1 Moles + Calculations

Date No.

Avogadro

→ constant = 6.02×10^{23} atoms per mole

$$\text{Moles} = \frac{\text{mass (g)}}{\text{RFM/RAM}}$$

Relative Atomic Mass (RAM)

→ Average mass of all isotopes of an element compared to $\frac{1}{12}$ the mass of a C_{12} atom

Relative Molecular Mass (RMM)

→ mass of all atoms in a molecule compared to 1/12 the mass of C_{12} atom

Ionic Equations

E.g → $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

$Ag^+ NO_3^- + Na^+ Cl^- \rightarrow AgCl(s) + Na^+ + NO_3^-$

Cancel out ions that stay ions on RHS + LHS

$\therefore Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl(s)$

Empirical Formula

E.g 50g of a compound contains 22.4g of K, 9.2 of S and the remaining oxygen. Find the ~~remaining~~ empirical formula

$50 - 22.4 - 9.2 = 18.4$

K	S	O
22.4g	9.2g	18.4g
39	32	16
0.574	0.287	1.15

÷ all by smallest number

≈ 2 : 1 : 4

Hence the formula is K_2SO_4

Atom economy

$$\frac{\text{Desired Product Mass}}{\text{Total Products mass}} \times 100\%$$

Yield

$$\frac{\text{Mass of products}}{\text{max theoretical mass}} \times 100\%$$

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Limiting Reagents → reagent not in excess

~~2SO₂~~ + E.g In making Ti, what mass of Ti can be formed when 1kg of $TiCl_4$ reacts with 0.1kg of Mg

$\frac{100g}{24.3} = 4.115$

$TiCl_4(s) + 2Mg(s) \rightarrow Ti(s) + 2MgCl_2(s)$

$\frac{1000g}{189.9} = 5.266$

From this we can see that half of Mg moles ($\frac{2}{4.057}$) is less than 1 mole of Ti. Hence Mg is limiting reagent

$\therefore \frac{4.115}{2} \times 189.9 = 390.8$

$= 400$ 98.6g

Ideal Gas Equation

Avogadros Law → $V \propto n$

Boyle's → $V \propto \frac{1}{P}$

Charles → $V \propto T$

$\Rightarrow PV = nRT$ (P: Pressure, n: moles, V: volume, R: 8.31, T: Temp)

$P = Pa$

$V = m^3$

n = moles

$R = 8.31$

$T = K$

Assumptions

1) Gas molecules do not interact with each other

2) $V \neq 0$

$PV = nRT$ but $R = \frac{m}{Mr}$

$n = \frac{Mass}{Mr}$

$n = \frac{PV}{RT}$

$PV = \frac{mRT}{Mr}$

$\frac{m}{Mr} = \frac{PV}{RT}$

$Mr = \frac{mRT}{PV}$

$Mr = \frac{density(g/m^3) \times R \times T}{P}$

Changing the conditions (divide $PV = nRT$ by factor that is changing & isolate changes on LHS)

$PV = nRT$ → lets say that pressure is changed. However, n, R, T are constant. $\therefore P_1V_1 = P_2V_2$

$PV = nRT$ → lets say that temperature is changed, $\therefore \frac{PV}{T} = nR$ hence $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{V}{T} = \frac{nR}{P}$ ← constants

$PV = nRT$ → lets say that volume is changed, $\therefore \frac{P}{V} = \frac{nRT}{V}$ $\therefore \frac{P_1}{T_1} = \frac{P_2}{T_2}$

$\frac{P}{T} = \frac{nR}{V}$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

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Back Titration

e.g What % of limestone is $CaCO_3$? 1g sample reacts with 100cm^3 0.2 mol/dm^3 HCl. Excess HCl required 24.8 cm^3 of 0.100 mol/dm^3 of NaOH to be neutralised

$CaCO_3 + 2HCl \rightarrow CO_2 + H_2O + CaCl$ $\quad$ $HCl + NaOH \rightarrow NaCl + H_2O$

~~120cm^3 × 0~~ 0.1dm^3 × 0.2 mol/dm^3 = 0.02 moles of HCl total

0.0248 × 0.1 mol/dm^3 = 0.00248 moles of NaOH and HCl used in neutralisation

∴ 0.02 mol − 0.00248 mol = 0.01752 mol of HCl reacted with $CaCO_3$

$\frac{0.01752}{2} \times (40+48+12) = 0.876g$ of $CaCO_3$

$\frac{0.867}{1.000} \times 100\% = 86.7\%$

Practise Questions [Calculations Allsorts]

3) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

$\frac{1000g}{56+48} = 9.62$ moles × 3

28.8 moles

× (12+16)

~~807~~ 806.0g

6) 0.004 mol/dm^3 × 0.0025

= 1×10^{-4} moles

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

5×10^{-5} moles of H_2SO_4

0.00205

0.0241 mol/dm^3

4) $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$

$\frac{8g}{104} = \frac{0.05}{2} = 0.0769$ moles

$2(56)+(48)$

= ~~0.154~~ 0.1

0.1 × (26.98) = ~~4.15g~~ ~~2.698~~ 2.70

7) 0.0235 × 0.250 = 0.005875 moles of acid

0.005875 moles × 10 = 0.05875

~~0.05875 × 13.8~~

$n = \frac{13.8}{?}$ $\quad$ $\frac{13.8}{0.05875} = 234.9$

$? n = 13.8$

$? = \frac{13.8}{n}$

VIP → Mixtures form when substances combine without chemical interaction, homogenous → same phase of matter; hetero is opposite

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solid $\underset{\text{deposition}}{\overset{\text{sublimination}}{\rightleftharpoons}}$ gas

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9) X has CHO only Mr = 85

0.43g

$C_xH_yO_z + O_2 \rightarrow 5CO_2 + 5H_2O$

CH_2O

$12+2+16 = 30$

$\left(\frac{1.10}{44}\right)$ → 0.025

$\frac{0.45g}{18}$ → 0.025

$1.1 + 0.45 - 0.43$

$1.1 + 0.02 = 1.12$

$C_5H_{10}O$

$\frac{1.12}{32} = 0.035$

5) $0.05 \times 0.250 = 0.0125$ moles

$0.1 \times 1 mol/dm^3 = 0.1$ mols

$0.1 - 0.0125 = 0.0875$

$NH_4Cl + NaOH \rightarrow NH_3 + NaCl + H_2O$

$0.0875 moles \times (14+4+35.5)$

$= 4.68125 \approx 4.68$

Hydrate Questions

- E.g: A sample has formula $K_2CO_3 \cdot xH_2O$. 10g.00g of it is heated and converted into an anhydrous salt, that was weighed and was found to be 7.93g

① Write Reaction: $K_2CO_3 \cdot xH_2O(aq) \xrightarrow{heat} K_2CO_3(s) + xH_2O(l)$

I	10g	0	0
C	-10g	+7.93 [0.057377mol]	?
E	0	7.93g	

② Moles of K_2CO_3: $\frac{7.93g}{138.21} = 0.057376$ moles

∴ it is $K_2CO_3 \cdot 2H_2O$

∴ moles of $K_2CO_3 \cdot xH_2O = 0.057376$

$0.057376 = \frac{10g}{138.21 + 18x}$ ∴ $138.21 + 18x = 174.29$

$18x \approx 36$

$x \approx 2$