Acids, Bases, Salts and Neutralisation [S]

1. Acids are used in many day-to-day applications.

    a. Define the term *acid* in terms of pH: **[2]**

    b. Describe how you could use phenolphthalein to distinguish an acid from an alkali: **[2]**

    c. When universal indicator is added to citric acid solution it goes orange, but when added to hydrochloric acid solution it goes red. State and explain which is the stronger acid: **[2]**

    d. Dilute hydrochloric acid is the active ingredient in many limescale (calcium carbonate) removers. Write a word equation to represent the reaction that would occur: **[2]**

    e. Write a balanced equation, with state symbols, for the reaction in part d. **[3]**

    f. Explain why dilute sulphuric acid would not be an adequate acid to remove limescale from the inside of a water pipe: **[2]**

2. Bronsted-Lowry theory describes the actions of acids, bases and alkalis in terms of hydrogen ions.

    a. Explain, using an equation, how nitric acid behaves as an acid: **[2]**

    b. Write a balanced equation, with state symbols, to represent the reaction between zinc and nitric acid: **[3]**

    c. Explain, using an equation, how magnesium oxide behaves as a base: **[2]**

    d. State and explain the colour of blue litmus paper after dipping into:

        i. Hydrogen chloride dissolved in water **[2]**

        ii. Hydrogen chloride dissolved in methylbenzene **[2]**

    e. Derive an ionic equation for the neutralisation of hydrochloric acid by copper(II) carbonate: **[4]**

3. A student wishes to find the concentration of $25cm^3$ of an unlabelled solution of hydrochloric acid using a 0.2M solution of potassium hydroxide.

   a. Write a balanced equation, with state symbols, for the reaction between hydrochloric acid and potassium hydroxide: **[3]**

   b. Write an ionic equation for this reaction: **[3]**

   c. Four titrations were carried out.

      i. Suggest a suitable indicator and colour change: **[3]**

      ii. Fill out the table: **[4]**

	Rough	1	2	3
Initial (cm^3)	0.15	0.30	0.20	2.25
Final (cm^3)	35.10	29.70	29.90	31.55
Titre (cm^3)				

      iii. Calculate the average titre using suitable values: **[2]**

      iv. Calculate the concentration of the hydrochloric acid solution: **[3]**

Acids, Bases, Salts and Neutralisation [S]

1. Acids are used in many day-to-day applications.

   a. Define the term *acid* in terms of pH: **[2]**

      a solution [1] with pH less than 7 [1]

   b. Describe how you could use phenolphthalein to distinguish an acid from an alkali: **[2]**

      goes colourless in acid [1]

      goes pink in alkali [1]

   c. When universal indicator is added to citric acid solution it goes orange, but when added to hydrochloric acid solution it goes red. State and explain which is the stronger acid: **[2]**

      orange = pH 3-5 and red = pH 0-2 [1]

      so hydrochloric acid is stronger [1]

   d. Dilute hydrochloric acid is the active ingredient in many limescale (calcium carbonate) removers. Write a word equation to represent the reaction that would occur: **[2]**

      hydrochloric acid + calcium carbonate → calcium chloride + water + carbon dioxide

      [1] for calcium chloride, [1] for water + carbon dioxide

   e. Write a balanced equation, with state symbols, for the reaction in part d. **[3]**

      $2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

      [formulae, balance, state symbols]

   f. Explain why dilute sulphuric acid would not be an adequate acid to remove limescale from the inside of a water pipe: **[2]**

      The $CaSO_4$ formed is not soluble [1]

      So it will not be washed away [1]

2. Bronsted-Lowry theory describes the actions of acids, bases and alkalis in terms of hydrogen ions.

   a. Explain, using an equation, how nitric acid behaves as an acid: **[2]**

      it donates H^+ ions to a solution [1]

      $HNO_3(aq) \rightarrow H^+(aq) + NO_3^-(aq)$ [1, state symbols optional]

   b. Write a balanced equation, with state symbols, to represent the reaction between zinc and nitric acid: **[3]**

      $Zn(s) + 2HNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + H_2(g)$ [formulae, balance, state symbols]

   c. Explain, using an equation, how magnesium oxide behaves as a base: **[2]**

      the oxide ion accepts H^+ [1]

      $O^{2-}(s) + 2H^+(aq) \rightarrow H_2O(l)$

   d. State and explain the colour of blue litmus paper after dipping into:

      i. Hydrogen chloride dissolved in water **[2]**

         red [1]

         HCl dissociates to give H^+ [1]

      ii. Hydrogen chloride dissolved in methylbenzene **[2]**

         blue [1]

         HCl does not dissociate, so no H^+ [1]

   e. Derive an ionic equation for the neutralisation of hydrochloric acid by copper(II) carbonate: **[4]**

      $2HCl(aq) + CuCO_3(s) \rightarrow CuCl_2(aq) + H_2O(l) + CO_2(g)$ [formulae, balance]

      Removal of Cl^- and Cu^{2+} as they are the same on both sides [1]

      $2H^+(aq) + CO_3^{2-}(s) \rightarrow H_2O(l) + CO_2(g)$ [1]

3. A student wishes to find the concentration of $25cm^3$ of an unlabelled solution of hydrochloric acid using a 0.2M solution of potassium hydroxide.

   a. Write a balanced equation, with state symbols, for the reaction between hydrochloric acid and potassium hydroxide: **[3]**

      $HCl(aq) + KOH(aq) \rightarrow KCl(aq) + H_2O(l)$ [formulae, balance, state symbols]

   b. Write an ionic equation for this reaction: **[3]**

      $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ [formulae, state symbols, charges]

   c. Four titrations were carried out.

      i. Suggest a suitable indicator and colour change: **[3]**

         EITHER phenolphthalein [1] (colourless [1] to pink [1]) OR methyl orange [1] (red [1] to yellow [1])

      ii. Fill out the table: **[4] (each must be to nearest $0.05cm^3$)**

	Rough	1	2	3
Initial (cm^3)	0.15	0.30	0.20	2.25
Final (cm^3)	35.10	29.70	29.90	31.55
Titre (cm^3)	**34.90 [1]**	**$29.40cm^3$**	**$29.70cm^3$**	**$29.30cm^3$**

      iii. Calculate the average titre using suitable values: **[2]**

         use values 1 and 3 (within $0.2cm^3$ of each other) [1]

         average = $29.35cm^3$ (must be to $0.05cm^3$) [1]

      iv. Calculate the concentration of the hydrochloric acid solution: **[3]**

         Moles KOH = conc * vol = 0.2 * (29.35/1000) = 0.00587mol [1]

         Moles HCl = 0.00587mol (1:1 ratio) [1]

         Conc HCl = mols / vol = 0.00587 / (25/1000) = 0.235 mol/dm^3 [1] (3sf only)