

WORKSHOP ON STOICHIOMETRY

POST-WORK

Q1. Write the equation that relates amount of a substance to mass.

$$\text{Amount of substance (in mol)} = \frac{\text{mass of substance}}{\text{formula weight}} \quad \text{or} \quad n = \frac{m}{M}$$

Q2. Calculate the mass of 1.87 mol of sulfur trioxide.

$$\begin{aligned} \text{Molecular weight of SO}_3 &= 32.07 + (3 \times 16.00) = 80.07 \\ \text{Mass of 1.87 mol of SO}_3 &= 1.87 \times 80.07 = 149.73 = 150 \text{ g (3 significant figures)} \end{aligned}$$

Q3. Calculate the amount (in mol) present in 200.0 g of silicon tetrachloride.

$$\begin{aligned} \text{Molecular weight of SiCl}_4 &= 28.09 + (4 \times 35.45) = 169.89 \\ n = m/M &= 200.0/169.89 = 1.1772 = 1.177 \text{ (4 significant figures)} \end{aligned}$$

Q4. Calculate the mass of 2.00×10^{20} molecules of water.

$$\begin{aligned} \text{Molecular weight of H}_2\text{O} &= (2 \times 1.008) + 16.00 = 18.016 \\ n &= (2.00 \times 10^{20}) / N_A = 3.32116 \times 10^{-4} \text{ mol} \\ m = n \times M &= (2.00 \times 10^{20} / N_A) \times 18.016 = 5.9834 \times 10^{-3} = 5.98 \times 10^{-3} \text{ g (3 significant figures)} \end{aligned}$$

Q5. Calculate the volume (in L) present in 5.45×10^{22} atoms of helium at STP.

$$\begin{aligned} n &= (5.45 \times 10^{22} / N_A) = 9.050 \times 10^{-2} \text{ mol} \\ \text{Volume occupied} &= 5.45 \times 10^{22} / N_A \times 22.4 = 2.027 = 2.03 \text{ L (3 significant figures)} \end{aligned}$$

Q6. Calculate the relative atomic mass of a natural sample of zinc, which contains the isotopes with masses and abundances given:

isotope	atomic weight	abundance	isotope	atomic weight	abundance
^{64}Zn	63.929	48.6%	^{68}Zn	67.925	18.8%
^{66}Zn	65.926	27.9%	^{70}Zn	69.925	0.6%
^{67}Zn	66.927	4.1%			

$$\begin{aligned} \text{Atomic weight of Zn} &= 63.929 \times 0.486 + 65.926 \times 0.279 + 66.927 \times 0.041 + 67.925 \times 0.188 + \\ &\quad 69.925 \times 0.006 = 65.3963 = 65.4 \text{ (3 significant figures)} \end{aligned}$$

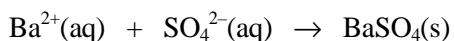
Q7. An iron supplement is used to treat anaemia and 50 mg (*i.e.* 50×10^{-3} g) of Fe^{2+} is required per tablet. If the iron compound used in the tablet is $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$, what mass of this compound would be required per tablet to provide the desired amount of Fe^{2+} ?

$$\begin{aligned} \text{Formula weight of FeSO}_4 \cdot 7\text{H}_2\text{O} &= 55.85 + 32.07 + (4 \times 16.00) + (7 \times 18.016) = 278.032 \\ 50 \text{ mg of Fe} &= 50 \times 10^{-3} / 55.85 \text{ mol} \\ \text{Mass of FeSO}_4 \cdot 7\text{H}_2\text{O} &= 50 \times 10^{-3} / 55.85 \times 278.032 = 0.24891 = 0.25 \text{ g (2 significant figures)} \end{aligned}$$

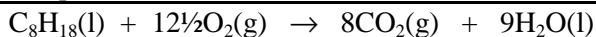
Q8. Write the equation that relates concentration of a solution to amount of solute and volume of solution.

$$\text{Concentration (in mol L}^{-1}\text{)} = \frac{\text{amount (in mol)}}{\text{volume (in L)}}$$

Q9. Write the net ionic equation for the reaction that occurs when a solution of barium nitrate is mixed with a solution of sodium sulfate. A white precipitate of barium sulfate forms.



Q10. Petrol is composed largely of octane, C_8H_{18} . (i) Write the balanced equation for the complete combustion of octane to form carbon dioxide gas and liquid water.



(ii) What amount (in mol) of carbon dioxide is formed when 5.5 mol (1 L) of petrol is burnt?

1 mol of $\text{C}_8\text{H}_{18}(\text{l})$ produces 8 mol of $\text{CO}_2(\text{g})$

\therefore 5.5 mol of $\text{C}_8\text{H}_{18}(\text{l})$ produces $8 \times 5.5 = 44$ mol of $\text{CO}_2(\text{g})$

(iii) What volume of carbon dioxide would this represent at STP?

Volume occupied = $44 \times 22.4 = 985.6 = 9.9 \times 10^2$ L (2 significant figures)

Q11. Hydrogen iodide gas (5.0 L at STP) is dissolved in water and the volume made up to 1.0 L. What is the molarity of the solution?

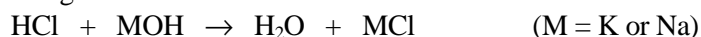
Amount of HI = $5.0 / 22.4 = 0.2232$ mol

Molarity of solution is therefore 0.22 M (2 significant figures)

Q12. What volume of 0.200 M hydrochloric acid would be needed to react completely with a mixture of 0.500 g of sodium hydroxide and 0.800 g of potassium hydroxide?

Formula weight of NaOH = $22.99 + 16.00 + 1.008 = 39.998$

Formula weight of KOH = $39.10 + 16.00 + 1.008 = 56.108$



Total amount of MOH = $(0.500 / 39.998) + (0.800 / 56.108) = 0.02676$ mol

Therefore 0.02676 mol of HCl is required.

Volume = amount / concentration = $0.02676 / 0.200 = 0.1338$ L = 134 mL (3 significant figures)

Q13. A solution was prepared by dissolving nickel (II) nitrate-6-water, $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, (29.1 g) in some water and making the volume up to 1.00 L with water. Assuming complete dissociation of the solid into ions, calculate:

(i) The amount (in mol) of nickel(II) ions in 100 mL of this solution.

Formula weight of $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O} = 58.69 + 2 \times (14.01 + 3 \times 16.00) + (6 \times 18.016) = 290.806$

Amount of $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O} = 29.1 / 290.806 = 0.100$ (3 significant figures)

Amount of Ni^{2+} ions in 100 mL = $0.100 \times 0.100 = 0.0100$ mol

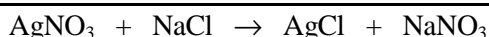
(ii) The amount (in mol) of nitrate ions in 100 mL of this solution.

Amount of NO_3^- ions = $0.0100 \times 2 = 0.0200$ mol

(iii) The number of individual nickel(II) ions in 100 mL of solution.

Number of Ni^{2+} ions = $0.0100 \times N_A = 6.022 \times 10^{21}$

Q14. What volume of 0.010 M silver nitrate solution will exactly react with 20 mL of 0.0080 M sodium chloride solution?



Amount of NaCl = 0.0080×0.020

\therefore Amount of AgNO_3 required = 0.0080×0.020

Volume = amount / concentration = $0.0080 \times 0.020 / 0.010 = 0.016$ L = 16 mL (2 sig figures)