INTRODUCTORY CHEMISTRY

SEMINAR 1 – MOLES & MOLARITY

The Mole

1 mole of any substance = 6.022×10^{23} atoms/molecules/ions

This is called *Avogadro's Number*

For example:

- 1 mole of lead (Pb) contains 6.022×10^{23} Pb Atoms
- 1 mole of hydrogen gas (H_2) contains 6.022×10^{23} H_2 molecules
  - It also contains 2 moles of H atoms (i.e. $2 \times 6.022 \times 10^{23}$ atoms)
- 1 mole of NaCl contains 6.022×10^{23} NaCl molecules
  - It also contains 1 mole of Na^+ ions (i.e. 6.022×10^{23} Na^+ ions) and 1 mole of Cl^- ions (i.e. 6.022×10^{23} Cl^- ions)

Remember…

$$\text{No. moles} = \frac{\text{Mass (g)}}{\text{Molar mass (g mol}^{-1}\text{)}}$$

Molar Concentrations

A **molar solution (1M)** is a solution containing 1 mole of substance (solute) in every litre of solvent

The **molarity** of a solution is the concentration of the solution expressed as the number of moles per litre:

mol L^{-1} or **mol dm^{-3}**
(both of these are the same)

ANSWER THE FOLLOWING QUESTIONS

1. What is the molar mass of Na_2CO_3?

2. How many moles are in 10g NaCl?

3. What mass of Na_2CO_3 would you need in 1L of H_2O to make a 1M solution?

4. Calculate the molarity of a solution containing 15g of Na_2CO_3 in 250cm^3.

5. 15 g of $CaCO_3$ was dissolved in water and made up to give a total volume of 200 cm^3. Calculate the concentration of the solution in mol dm^{-3}.

6. How many molecules are there in 106g of Na_2CO_3 and what is this called?

7. If 10g of $Na_2CO_3.10H_2O$ is used to make up a 500 cm^3 solution instead of 10g anhydrous Na_2CO_3, calculate the difference in concentration of the two solutions obtained, in mol dm^{-3} and in g dm^{-3}.

8. How many moles of molecules are present in 5.60 g of hexane (C_6H_{14})?

9. If 3.15g of caesium chloride is dissolved in water and made up to 100 cm^3 of aqueous solution, what is the concentration of the solution?

10. What mass of potassium iodide (KI) must be dissolved in water and made up to 25.00 cm^3 to give a solution of concentration 0.0300 M?

11. Determine the amount present (in moles) in each of the following:
    (a) 5.2 g $BaCl_2$
    (b) 10 ml of 0.05M HCl
    (c) 3.4820 g $AgNO_3$
    (d) 1kg NH_4NO_3

12. What mass of solid is required to prepare 50 cm^3 of each of the following solutions?
    (e) 0.0100 mol dm^{-3} MnO_2
    (f) 0.0500 M $KMnO_4$
    (g) 1M $NaClO_4$
    (h) 4M $FeCl_3$

13. Typical blood serum is about 0.14 M NaCl. What volume of blood contains 1.0 mg of NaCl?

14. Calculate the number of moles of Cl^- ions in 1.75 L of $1.0x10^{-3}$ M $AlCl_3$

15. How many grams of sugar (sucrose $C_{12}H_{22}O_{11}$) are needed to make 250 ml of a 0.01 mol dm^{-3} solution?

16. What volume of a 4M solution of NaOH contains 17 g of NaOH?

17. To analyse the alcohol content of a certain wine, a forensic scientist needs 1.00 dm^3 of an aqueous 0.200 M potassium dichromate ($K_2Cr_2O_7$) solution. How much solid $K_2Cr_2O_7$ must be weighed out to make this solution?

And now for some to stretch the brain…

18. A solution is prepared by dissolving 25.0 g of ammonium sulphate $(NH_4)_2SO_4$ in enough water to make 100 ml of stock solution. A 10.00 ml sample of this stock solution is added to 50.00 ml of water. Calculate the concentration of ammonium ions and sulphate ions in the final solution.

19. A solution of ethanol (C_2H_5OH) in water is prepared by dissolving 75.0 cm^3 of ethanol (density = 0.79 g/cm^3) in enough water to make 250.00 cm^3 of solution. What is the molarity of the ethanol in this solution?

20. A standard solution is prepared for the analysis of fluoxymesterone ($C_{20}H_{29}FO_3$), an anabolic steroid. A stock solution is first prepared by dissolving 10.0 mg of fluoxymesterone in enough water to give a total volume of 500.0 ml. A 100.0 μl aliquot (portion) of this solution is diluted to a final volume of 100.0 ml. Calculate the concentration of the final solution in terms of molarity.

21. A stock solution containing Mn^{2+} ions is prepared by dissolving 1.584 g of pure manganese metal in nitric acid and diluting to a final volume of 1.000 L. The following solutions are prepared by dilution:
    (i) For solution A: 50.00 ml of stock solution is diluted 1000.0 ml
    (j) For solution B: 10.00 ml of A is diluted to 250.0 ml
    (k) For solution C: 10.00 ml of B is diluted to 500.0 ml

    Calculate the molar concentrations of the stock solution and solutions A, B and C.