

PROBLEM SOLVING IN CHEMISTRY

I. Techniques

A. Steps for success

- 1) identify unknown (read carefully)
- 2) identify known (read carefully)
- 3) plan solution
- 4) calculate
- 5) check (sig. figs., units, and math)

B. **conversion factor**—a ratio of two equivalent measurements

$$(\text{SMALL \#}) (\text{LARGE UNIT}) = (\text{LARGE \#}) (\text{SMALL UNIT})$$

$$1 \quad \text{foot} \quad = \quad 12 \quad \text{inches}$$

$$1 \quad \text{century} \quad = \quad 100 \quad \text{years}$$

Conversion factors that are exact are an infinite number of sig. figs. (do not limit the sig. figs.)

C. *dimensional analysis*

- 1) also known as the *factor unit* and *factor label* methods
- 2) using the units (dimensions) to solve problems
- 3) using dimensional analysis:

“Play checkers” with the units, moving them diagonally, canceling when appropriate. All units should cancel except those of the desired answer.

II. Examples

PROBLEM 1: How many seconds are in exactly one century?

$$1 \text{ century} \times \frac{100 \text{ yrs.}}{1 \text{ century}} \times \frac{365.25 \text{ days}}{1 \text{ yr.}} \times \frac{24 \text{ hrs.}}{1 \text{ day}} \times \frac{60 \text{ min.}}{1 \text{ hour}} \times \frac{60 \text{ sec.}}{1 \text{ min.}} = \boxed{3\,155\,760\,000 \text{ sec.}} (\infty \text{ s.f.})$$

PROBLEM 2: Convert 0.760 cm to km using dimensional analysis.

$$0.760 \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1 \text{ km}}{1000 \text{ m}} = \boxed{0.000\,007\,60 \text{ km}} (3 \text{ s.f.})$$

PROBLEM 3: Convert a density of 3.641 kg/m³ to g/cm³.

Since two different parts of the density unit have to be changed, focus on one at a time. Also, 100 cm = 1 m, so 100³ cm³ or (10²)³ = 1³ m³ which is 1 m³.

$$\frac{3.641 \text{ kg}}{\text{m}^3} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ m}^3}{(10^2)^3 \text{ cm}^3} = \boxed{0.003\,641 \text{ g/cm}^3} (4 \text{ s.f.})$$

III. Some Important Conversion Factors

LENGTH:

1 inch = 2.54 cm *exactly*

(This is the only exact English to metric conversion factor. The rest are approximations and are accurate to the number of sig. figs. shown.)

1 m = 1.094 yd

0.914 m = 1 yd

1 m = 1.06×10^{-16} light year

1.61 km = 1 mi.

1 km = 0.625 mi

5280 ft. = 1 mi.

MASS and WEIGHT:

1 lb = 454 grams = 0.454 kg

1 kg = 2.2 lb

28.4 g = 1 oz.

VOLUME:

1 cm³ = 1 mL

1 m³ = 1 L

4 qt. = 1 gal

1 liter = 1.06 qt.

1 qt. = 0.946 liters = 946 mL

20 drops = 1 mL

TIME:

365.25 days = 1 yr.

100 years = 1 century

1000 years = 1 millennium

ENERGY: *J = Joule, Nm = Newton-meter, cal = calorie*

1.0 J = 1.00 Nm = 0.239 cal

4.184 J = 1 cal

QUANTITY:

6.023×10^{23} = 1 mole

PRESSURE: *atm = atmosphere, Hg = mercury, Pa = pascal*

1.00 atm = 760 mm Hg 760 torr = 1.013×10^5 Pa = 14.7 psi = 14.7 lb/in² = 29.9 in. Hg

FREQUENCY: *Hz = Hertz*

1/s = cps = cycles/sec = Hz

FORCE: *N = Newton*

1 N = 1 kg m/s²