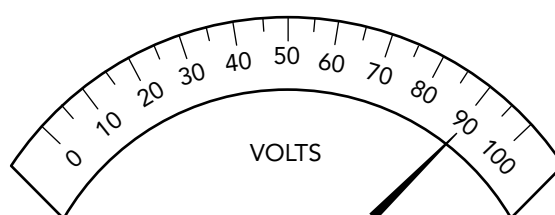
13. What is the approximate reading, in amperes, of the meter shown at the right?



14. The diagram at the right shows a voltmeter. Volts are a measure of electromotive force. What is the approximate reading, in volts, on the meter?



15. The voltmeter pictured at the right takes $\frac{1}{10}$ of a second to rise one volt. How many seconds has it taken to rise to the amount shown?



GED PRACTICE

Measurement Review

PART I

Directions: Use a calculator to solve any of the problems in this section. For problems 1 and 2, mark each answer on the corresponding number grid.

1. 22 inches are what fraction of a yard?

	/	/	/	
.
0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

2. 115 centimeters are the same as how many meters?

	/	/	/	
.
0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

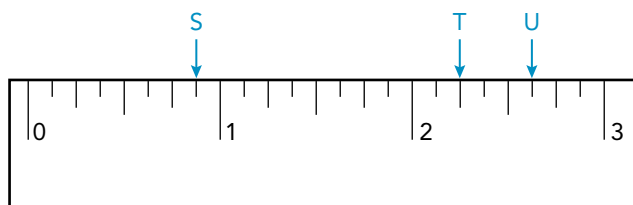
Choose the correct answer for the following problems.

3. At a price of \$4.80 per pound, what is the cost of 2 lb 4 oz of cheese?
- (1) \$ 9.60
(2) \$10.80
(3) \$12.60
(4) \$14.40
(5) \$19.20
4. From a cable 4 meters long, Carlo cut a piece 2.15 meters long. Find the length, in *centimeters*, of the remaining piece.
- (1) 285
(2) 215
(3) 185
(4) 115
(5) 85
5. Gianni needs 3 yd 18 in. of material to make a suit. What is the greatest number of suits that he can make from 15 yards of material?
- (1) 5
(2) 4
(3) 3
(4) 2
(5) 1
6. For a blood drive at Heather's office, the workers donated 36.5 liters on Wednesday, 42.2 liters on Thursday, and 50.1 liters on Friday. To the nearest tenth of a liter, what was the average amount donated each day?
- (1) 42.9
(2) 50.1
(3) 58.8
(4) 64.4
(5) 128.8

PART II

Directions: Solve the problems below without using a calculator.

Use the 3-inch ruler pictured below to answer problems 7 and 8.



7. What is the distance, in inches, from zero to point U?

- (1) $2\frac{1}{2}$
- (2) $2\frac{3}{8}$
- (3) $2\frac{1}{2}$
- (4) $2\frac{5}{8}$
- (5) $2\frac{7}{8}$

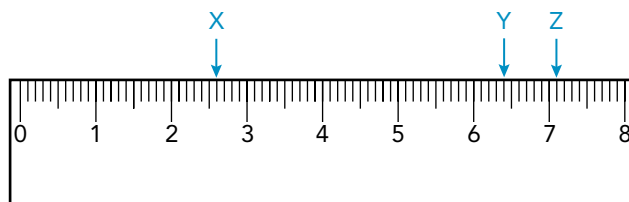
8. What is the distance, in inches, between points S and T?

- (1) $\frac{3}{4}$
- (2) $\frac{7}{8}$
- (3) $1\frac{1}{8}$
- (4) $1\frac{5}{8}$
- (5) $1\frac{3}{8}$

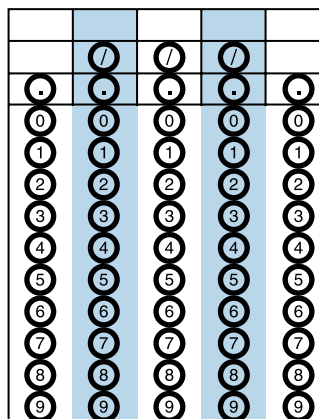
9. Which of the following represents the average weight of three boxes that weigh 2.5 kg, 0.96 kg, and 1.2 kg respectively?

- (1) $2.5 + 0.96 + 1.2$
- (2) $2(2.5 + 0.96 + 1.2)$
- (3) $2.5 \times 0.96 \times 1.2$
- (4) $\frac{2.5 + 0.96 + 1.2}{3}$
- (5) $\frac{2.5 + 0.96 + 1.2}{2}$

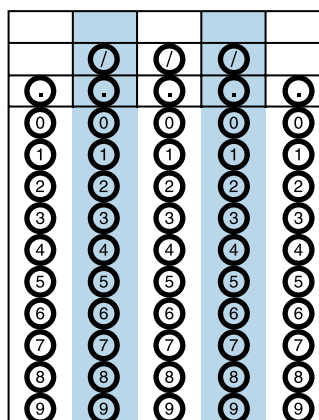
Use the 8-centimeter ruler pictured below to answer problems 10 and 11. Mark each answer on the corresponding number grid.



10. What is the distance, in centimeters, from zero to point Z?



11. What is the distance, in centimeters, between points X and Y?



12. Fred bought 5 cans of tomato paste. Each can weighed 14 ounces. Which of the following represents the total weight of the cans in pounds?

(1) $5 \times 14 \times 16$

(2) $\frac{5 + 14}{16}$

(3) $\frac{14 \times 16}{5}$

(4) $\frac{5 \times 16}{14}$

(5) $\frac{5 \times 14}{16}$

13. What is the reading, in amperes, on the meter below?

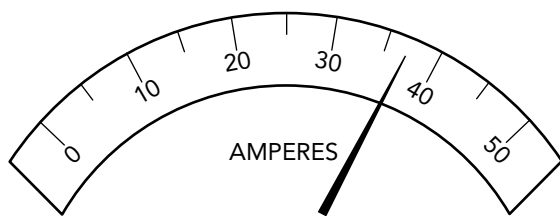
(1) 29

(2) 31

(3) 34

(4) 37

(5) 41



14. What is the reading, in volts, on the meter below?

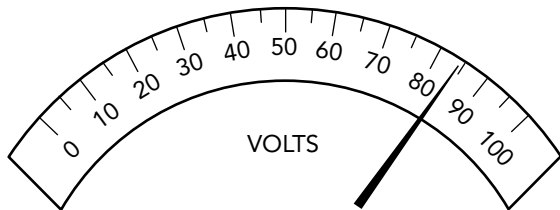
(1) 76

(2) 79

(3) 84

(4) 89

(5) 91



Answers are on page 413.

You should have gotten at least 11 problems right on this exercise. If you did not get 11 right, review your measurements skills before you go on. If you got 11 or more right, correct any problem you got wrong. Then go on to the next chapter.