Calculating # moles using molar mass

examples

1) How many moles of fluorine atoms are present in 3.8g of fluorine?

$3.8\text{ g F} \times \frac{1\text{ mol F}}{19.00\text{ g F}} = 0.2\text{ mol F}$

2) a) How many moles of CO_2 are in 100.0 g of CO_2?

12.01 + 16.00 × 2 = 44.01 g

$100.0\text{ g } CO_2 \times \frac{1\text{ mol } CO_2}{44.01\text{ g } CO_2} = 2.272\text{ mol } CO_2$

4 sig figs

100 ⇒ 1 sig fig

10. 0.10

b) How many molecules of CO_2 are in 100.0 g of CO_2?

$100.0\text{ g } CO_2 \times \frac{1\text{ mol } CO_2}{44.01\text{ g } CO_2} \times \frac{6.02\times10^{23}\text{ molecules of } CO_2}{1\text{ mol } CO_2} = 1.368\times10^{24}\text{ molecules } CO_2$

c) How many atoms of oxygen are in 100.0 g of CO_2?

$100.0\text{ g } CO_2 \times \frac{1\text{ mol } CO_2}{44.01\text{ g } CO_2} \times \frac{6.02\times10^{23}\text{ molecules } CO_2}{1\text{ mol } CO_2} \times \frac{2\text{ atoms Oxy.}}{1\text{ molecule } CO_2}$

2.736×10^{24} atoms oxygen

Challenge: Watering of a Ficus

1.5 L of water ⟶ molecules of water, atoms of hydrogen

We know: water → density = 1 g/ml

molar mass of water H_2O

$2(1.01) + 16.00 = 18.02$ g/mol

1 mol = 6.02×10^{23} particles

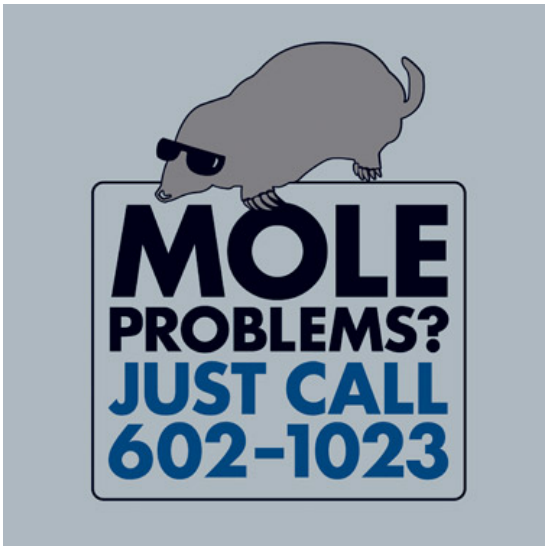
a) $1.5\text{ L } H_2O \times \frac{1000\text{ ml } H_2O}{1\text{ L } H_2O} \times \frac{1\text{ g } H_2O}{1\text{ ml } H_2O} \times \frac{1\text{ mol } H_2O}{18.02\text{ g } H_2O} \times \frac{6.02\times10^{23}\text{ molecules } H_2O}{1\text{ mol } H_2O}$

$= 5.01\times10^{25}$ molecules of H_2O

5 010 000 000 000 000 000 000 000 molecules of H_2O

b) $5.01\times10^{25}\text{ molecules } H_2O \times \frac{2\text{ atoms hydrogen}}{1\text{ molecule } H_2O} = 1.00\times10^{26}$ atoms of hydrogen

compound	# mols	# molecules	# atoms	molar mass (g/mol)
HCl	1	6.02×10^{23}	2 (6.02×10^{23})	1.01 + 35.45 = 36.46
K	1	-----	6.02×10^{23}	39.10
NaOH	1	6.02×10^{23}	3 (6.02×10^{23})	22.99 + 16.00 + 1.01 = 40.00
H_3PO_4	1	6.02×10^{23}	8 (6.02×10^{23})	3(1.01) + 30.97 + 4(16.00) = 98.00
$Mg(OH)_2$	1	6.02×10^{23}	5 (6.02×10^{23})	24.31 + 2(16.00) + 2(1.01) = 58.33



or contact Nancy Turriff during her office hours (Fridays, 3-4 PM)

Molar concentration

- mol/L aka M (molarity)
- solution problems are like "regular" problems but with one extra step (using moles)

examples:

A) Finding mass and volume

1. How much solute is needed to make 500.0ml of a 6.0mol/L KCl solution?

$$500.0\,\text{mL} \times \frac{6.0\,\text{mol KCl}}{1000\,\text{mL}} \times \frac{74.55\,\text{g KCl}}{1\,\text{mol KCl}} = 223.65\,\text{g} \rightarrow 223.7\,\text{g}$$

2. What volume of solution will be made if 23.0 g of NaCl are used to prepare a 1.0M solution?

$$23.0\,\text{g NaCl} \times \frac{1\,\text{mol NaCl}}{58.44\,\text{g NaCl}} \times \frac{1000\,\text{mL}}{1.0\,\text{mol NaCl}} = 393.566\,\text{mL} \rightarrow 394\,\text{mL}$$

B) Finding Molarity (These problems take 2 steps.)

1. What is the molar concentration of 4.0L of sodium hydroxide (NaOH) solution that is made of 120g of NaOH?

① $120\,\text{g NaOH} \times \frac{1\,\text{mol}}{40.00\,\text{g NaOH}} = 3\,\text{mol NaOH}$

② $\frac{3\,\text{mol NaOH}}{4.0\,\text{L}} : \frac{x\,\text{mol NaOH}}{1\,\text{L}} = 0.75\,\text{mol/L}$ or $0.75\,\text{M}$

more examples: molar concentration

3. What mass of solute is required to make 200.0mL of HCl at a concentration of 2.00mol/L?

$$200.0\,\text{mL HCl} \times \frac{2.00\,\text{mol}}{1000\,\text{mL}} \times \frac{36.46\,\text{g HCl}}{1\,\text{mol HCl}} = 14.584\,\text{g HCl} \rightarrow 14.58\,\text{g HCl}$$

4. What is the molar concentration of 500.0mL of an NaCl solution prepared with 232g of NaCl?

① $232\,\text{g NaCl} \times \frac{1\,\text{mol NaCl}}{58.44\,\text{g NaCl}} = 3.97\,\text{mol NaCl}$

② $\frac{3.97\,\text{mol NaCl}}{500.0\,\text{mL}} : \frac{x\,\text{mol NaCl}}{1000\,\text{mL}} \rightarrow 7.94\,\text{mol/L}$ or $7.94\,\text{M}$

Making a Solution

#1) How would you prepare 250.0mL of a 3.6M solution of NaF?

1) Calculate mass of NaF needed.

2) Mass 38g of NaF

3) Put solute in a 250mL flask

4) Fill bulb of flask half-way up with water

5) Swirl to dissolve solute

6) Add water up to 250mL mark

7) Mix

#2) How would you prepare 5.0L of a 2.0M solution of $MgSO_4$?

1) Calculate mass of $MgSO_4$ needed.

2) ⟶7) as above

STOICHIOMETRY

- The study of the ratio of quantities of substances involved in chemical reactions.
- Possible because coefficients of balanced equations establish ratios of quantities (molecules or moles) between reactants and products.

ex. $2H_2 + O_2 \longrightarrow 2H_2O$

Steps involved in stoichiometry problems

1) BALANCE EQUATION
2) Write down what is GIVEN and what is UNKNOWN
3) find MOLAR MASS of molecules involved
4) find MOLAR RATIO between 2 elements/molecules involved

How to ..... Stoichiometry

Remember steps: 1) balance
2) given/unknown
3) molar mass
4) mole ratio

1) If 60.0g of propane (C_3H_8) is burned in a stove, carbon dioxide (CO_2) and water (H_2O) are produced as shown in the balanced equation below:

$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

What mass of CO_2 will be released into the environment?

2) Burning ethane (C_2H_6) in air containig oxygen (O_2) produces carbon dioxide (CO_2) and water (H_2O). You are to produce 32 moles of CO_2. What mass of oxygen is required?

3) Sodium iodide (NaI) reacts with a solution of lead nitrate ($Pb(NO_3)_2$) to form a lead iodide precipitate (PbI_2) and a solution of sodium nitrate ($NaNO_3$). When a scientist adds 37.5g of NaI to enough $Pb(NO_3)_2$ solution, all of the NaI reacts. What is the mass of the PbI_2 formed?

The equation representing the reaction is:

$$2\ NaI + Pb(NO_3)_2 \longrightarrow PbI_2 + 2\ NaNO_3$$

4) The following equation describes the oxidation of iron:

$$Fe_{(s)} + O_{2(g)} \longrightarrow Fe_2O_{3(s)}$$

How many molecules of Fe_2O_3 are formed by the complete oxidation of 112g of Fe?

5) Use the following balanced equation to determine what mass of nitric acid (HNO_3) is necessary to obtain 6 moles of water.

$$3Ag_{(S)} + 4HNO_{3(aq)} \longrightarrow 3AgNO_{3(aq)} + NO(g) + 2H_2O$$