# PROBLEM SOLVING BY DIMENSIONAL ANALYSIS

## Answers to Problems: Dimensional Analysis

**NOTE:** The following problems can be solved using relationships or conversion factors other than those shown. In some cases, alternative conversion factors are indicated.

1. Convert 3.56 g to cg.

$$? \text{cg} = 3.56 \text{g} \times \frac{100 \text{ cg}}{1 \text{ g}} = 356 \text{cg}$$

2. Convert 42.5 mL to dL.

$$? \text{dL} = 42.5 \text{mL} \times \frac{1 \text{cL}}{10 \text{ mL}} \times \frac{1 \text{dL}}{10 \text{cL}} = 0.425 \text{dL}$$

This can also be solved using the relationship 100 mL = 1 dL

3. Convert 204 dm to km.

$$? \text{km} = 204 \text{dm} \times \frac{1 \text{m}}{10 \text{ dm}} \times \frac{1 \text{km}}{1000 \text{m}} = 0.0204 \text{km}$$

4. Convert 45.4 kg to Mg.

$$? \text{Mg} = 45.4 \text{kg} \times \frac{1 \text{Mg}}{1000 \text{ kg}} = 0.0454 \text{Mg} = 4.54 \times 10^{-2} \text{Mg}$$

This can also be solved using the relationships 1000 g = 1 kg and 1 000 000 g = 1 Mg

5. Convert 2.60 cL to μL.

$$? \mu\text{L} = 2.60 \text{cL} \times \frac{10 \text{mL}}{1 \text{ cL}} \times \frac{1000 \mu\text{L}}{1 \text{mL}} = 26\,000 \mu\text{L} = 2.60 \times 10^{4} \mu\text{L}$$

This can also be solved using the relationships 100 cL = 1 L and $1 \times 10^6$ μL = 1 L

6. Convert 254 pm to nm.

$$? \text{nm} = 254 \text{pm} \times \frac{1 \text{nm}}{1000 \text{ pm}} = 0.254 \text{nm} = 2.54 \times 10^{-1} \text{nm}$$

This can also be solved using the relationships $1 \times 10^{12}$ pm = 1 m and 1 m = $1 \times 10^{9}$ nm

7. The mass of a hydrogen atom is 1.67 x $10^{-24}$ g. Express this mass in pg.

$$?\,\text{pg} = 1.67\,x10^{-24}\ \text{g x}\ \frac{1x10^{12}\text{pg}}{1\ \text{g}} = 1.67\,x10^{-12}\ \text{pg}$$

8. The diameter of a carbon atom is 182 pm. What is the diameter in a) nm b) cm c) m ?

a) $$?\,\text{nm} = 182\,\text{pm x}\ \frac{1\,\text{nm}}{1000\ \text{pm}} = 1.82\,x10^{-1}\ \text{nm}$$

This can also be solved using the relationships 1 x $10^{12}$ pm = 1 m and 1 m = 1 x $10^{9}$ nm

b) $$?\,\text{cm} = 182\,\text{pm x}\ \frac{1\,\text{nm}}{1000\ \text{pm}}\ \text{x}\ \frac{1\,\mu\text{m}}{1000\,\text{nm}}\ \text{x}\ \frac{1\,\text{mm}}{1000\,\mu\text{m}}\ \text{x}\ \frac{1\,\text{cm}}{10\,\text{mm}} = 1.82\,x10^{-8}\ \text{cm}$$

This can also be solved using the relationships 1 x $10^{12}$ pm = 1 m and 1 m = 100 cm

c) $$?\,\text{m} = 182\,\text{pm x}\ \frac{1\,\text{m}}{1\ \text{x}\ 10^{12}\ \text{pm}} = 1.82\,x10^{-10}\ \text{m}$$

9. In a gas chromatography experiment, a 5.0 µL sample of gasoline was analyzed. Express this volume in mL.

$$?\,\text{mL} = 5.0\,\mu\text{L x}\ \frac{1\,\text{mL}}{1000\ \mu\text{L}} = 5.0\,x10^{-3}\ \text{mL}$$

This can also be solved using the relationships 1 L = 1 x $10^{6}$ µL and 1 L = 1 x $10^{3}$ mL

10. The speed of light is 3.0 x $10^{10}$ cm/s. Calculate the length of a light year in a) m b) km.
(A light year is the distance light travels in one year [365 days])

$$1\ \text{light year} = \frac{?\,\text{m}}{1\,\text{year}} = \frac{3.0\ \text{x}\ 10^{10}\text{cm}}{1\text{s}}\ \text{x}\ \frac{60\,\text{s}}{1\ \text{min}}\ \text{x}\ \frac{60\text{min}}{1\text{hr}}\ \text{x}\ \frac{24\,\text{hr}}{1\text{day}}\ \text{x}\ \frac{365\,\text{days}}{1\,\text{year}}\ \text{x}\ \frac{1\text{m}}{100\,\text{cm}} = \frac{9.5\,\text{x}\,10^{15}\ \text{m}}{\text{year}}$$

Note: This set up is simplified by using the relationship that a light year will be experessed as the distance in meters that light travels in one year

11. How many dg are there in 1.0 kg of flour?

$$?\,\text{dg} = 1.0\,\text{kg} \times \frac{1000\ \text{g}}{1\,\text{kg}} \times \frac{10\,\text{dg}}{1\ \text{g}} = 1.0 \times 10^{4}\ \text{dg}$$

12. A jogger runs a km in 6.0 minutes. Calculate her speed in a) km/hr b) m/min c) cm/s.

a) $$?\frac{\text{km}}{\text{hr}} = \frac{1.0\,\text{km}}{6.0\,\text{min}} \times \frac{60\ \text{min}}{1\,\text{hr}} = \frac{10\,\text{km}}{\text{hr}}$$

b) $$?\frac{\text{m}}{\text{min}} = \frac{1.0\,\text{km}}{6.0\,\text{min}} \times \frac{1000\ \text{m}}{1\,\text{km}} = \frac{167\,\text{m}}{\text{min}} = 170\,\text{m/min}$$ (2 significan figures)

c) $$?\frac{\text{cm}}{\text{s}} = \frac{1.0\,\text{km}}{6.0\,\text{min}} \times \frac{1000\ \text{m}}{1\,\text{km}} \times \frac{100\,\text{cm}}{1\,\text{m}} \times \frac{1\,\text{min}}{60\,\text{s}} = \frac{278\,\text{cm}}{\text{s}} = 280\,\text{cm/s}$$

(2 significan figures)