The Mole

What is a Mole?

- A mole is the amount of pure substance containing the same number of chemical units as there are atoms in exactly 12 grams of carbon-12

$$6.02 \times 10^{23}$$

Avogadro's Number

- This involves the acceptance of two dictates
  - the scale of atomic masses
  - the magnitude of the gram
  - (Both have been established by international agreement)
- Current usage tends to apply the term "mole" to an amount containing Avogadro's number of whatever units are being considered.

Molar Mass

- A sample of any element with a mass equal to that element's atomic weight (in grams) will contain precisely one mole of atoms (6.02×10^{23} atoms).
  - For example, helium has a relative atomic mass of 4.0. Therefore, the mass of one mole of helium atoms (molar mass) will be 4.0 g mol^{-1}.

Mole Conversions

- Moles to Mass
  - What is the mass of 4.0 mol of He?

$$4.0\ mol \times \frac{4.00\ g}{1\ mol} = 16.0\ g$$

- Mass to Moles
  - How many moles of CH_4 are in 38.0 g?

$$38.0\ g \times \frac{1\ mol}{16.04\ g} = 2.4\ mol$$

- Moles to Particles
  - How many molecules of H_2O are in 2.5 moles?

$$2.5\ mol \times \frac{6.02 \times 10^{23}}{1\ mol} = 1.51 \times 10^{24}$$

- Particles to Moles
  - How many moles are in 1.2×10^{23} atoms of Na?

$$1.2 \times 10^{23} \times \frac{1\ mol}{6.02 \times 10^{23}} = 0.2\ mol$$

- Mass to Particles
  - How many molecules of CH_3OH are in 56.0 g?

Mass to Moles

$$56.0\ g \times \frac{1\ mol}{32.04\ g} = 1.75\ mol$$

Moles to Particles

$$1.75\ mol \times \frac{6.02 \times 10^{23}}{1\ mol} = 1.05 \times 10^{24}$$

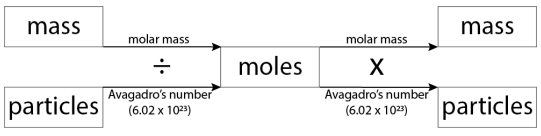
- Particles to Mass
  - What is the mass of 2.5×10^{24} molecules of NaCl?

Particles to Moles

$$2.5 \times 10^{24} \times \frac{1\ mol}{6.02 \times 10^{23}} = 4.15\ mol$$

Moles to Mass

$$4.15\ mol \times \frac{58.5\ g}{1\ mol} = 242.78\ g$$



$$\frac{\text{mass}}{\text{moles}} = \frac{\text{molar mass}}{1\ \text{mol}}$$

$$\frac{\text{particles}}{\text{moles}} = \frac{6.02 \times 10^{23}}{1\ \text{mol}}$$