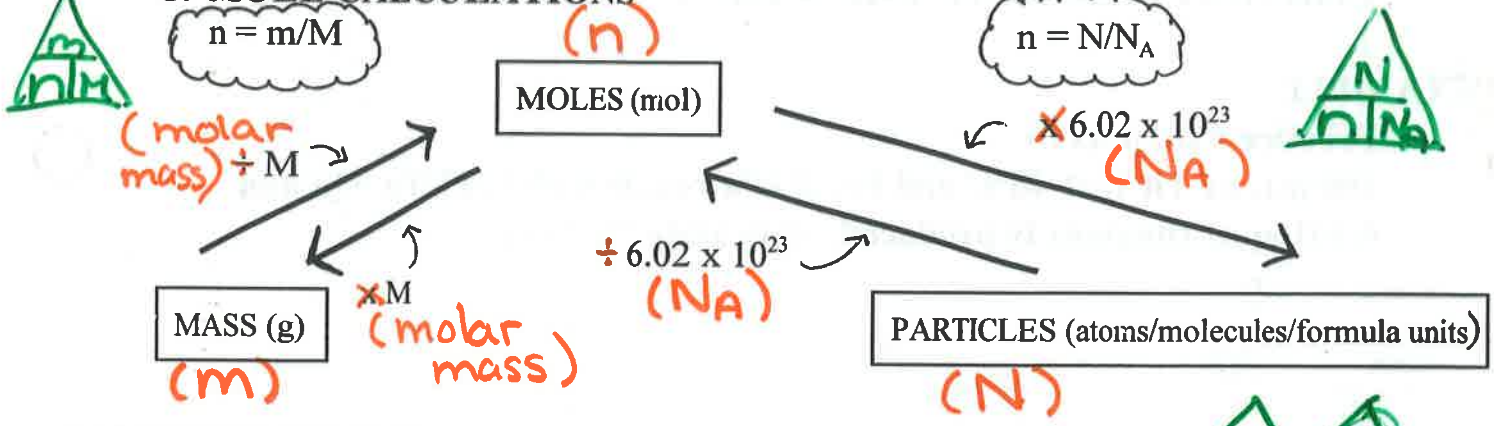
C. MOLE CALCULATIONS



SAMPLE PROBLEMS

1. What is the mass of 2.734×10^{24} formula units of Cu3(PO4)2 ?

$N \rightarrow n \rightarrow m$

$N = 2.734 \times 10^{24}$

$M = 3(Cu) + 2(P) + 8(O) = 380.59\ g/mol$

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

1st $n = \frac{N}{N_A} = \frac{2.734 \times 10^{24}}{6.02 \times 10^{23}} = 4.54\ mol$

2nd $m = n \times M = 4.54\ mol \times \frac{380.59\ g}{mol} = 1728\ g$

Practice #10 (p. xxvii) How many moles of iron(III)acetate have a mass of 1.36×10^3 g?

$Fe(C_2H_3O_2)_3 \Rightarrow 232.85\ g/mol$

$m \rightarrow n$

$n = \frac{m}{M} = 1.36 \times 10^3\ g \times \frac{1\ mol}{232.85\ g} = 5.84\ mol$

3. Practice #13 (p.xxvii) A 5 g sample is 88.4% zinc hydroxide. How many atoms of ~~zinc~~ Oxygen are in the sample?

$Zn(OH)_2$

(1.) $m = 5\ g \times 88.4\% = 4.42\ g\ Zn(OH)_2$

(2) $n = \frac{m}{M} = \frac{4.42\ g}{99.4\ g/mol} = 0.0445\ mol$

(3) $N = n \times N_A = 0.0445\ mol \times 6.02 \times 10^{23}\ \frac{molecules}{mol} = 2.68 \times 10^{22}$ molecules of $Zn(OH)_2$

(4) $2.68 \times 10^{22}\ molecules \times \frac{2\ atoms}{molecule} = 5.36 \times 10^{22}$ atoms

Do Practice Problems p. xxvii #9, 11, 12, 14 - 16

REVIEW D. CONCENTRATION CALCULATIONS

See Table on page xxvii

$n = C \times V$ or $C = \frac{n}{V}$

- for solutions and mole calculations

$C_1V_1 = C_2V_2$

initial mol/L (concentration) ; volume (initial) (L)

- for dilutions

EXAMPLES

1. What volume of 0.0259 mol/L iron(III)nitrate can be prepared from 30 g $Fe(NO_3)_3 \cdot 9H_2O$?

Given: $C = 0.0259$ mol/L, $m = 30$ g

i) Molar mass:

1 Fe, 3 N, (9+9) O = 18 O, 18 H → 403.97 g/mol

ii) Moles:

$n = \frac{m}{M} = \frac{30g}{403.97 g/mol}$ or $n = 30g \times \frac{1 mol}{403.97g} = 0.07426$ mol

iii) Volume:

$V = \frac{n}{C} = \frac{0.07426 mol}{0.0259 mol/L} = 2.87 L$ or $V = 0.07426 mol \times \frac{1 L}{0.0259 mol} = 2.87 L$

2. Practice #17, p. xxviii

$C_1 = 1$ mol/L, $C_2 = 0.655$ mol/L

$V_1 = ?$, $V_2 = 2$ L

$C_1V_1 = C_2V_2$

$1 \frac{mol}{L}(V_1) = (0.655 \frac{mol}{L})(2L) \times \frac{1 L}{mol}$

$V_1 = 1.31$ L

Homework: p.xxviii Practice # 18 - 25

E. STOICHIOMETRY

- using mole ratio

STP = 25°C + 101.3 kPa

1 mol of gas @ STP = 22.4 L

STEPS:

1. Balanced Equation
2. Convert amount to moles
3. Use mole ratio to determine required number of moles
4. Convert to appropriate (required) unit

$n = \frac{N}{N_A}$

FORMULAS:

$n = \frac{m}{M}$ $\qquad$ $PV = nRT$ $\qquad$ $n = C \times V$

(P: kPa; V: L; n: mol; R: 8.314; T: K = °C + 273)

EXAMPLES:

1. Chlorine gas plus sulfur produces disulfur dichloride. How many atoms of sulfur react to produce 50 g of disulfur dichoride?

i) $Cl_2 + 2S \rightarrow S_2Cl_2$ $\quad$ Eqn

ii) ? atoms $\quad$ 50 g $\quad$ Given/Requid

$n = \frac{m}{M}$ $\quad$ Calculations to moles

$= \frac{50\,g}{135.02\,g/mol}$ $\quad$ 2S, 2Cl } 135.02

$= 0.37\,mol$

iii) 0.74 mol ← ÷1 × 2 (2 : 1)

iv) ∴ $0.74\,mol \times \frac{6.02 \times 10^{23}\,atoms}{mol}$ $\quad$ $N = n \times N_A$

$= 4.46 \times 10^{23}$ atoms of S

F. LIMITING REACTANT AND % YIELD

EXAMPLE

1. Practice #28, p. xxxii
300 mL of $TiCl_4$ at 48^{0}C and 105.3 kPa reacts with 0.4320g Mg and 0.4016g of titanium is produced. Calculate % yield.

$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$

V = 300 mL = .3 L   m = 0.4320 g   → 0.4016 g Actual Yield

T = 48°C = 48 + 273 = 321 K

P = 105.3 kPa

$PV = nRT$ $n = \frac{m}{M}$

$n = \frac{PV}{RT}$ $= \frac{0.4320g}{24.31 g/mol}$

$= \frac{(105.3)(.3)}{(8.314)(321)}$ $= 0.0178 mol$

$= 0.012 mol$ $\div 2$

$\div 1$ $= 0.00889 mol \Leftarrow LR$

Ratio 1 : 2

TY = 0.00889 mol × 47.87 g/mol
= 0.4256 g Ti

$\%Y = \frac{AY}{TY} \times 100 = \frac{0.4016}{0.4256} \times 100 =$

Homework: p. xxxii Practice # 26, 27, #29 - 36