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- **1(a)** The chlorides of sodium to phosphorus (NaC*l*, MgC*l*₂, A*l*C*l*₃, SiC*l*₄ and PC*l*₅) are separately added to water.
 - (i) Sketch a graph to show the pH of the resulting solution, indicating clearly the pH of sodium chloride.



(ii) Account for the pH value of aluminium chloride.

[1]

(iii) Write equations for the reactions of silicon chloride and phosphorus pentachloride with water.

- (b) Under suitable conditions iodine and chlorine react to give interhalogen compound, ICl_x . When a pure sample of ICl_x was dissolved in an excess of aqueous potassium iodide, the iodine liberated requires 17.1 cm³ of 0.1 mol dm⁻³ of Na₂S₂O₃ for the titration. On the other hand, the chloride ion liberated requires 12.8 cm³ of 0.1 mol dm⁻³ silver nitrate for complete precipitation.
 - (i) Determine the value of *x*. Hence, write a balanced equation for the reaction between ICl_x and I^- .

[4]

(ii) Sketch on the same axes, the variation of pV_m / RT against p at 300K, for 1 mol of (I) an ideal gas and (II) ICl_x gas. Label your graphs clearly where V_m is the gas molar volume.



[2]

(iii) Using the same axes as in (b)(ii), show the change at 700K for one mol of ICl_x . Explain your sketch.

[2]

[Total: 13]

- 2 This question is about a Group II element, barium and the reactions of its compounds.
 - (a) Write a balanced chemical equation, with state symbols, for the decomposition of barium nitrate.

[1]

(b) How would you expect the decomposition temperature of barium nitrate to differ from that of calcium nitrate? Explain your answer.

(c) Draw the dot-and-cross diagram of the NO_3^- anion.

[2]

(d) The solid product formed in (a) reacts with dilute hydrochloric acid to give $BaCl_2$ and H_2O . Write a balanced chemical equation, with state symbols, for the reaction of $BaCl_2$ with concentrated sulfuric acid.

[1]

(e) Predict the products formed from the reaction of barium bromide, BaBr₂ with concentrated sulfuric acid.

[2]

(f) Suggest an explanation for the difference in products formed in (d) and (e). Support your explanation with relevant data from the *Data Booklet*.

[3]

[Total: 12]

3 The technology behind Direct Methanol Fuel Cells (DMFC) is still in the early stages of development, but it has successfully powered mobile phones and laptop computers, the target end uses in future years. The fuel and oxygen are pumped continuously to the two electrodes which are made of platinum.



(a) Write equations for the reactions which take place for the fuel cell.

Anode:

Cathode:

Overall:

(b) Write the cell diagram.

[1]

[3]

(c) Give an advantage of the fuel cell with methanol as a fuel.

[1]

[Total: 5]

- **4** Magnesium hydroxide, Mg(OH)₂, is sparingly soluble in water. The solubility product of magnesium hydroxide in water is $5.61 \times 10^{-12} \text{ mol}^3 \text{ dm}^{-9}$.
 - (a) Write an expression for the solubility product, K_{sp} of magnesium hydroxide.

[1]

(b) Calculate the solubility of magnesium hydroxide in g dm^{-3} for a saturated solution of magnesium hydroxide at 25°C.

[2]

(c) Calculate the solubility of $Mg(OH)_2$ in 5.00 x 10^{-2} mol dm⁻³ aqueous sodium hydroxide.

[2]

(d) Equal volumes of solutions containing 5.0×10^{-3} mol dm⁻³ magnesium nitrate and 6.0×10^{-3} mol dm⁻³ of sodium hydroxide are mixed. Predict if a precipitate will be formed. Explain your answer with the aid of relevant calculations.

[3] [Total: 8]

5 Complete the reaction scheme below by writing the structural formula of the organic products (A-D) and the reagents and conditions (1-6) in the spaces below.





6 Oseltamivir is an antiviral drug that slows the spread of non-resistant strains of the influenza virus between cells in the body. It blocks the action of a viral enzyme called neuraminidase and has since been indicated for the treatment of H5N1 and H1N1 infection. The standard adult dosage is 75 mg twice daily. The relative molecular mass of this drug is 312.4.



oseltamivir

(a) A male adult patient has been put on a 5-day Tamiflu treatment. Calculate the total number of moles of Tamiflu taken by this patient over this period of treatment.

[1]

(b) Name the functional groups present in oseltamivir.

(c) Neuraminidase is described as a tertiary protein. Explain what is meant by the term *tertiary protein*.

(d) Describe the hybridisation, geometry and bond angle about C_1 atom.

[3]

(e) Compare the basicity of N_1 and N_2 atom of oseltamivir. Explain which nitrogen atom has a lower p K_b value.

[3]

[Total: 12]

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