

3B**Problem Solving in Chemistry****Extra Practice Problems****Problem-Solving Practice**

Here are more word problems for practice. **Dimensional analysis** provides a uniform approach to help you solve many word problems.

Example A

If a person's measured pulse rate is 72 heart beats per minute, how many times does the heart beat in 5 minutes?

Solution

Step 1. Begin setting up the problem by identifying the unknown:

$$= ? \text{ beats}$$

Step 2. Now determine the known and add it to the equation.

$$5 \text{ minutes} = ? \text{ beats}$$

Step 3. Plan a solution to the problem. In the dimensional analysis approach to problem solving, the plan always involves determining what conversion factors can be used to convert the units of the known to the units of the unknown. In this problem, the units of the known are minutes and the units of the unknown are heartbeats. The conversion factor that will convert minutes to heartbeats is heartbeats/minute. The problem gives the value of this conversion factor as 72 heartbeats/minute. The known can then be multiplied by this conversion factor and the units will cancel in such a way as to give the units of the unknown. The value of the answer is the value of the unknown.

$$5 \text{ min} \times \frac{72 \text{ beats}}{1 \text{ min}} = ? \text{ beats}$$

Step 4. Set up and solve. Note that the given unit (minutes) cancels with a unit of the conversion factor (minutes) leaving you with the desired units (beats).

$$5 \text{ min} \times \frac{72 \text{ beats}}{1 \text{ min}} = 3.6 \times 10^2 \text{ beats}$$

Step 5. Finish and check your work. Does the answer make sense? Yes, because 360 beats in 5 minutes corresponds to a rate of 72 beats/minute.

$$\frac{360 \text{ beats}}{5 \text{ min}} = \frac{72 \text{ beats}}{\text{min}}$$

Be sure that your answer is expressed in the correct number of significant figures. In this case, the answer should have two significant figures. This is because the least precise measurement in the calculation is 72 beats/minute, which has two significant figures. As you will recall, the result of a calculation can have no more significant figures than are present in the least precise measurement used in the calculation. The result (360 beats) has two significant figures and therefore is correct as it is. (Note that the known, 5 minutes, is considered an exact quantity and is therefore not considered in determining the correct number of significant figures.)

Answer (with correct number of significant figures) = 3.6×10^2

You Try It

1. The price of gasoline is 98¢ per gallon. If your car averages about 32 miles per gallon, how far can you go on \$5.00 worth of gasoline?

Example B

Now use the information from Example A to calculate how many times the heart will beat in 1 year.

Solution

Step 1. Begin by identifying the unknown:

$$= ? \text{ beats}$$

Step 2. Determine the known and add it to the equation.

$$1 \text{ yr} = ? \text{ beats}$$

Step 3. Plan a solution to the problem, using the dimensional analysis approach.

Determine the appropriate conversion factors and add them to the equation:

$$1 \text{ yr} \times \frac{365 \text{ days}}{1 \text{ yr}} \times \frac{24 \text{ hr}}{1 \text{ day}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{72 \text{ beats}}{1 \text{ min}} = ? \text{ beats}$$

Step 4. Finally, note that the given unit (years) cancels, as do days, hours, and minutes, leaving you with the desired units (beats).

$$1 \text{ yr} \times \frac{365 \text{ days}}{1 \text{ yr}} \times \frac{24 \text{ hr}}{1 \text{ day}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{72 \text{ beats}}{1 \text{ min}} = ? \text{ beats}$$

Now solve to obtain:

$$1 \text{ yr} \times \frac{365 \text{ days}}{1 \text{ yr}} \times \frac{24 \text{ hr}}{1 \text{ day}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{72 \text{ beats}}{1 \text{ min}} = 37\,843\,200 \text{ beats}$$

Step 5. Finish and check your work. Make sure that the answer is expressed in the correct number of significant figures.

Answer (rounded to correct number of significant figures) = 3.8×10^7 beats

That's almost 40 million heartbeats every year! WOW!

You Try It

2. If your car averages about 32 miles per gallon, what is its "mileage rate" in kilometers/liter? (Hint: $1.61 \text{ km} = 1 \text{ mi}$ and $0.946 \text{ L} = 1 \text{ qt}$)

Your Solution

3. The number of seconds in an 8-hour work day can be calculated as follows.

a. $60 \text{ s} \times \frac{1 \text{ min}}{60 \text{ s}} \times \frac{1 \text{ hr}}{60 \text{ min}} =$

b. $8 \text{ hrs} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{60 \text{ s}}{1 \text{ min}} =$

c. $1 \text{ s} \times \frac{1 \text{ min}}{60 \text{ s}} \times \frac{8 \text{ hr}}{60 \text{ min}} =$

d. $8 \text{ hrs} \times \frac{60 \text{ min}}{8 \text{ hrs}} \times \frac{60 \text{ s}}{60 \text{ min}} =$

4. Five kilometers are equal to how many centimeters?

a. $5.0 \times 10^{-3} \text{ cm}$ b. $5.0 \times 10^5 \text{ cm}$ c. $5.0 \times 10^{-5} \text{ cm}$ d. $1.0 \times 10^3 \text{ cm}$

5. The diameter of a sodium atom is 3.7 nanometers. What conversion factor(s) would you use to express this measurement in centimeters?

a. $\frac{1 \text{ m}}{10^9 \text{ nm}}$

c. $\frac{1 \text{ m}}{10^9 \text{ nm}} \times \frac{100 \text{ cm}}{1 \text{ m}}$

b. $\frac{10^9 \text{ nm}}{1 \text{ m}}$

d. $\frac{10^9 \text{ nm}}{1 \text{ m}} \times \frac{1 \text{ m}}{100 \text{ cm}}$

6. What is the volume of 70.0 g of ether if the density of ether is 0.70 g/mL?

a. 56 mL b. $1.0 \times 10^2 \text{ mL}$ c. $8.9 \times 10^{-3} \text{ mL}$ d. $6.0 \times 10^1 \text{ mL}$

7. The density of aluminum is 2.70 g/cm³. What is the mass of a cube of aluminum 1.00 cm on each edge?

a. 2.70 g b. 5.4 g c. 27.0 g d. 81 g

8. A conversion factor:

- a. is equal to 1.
- b. is a ratio of equivalent measurements.
- c. does not change the value of a measurement.
- d. all of the above

9. How many calories of energy are required to heat an 87 g piece of iron from 30°C to 40°C? The specific heat of iron is 0.110 cal/(g × °C).

a. 87 b. 96 c. 870 d. 975

10. On a typical day you inhale about 1×10^4 liters of air. What conversion factor would you use to express the volume in cubic centimeters?

a. $\frac{1.0 \times 10^3 \text{ cm}^3}{1 \text{ L}}$

c. $\frac{1.0 \times 10^2 \text{ cm}^3}{1 \text{ L}}$

b. $\frac{1 \text{ L}}{1.0 \times 10^3 \text{ cm}^3}$

d. $\frac{1 \text{ L}}{1.0 \times 10^2 \text{ cm}^3}$

11. A blacksmith has to put new shoes on a stable of 20 horses. Each shoe requires 3 nails. How can he calculate the number of nails he has to bring to the stable?

a. $\text{number of nails} \times \frac{4 \text{ shoes}}{3 \text{ nails}} \times \frac{1 \text{ horse}}{4 \text{ shoes}} =$

b. $\text{number of horses} \times \frac{4 \text{ shoes}}{1 \text{ horse}} \times \frac{3 \text{ nails}}{1 \text{ shoe}} =$

c. $\text{number of shoes} \times \frac{1 \text{ horse}}{4 \text{ shoes}} \times \frac{3 \text{ nails}}{1 \text{ horse}} =$

d. $\text{number of nails} \times \frac{1 \text{ shoe}}{\text{nails}} \times \frac{3 \text{ nails}}{1 \text{ shoe}} =$

Apply the techniques of **dimensional analysis** to a variety of conversion problems.

- 12 Example: What is the mass of a cube of aluminum 5.0 cm on each edge if the density of aluminum is 2.7 g/cm^3 ?

- 13 Convert measurements within the metric system.
Example: Express 145 kg in grams.

- 14 Use dimensional analysis to solve multistep problems.
Example: How many seconds are there in one week?

- 15 Solve rate conversion problems using dimensional analysis.
Example: If a car gets 30.0 miles/gallon of gasoline, how many kilometers could it travel on 1 liter of gasoline? ($1.61 \text{ km} = 1 \text{ mile}$; $1 \text{ gal} = 4 \text{ qt}$; and $1.06 \text{ qt} = 1.0 \text{ L}$)

- Find the mass, volume, or density of a substance when any two of these values are known.
Examples: 16 Given: mass = 20 g; volume = 10 mL; find density.

- 17 Given: density = 2 g/mL ; volume = 10 mL; find mass.

- 18 Given: mass = 20 g; density = 2 g/mL ; find volume.

- 19 Construct conversion factors from equivalent measurements.
Example: $1 \text{ L} = 1000 \text{ mL}$

★ Apply the techniques of **dimensional analysis** to a variety of conversion problems.

D. Additional Problems

Solve the following problems in the space provided. Show your work.

- 20 Light travels at a speed of 186 000 miles/second. How many kilometers will it travel in two hours? (1 km = 0.621 mile)

- 21 An automobile can travel 30 miles on 1 gallon of gasoline. How many kilometers per liter is this? (1.61 km = 1 mi; 1 L = 1.06 quart; 1 gallon = 4 quarts)

- 22 In 1976 an airplane was flown at a speed of 12 193 miles per hour. What was the speed in meters per second? (1 km = 0.621 mi)

- 23 Gold has sold for \$500/ounce. Considering that there are 16 ounces (or 454 grams) in a pound, how many milligrams of gold could you buy for one cent?

- 24 The density of water is 1.0 g/mL. What is the density of water in pounds/gallon? (1 quart = 9.46×10^{-1} L; 1 g = 2.20×10^{-3} lb.)

