Quantitative Aspects of Chemical Change: Concentration

- **Concentration** of a solution can be calculated using
  c = n/V (on data sheet), with
  c = concentration in mol·dm^{-3}, V = volume in dm^3, n = number of moles
- **c = m/MV** (on data sheet)
- A **standard solution** is any solution of which the concentration is known.
- Whenever you have to make a solution with a specified concentration and a specified volume (say 0,1 dm^3), then you do **not** add 0,1 dm^3 of water to the solute - the **final volume** of the solution should be 0,1 dm^3.
- If you have an existing solution with concentration c_1, and you have to use some of it to make a new solution with a certain volume (V_2) of a new concentration (c_2) then what volume (V_1) of the existing solution do I need?
  It is important to understand that if you know how many **moles** of the substance is required in the new solution, you can calculate what volume of the old solution you need to take that contains that same number of moles for the new solution.
  Therefore, first calculate the number of moles in the new solution from c = n/V: $n = c_2V_2$
  This same number of moles is taken from the old solution, therefore $n = c_1V_1$.
  We can therefore say that $n = \mathbf{c_1V_1 = c_2V_2}$.

Exercise 34:

1 Give ONE word/term for

1.1 a measure of how much solute is dissolved in a solution. (1)
1.2 a solution of which the concentration is known. (1)

2 Which one of the following solutions has the highest concentration of H^+ ions?
(Assume total ionisation.)

A 1 dm^3 of 6 mol·dm^{-3} HCℓ B 0,5 dm^3 of 10 mol·dm^{-3} HNO_3
C 0,4 dm^3 of 10 mol·dm^{-3} H_2SO_4 D 2 dm^3 of 2 mol·dm^{-3} HCℓ (2)

3 10 cm^3 of a solution of HCℓ with a concentration of 5 mol·dm^{-3} is diluted to 2 dm^3.
The concentration (in mol·dm^{-3}) of the new solution is (2)

A 1 B 4×10^2 C 10 D $2,5 \times 10^{-2}$

4 A standard solution is a solution

A at 25 ºC. B of an acid or a base.
C of which the volume is known. D of which the concentration is known. (2)

5 A solution of $X_2(SO_4)_3$ in water has a concentration of 0,1 mol·dm^{-3} and is dissociated according to the equation

$$X_2(SO_4)_3(s) \rightarrow 2X^{3+}(aq) + 3SO_4^{2-}(aq)$$

If the solid is completely dissociated, what is the concentration of X^{3+} ions?

A 0,05 mol·dm^{-3} B 0,1 mol·dm^{-3}
C 0,15 mol·dm^{-3} D 0,2 mol·dm^{-3} (2)

6 Ezhekiel Sepeng wants to prepare a "slowmag" vitamin supplement.
He dissolves 0,1 moles of magnesium chloride ($MgC\ell_2$) and 0,1 moles of magnesium phosphate ($Mg_3(PO_4)_2$) in some distilled water. He dilutes the solution to exactly 1 dm^3 (1 000 cm^3).
What is the magnesium cation [Mg^{2+}] concentration?

A 0,1 mol·dm^{-3} B 0,2 mol·dm^{-3}

C 0,3 mol·dm^{-3} D 0,4 mol·dm^{-3} (2)

7.1 Calculate the relative formula mass (M_r) of sodium carbonate (Na_2CO_3) (2)
7.2 Calculate the mass of sodium carbonate needed to make up 250 cm^3 of a 0,2 mol·dm^{-3} aqueous solution. (3)

8 Sodium sulphide dissolves in water according to the equation:

$$Na_2S(s) \xrightarrow{H_2O} 2Na^+(aq) + S^{2-}(aq)$$

If 0,1 mol $Na_2S(s)$ is dissolved in water in a volumetric flask and the solution is made up to 1 dm^3, what is the concentration, in mol·dm^{-3} of …… (Assume no further reactions occur)

8.1 sulphide ions? 8.2 sodium ions? (4)

9 Calculate the **quantity** of H^+-ions present in 200 cm^3 of a solution of nitric acid of 0,25 mol·dm^{-3}. (5)

10 10,6 g **anhydrous** sodium carbonate (Na_2CO_3) is dissolved in water and the volume made up to 50 cm^3.

10.1 Why is it sometimes necessary, as it is here, to use the term **anhydrous**? (1)
10.2 Calculate $M_r(Na_2CO_3)$. (2)
10.3 Determine the concentration, in mol·dm^{-3}, of the sodium carbonate solution. (3)

11 10,6 g anhydrous sodium carbonate (Na_2CO_3) is dissolved in sufficient water to make the final volume of the solution 200 cm^3.

11.1 Calculate the concentration of the solution. (5)
11.2 What is the concentration of the sodium ions? (1)
11.3 How much water should be added to 50 cm^3 of the solution to reduce the concentration to 0,125 mol·dm^{-3}? (6)

12 2,52 g of oxalic acid [$(COOH)_2.2H_2O$] was dissolved in water and water added till the total volume was 250 cm^3.

12.1 Calculate the concentration of the oxalic acid solution in mol·dm^{-3}. (6)
12.2 What volume of this solution of oxalic acid should be made up with water to give 250 cm^3 of a 0,05 mol·dm^{-3} oxalic acid solution? (6)

13.1 Calculate the volume of sulphuric acid (10 mol·dm^{-3}) required to make up a 50 cm^3 solution with a concentration of 0,1 mol·dm^{-3}. (4)
13.2 How much water is used to make up the solution in the previous question? (1)

14 A pupil adds 5 cm^3 of 12 mol·dm^{-3} sulphuric acid (H_2SO_4) to water to make a 250 cm^3 solution. Calculate the concentration of the diluted acid. (5)

15 A standard solution of sodium hydroxide is made up by dissolving exactly 2,5 g of NaOH in enough water to make up exactly 500 cm^3 of solution. Calculate the concentration of this solution. (4)

16 4,4 g of NaOH is dissolved in water to make up 500 cm^3 of solution.
Calculate the concentration of this solution. (5)

17 Two beakers contain the following two solutions: X and Y.
The contents of the two beakers are mixed.
What is the concentration of sodium ions in the mixture? (7)