# Chapter 6: Chemical Quantities

## Measuring matter

- A mass
- A volume
- A count

## Count

- One dozen = 12
- One mole = Avogadro's number of items
- Avogadro's number = $6.022 \times 10^{23}$

# Molar Mass - the mass of one mole of a substance

Determine the molar mass of the following substances.

1. Carbon $C = 12.011$ g/mol

2. Iron $Fe = 55.847$ g/mol

3. water $H_2O$

| | |
|---|---|
| 2(H) | 2(1.007 94 g/mol) |
| 1(O) | 1(15.9994 g/mol) |
| | 18.015 28 g/mol |

4. ammonium carbonate $(NH_4)_2CO_3$

| | |
|---|---|
| 2(N) | 2(14.0067 g/mol) |
| 8(H) | 8(1.007 94 g/mol) |
| 1(C) | 1(12.011 g/mol) |
| 3(O) | 3(15.9994 g/mol) |
| | 96.086 12 = 96.086 g/mol |

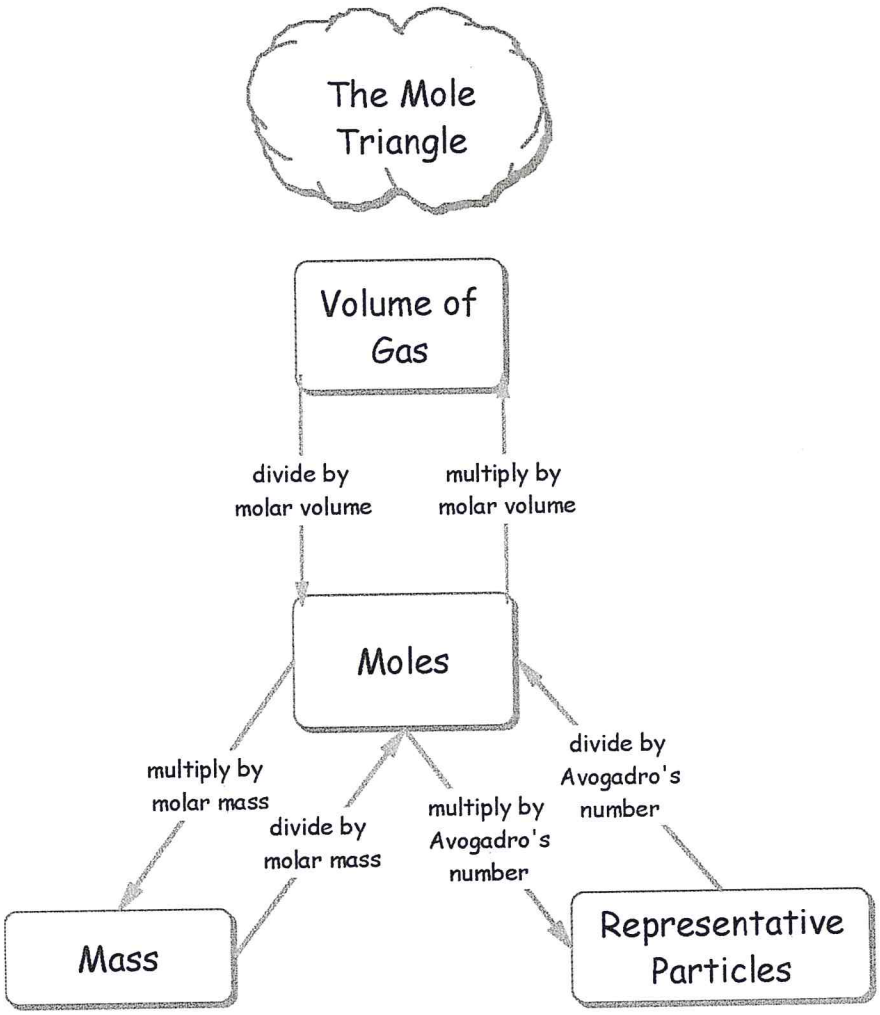
# Converting between moles and mass.

$$moles = \frac{mass}{molar\ mass} \qquad or \qquad mass = (moles)(molar\ mass)$$

Example: What is the mass of 5.00 mol of water?

Mass = (moles)(molar mass)
= (5.00 mol)(18.105 28 g/mol)
= 90.0764
= **90.1 g/mol**

# The Mole Triangle




$$mol = \frac{mass}{molar\ mass}$$

$$mol = \frac{volume\ of\ gas}{molar\ volume}$$

$$mol = \frac{representative\ particles}{Avogadro's\ Number}$$

# Mole Calculations

1. Determine the molar mass of the following compounds:
   a. Nitrogen monoxide
   b. Ammonia
   c. Ammonium phosphate
   d. Aluminum nitrate
   e. Tin(II) oxalate
   f. Calcium hydroxide
   g. Ferric chloride
   h. Silver nitrate
   i. Magnesium glutamate
2. Calculate the mass of the following:
   a. 1.00 mol of ammonium chloride
   b. 3.50 mol of phosphorus trichloride
   c. $1.70 \times 10^{-24}$ mol of iron
   d. $3.25 \times 10^{2}$ mol of sodium hydrogen phosphate
   e. 0.0035 mol of ammonia
   f. 4.50 mol of carbon dioxide
   g. $1.00 \times 10^{-3}$ mol of sodium hydroxide
   h. 2.65 mol of plumbic nitrate
   i. $7.91 \times 10^{-4}$ mol of sulfurous acid
   j. 0.0125 mol of sodium tartrate
3. How many moles of the following substances are contained in:
   a. 17.0 g of sulfuric acid
   b. $4.00 \times 10^{12}$ molecules of ferric oxide
   c. 91.0 g of water
   d. 175 mL of chlorine gas at STP
   e. $5.50 \times 10^{25}$ molecules of carbon tetrachloride
   f. 10.6 L of sulfur dioxide gas at STP
   g. 0.120 L of nitrogen dioxide gas at STP
   h. 53.0 g of carbon
   i. $7.50 \times 10^{21}$ molecules of nitric acid
   j. 25.0 mL of nitrogen gas at STP
4. Calculate the mass, in grams, of:
   a. $2.00 \times 10^{6}$ molecules of carbon monoxide
   b. 1.25 L of ammonia gas at STP
   c. 5.00 molecules of nitrogen gas
   d. $3.41 \times 10^{20}$ atoms of silver
   e. $5.50 \times 10^{-6}$ mol of water
   f. $4.15 \times 10^{15}$ molecules of dinitrogen tetroxide
   g. 1 atom of gold
   h. 7 molecules of nitrogen
   i. 3.47 mL of oxygen gas at STP
   j. 20 atoms of helium
   k. $1.00 \times 10^{8}$ L of hydrogen at STP
   l. 5.91 mol of potassium oxalite
5. Determine the number of atoms contained in:
   a. 1.00 mol of ammonium chloride
   b. 8.00 g of iron
   c. 12.0 g of hydrogen peroxide
   d. 55.0 mL of dinitrogen monoxide at STP
   e. 5.00 g of sodium chloride
   f. $8.30 \times 10^{-4}$ mL of boron trifluoride at STP
   g. 2.50 mol of oxygen
   h. 15.0 L of argon at STP
   i. 40.0 g of potassium
   j. 100.0 g of ammonium citrate
   k. 15.0 g of potassium dichromate
6. Calculate the volume at STP occupied by the following gases:
   a. 0.235 mol of ozone
   b. 16.5 g of sulfur dioxide
   c. 28.4 mg of hydrogen telluride
   d. $8.65 \times 10^{21}$ molecules of hydrogen chloride
   e. 9.36 mol of helium
   f. $6.98 \times 10^{15}$ atoms of xenon
   g. $5.65 \times 10^{22}$ molecules of ammonia
   h. 15.7 g of chlorine
7. Calculate the percentage composition of each of the elements in the compounds below:
   a. Potassium nitrite
   b. Ammonium sulfate
   c. Calcium phosphate
   d. Ammonium carbonate
   e. Aluminum nitrate
   f. Calcium acetate
8. Determine the empirical formula for each compound listed below:
   a. 80.0% carbon; 20.0% hydrogen
   b. 35.0% nitrogen; 5.0% hydrogen; 60.0% oxygen
   c. 83.7% carbon; 16.3% hydrogen
   d. 26.6% potassium; 35.4% chromium; 38.0% oxygen
   e. Chemical analysis of a 10.000 g sample of oil of wintergreen shows that it consists of 6.320 g of carbon, 0.530 g of hydrogen, and 3.16 g of oxygen. What is the simplest formula for oil of wintergreen?
   f. A rock sample weighing $5.88 \times 10^{-4}$ g is known to contain calcium, phosphorus, and oxygen. The amount of the first two elements in this rock is found to be $2.28 \times 10^{-4}$ g and $1.18 \times 10^{-4}$ g respectively. What is the empirical formula for the compound in this rock sample?
9. Calculate the molecular formula for the following compounds.
   a. 26.7% carbon; 2.2% hydrogen; 71.1 % oxygen; molar mass = 90.0 g/mol
   b. 54.6% carbon; 9.0% hydrogen; 36.4% oxygen; molar mass = 176 g/mol
   c. Analysis of a compound shows that it consists of 24.3% carbon, 4.1% hydrogen, and 71.6% chlorine. The molecular mass of the compound is determined to be 99.8 g/mol. What molecular formula corresponds to these data?
   d. Chemical analysis of a gaseous compound show its composition to be 36.4% carbon, 57.5% fluorine, and 6.1% hydrogen. A sample of 1.00 L of this gas has a mass of 2,96 g. What molecular formula do these data suggest for this compound?
   e. Analysis of an organic compound indicates that it has a percentage composition as follows: 40.7% carbon; 5.0% hydrogen; 54.3% oxygen. When this compound is vapourized, 35.0 mL of the vapour has a mass of 0.184 g. Determine the molecular formula for this compound.
   f. A gaseous compound is found to have the following composition: 30,5% nitrogen and 69.5% oxygen. The molar mass of the gas if found to be 91.8 g/mol. What is the molecular formula of this gas?