Warm up

Name each of the following:

1) PS_2 2) $CaCl_2$ 3)N_2O_4

4) H_2SO_4 5) $Ca(OH)_2$

Avogadro's Number

6.0221409×10^{23}

typically we only use 3 sig figs (6.02×10^{23})

This number is how many things are in a mole (commonly abbreviated mol)

Think of a mol like a dozen.....

If you have 4 dozen eggs, then you have 48 eggs because 4 x 12 is 48.

If you have 4 mols of eggs, then you have 2.41×10^{24} eggs ($4 \times 6.02 \times 10^{23}$)which equals 2,410,000,000,000,000,000,000,000 eggs, also known as 2,410 sextillion eggs.

With the world annual production of eggs being around 1.1 trillion (progressive-economy.org), that means that it would take over 2 trillion years to produce 4 mols of eggs.

So why do we have a number that seems unreachable?

In macroscopic terms, a mol is unrealistic, even in microscopic it is too large of a number, but in nanoscopic, it is very much appropriate.

One atom of Carbon has a mass of 12 amu (atomic mass units), one mol of Carbon has a mass of 12 grams.

When we are dealing with elements, compounds, ions, etc, we need lots and lots of them in order to be able to measure their mass and volume, hence we do not deal in individual molecule, but instead in mols of molecules.

If you have 24 grams of water, how many mols of water is there?

$$\text{molar mass } 18.0\ g/mol = \frac{24\ g}{18.0\ g/mol} = 1.3\ mol$$

How many molecules of water?

$$(1.3\ mol)\left(6.02\times10^{23}\ \frac{\text{molecule}}{mol}\right) = 7.8\times10^{23}\ \text{molecule}$$

How many total atoms?

$$(7.8\times10^{23}\ \text{molecules})\left(3\ \frac{\text{atoms}}{\text{molecule}}\right)$$

How many atoms of hydrogen?

Percent mass

It is often important to be able to determine the percent mass of individual atoms in molecules.

H_2O

In order to do this, first determine the ***molar mass*** of the species. 18.0 g/mol

Then determine the molar mass of each element and multiply this by how many there are of each. Hydrogen $2(1.01\ g/mol) = 2.02\ g/mol$

Finally, take this number and divide it by the total molar mass of the species.

$$11.2\% = \frac{2.02\ g/mol}{18.0\ g/mol}$$

Example:

Determine what percent (by mass) of H_2SO_4 is Oxygen.

Determine the molar mass of each of the following and then determine the percent mass of each element. Finally, determine how many mols of each compound you have if you have 25.4g (of each).

1) CO_2 2) CH_4 3) sulfur dioxide

4) potassium sulfate 5) C_2H_6O

1) 44.0 g/mol

27.3 % C

72.7% O

25.4 g = 0.577 mols

2) 16.0 g/mol

25.0% H

75.0% C

25.4 g = 1.59 mol

3) SO_2

64.1 g/mol

50.1% S

49.9% O

25.4 g = 0.396 mol

4) K_2SO_4

174.3 g/mol

44.9% K

18.4% S

36.7% O

25.4 g = 0.146 mol

5) Ethanol (C_2H_6O)

46.1 g/mol

52.1% C

13.1% H

34.7% O

25.4 g = 0.551 mol

find molar mass of N_2O_5

$2(14.0\ g/mol) + 5(16.0\ g/mol)$

$28.0\ g/mol + 80.0\ g/mol = 108.0\ g/mol$