Group 7

Question Paper 4

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Group 7
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 4

Time Allowed: **70 minutes**

Score: **/58**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** The halogens chlorine and bromine react readily with hydrogen.

$$X_2(g) + H_2(g) \longrightarrow 2HX(g) \qquad [X = Cl \text{ or } Br]$$

(i) Describe how you could carry out this reaction using chlorine.

.....

(ii) Describe **two** observations you would make if this reaction was carried out with bromine.

.....

.....

(iii) Use bond energy data from the *Data Booklet* to calculate the $\Delta H^{\ominus}$ for this reaction when

X = C*l*,

$\Delta H^{\ominus}$ = ... kJ mol^{-1}

X = Br.

$\Delta H^{\ominus}$ = ... kJ mol^{-1}

(iv) What is the major reason for the difference in these two $\Delta H^{\ominus}$ values?

.....

[8]

(b) Some halogens also react readily with methane.

$$CH_4(g) + X_2(g) \longrightarrow CH_3X(g) + HX(g)$$

(i) What conditions are needed to carry out this reaction when X is bromine, Br?

.....

(ii) Use bond energy data from the *Data Booklet* to calculate the $\Delta H^{\ominus}$ of this reaction for the situation where X is iodine, I.

$\Delta H^{\ominus}$ = ... $kJ\,mol^{-1}$

(iii) Hence suggest why it is not possible to make iodomethane, CH_3I, by this reaction.

.....

[4]

(c) Halogenoalkanes can undergo *homolytic fission* in the upper atmosphere.

(i) Explain the term *homolytic fission*.

.....

.....

(ii) Suggest the most likely organic radical that would be formed by the homolytic fission of bromochloromethane, CH_2BrCl. Explain your answer.

.....

.....

.....

[3]

(d) The reaction between propane and chlorine produces a mixture of many compounds, four of which are structural isomers with the molecular formula $C_3H_6Cl_2$.
Draw the structural or skeletal formulae of these isomers, and indicate any chiral atoms with an asterisk (*).

[3]

[Total: 18]

2 The gaseous hydrogen halides HC*l*, HBr and HI, may be prepared by reacting the corresponding sodium salt with anhydrous phosphoric(V) acid, H_3PO_4.

When the sodium halide Na*X* was used, the following reaction occurred and a sample of gaseous H*X* was collected in a gas jar.

$$NaX + H_3PO_4 \rightarrow NaH_2PO_4 + HX$$

A hot glass rod was placed in the sample of H*X* and immediately a red/orange colour was observed.

(a) What is the identity of Na*X*?

.....

[1]

(b) What gas, other than H*X*, would be formed if concentrated sulfuric acid were used with Na*X* instead of phosphoric(V) acid?

.....

[1]

(c) Suggest why phosphoric(V) acid rather than concentrated sulfuric acid is used to make samples of H*X* from the corresponding sodium salt.
Explain your answer.

.....

.....[1]

[Total: 3]

3 **(a)** Describe the observations you would make when concentrated sulfuric acid is added to separate portions of NaC*l*(s) and NaBr(s). Write an equation for **each** reaction that occurs.

NaC*l*(s): observation .....

.....

equation

NaBr(s): observation .....

.....

equation

[4]

(b) By quoting relevant $E^{\ominus}$ data from the *Data Booklet*, explain how the observations you have described above relate to the relative oxidising power of the elements.

.....

.....

..... [2]

(c) By referring to relevant $E^{\ominus}$ data choose a suitable reagent to convert Br_2 into Br^-. Write an equation and calculate the $E^{\ominus}$ for the reaction.

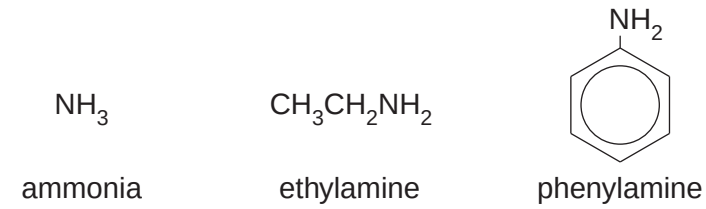
.....

.....

..... [3]

[Total: 9]

4 **(a)** Describe and explain how the basicities of ammonia, ethylamine and phenylamine differ.



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.....

.....

.....[3]

(b) Describe how the use of aqueous silver nitrate and aqueous ammonia can distinguish between aqueous solutions containing chloride, bromide or iodide ions by filling in the following table.

halide	vation when $AgNO_3(aq)$ is added	observation when dilute $NH_3(aq)$ is added	observation when concentrated $NH_3(aq)$ is added
chloride			
bromide			
iodide			

[3]

(c) Silver bromide is sparingly soluble in water.

$$AgBr(s) \rightleftharpoons Ag^+(aq) + Br^-(aq) \qquad K_{sp} = 5 \times 10^{-13}\ mol^2\ dm^{-6}$$

(i) Calculate $[Ag^+(aq)]$ in a saturated aqueous solution of AgBr.

$[Ag^+(aq)]$ = ... $mol\ dm^{-3}$

(ii) State and explain whether AgBr will be less or more soluble in $0.1\ mol\ dm^{-3}$ KBr than it is in pure water.

.....

.....

[2]

(d) Silver ions form complexes with ammonia and with amines.

$$Ag^+(aq) + 2RNH_2(aq) \rightleftharpoons [Ag(RNH_2)_2]^+(aq)$$

(i) Write an expression for the K_c for this reaction, and state its units.

K_c = ... units .....

K_c has the numerical value of 1.7×10^7 when R = H.

(ii) Using your expression for K_c calculate the $[NH_3(aq)]$ needed to change the $[Ag^+(aq)]$ in a 0.10 mol dm^{-3} solution of silver nitrate to the value that you calculated in **(c)(i)**.

$[NH_3(aq)]$ = ... mol dm^{-3}

(iii) Explain whether you would expect the K_c for the reaction where R = C_2H_5 to be greater or less than that for the reaction where R = H.

.....

.....

[5]

[Total: 13]

5 This question is about the elements of Group VII, the halogens.

(a) Complete the following table.

halogen	colour	physical state at room temperature
chlorine		
bromine		
iodine		

[2]

(b) Concentrated sulphuric acid is added to separate solid samples of magnesium chloride, magnesium bromide, and magnesium iodide.

(i) Describe, in **each** case, **one** observation you would be able to make.

$MgCl_2$ .....

.....

$MgBr_2$ .....

.....

MgI_2 .....

.....

(ii) Give an equation for the reaction of concentrated sulphuric acid with magnesium chloride.

.....

[4]

(c) When dilute nitric acid and aqueous silver nitrate are added to a solution of a magnesium halide, MgX_2, a pale cream precipitate is formed.
This precipitate is soluble in concentrated aqueous ammonia but not soluble in dilute aqueous ammonia.

(i) What is the identity of the precipitate?

.....

(ii) Give an equation, with state symbols, for the reaction of the precipitate with concentrated aqueous ammonia.

.....

[3]

(d) A hot glass rod is plunged into separate gas jars, one containing hydrogen chloride and one containing hydrogen iodide.

(i) For **each** gas, state what you would observe, if anything, and write an equation for any reaction that takes place.

HC*l* .....

.....

HI .....

.....

(ii) Explain your answer to **(i)** in terms of enthalpy changes.

.....

.....

.....

(iii) What is the role of the hot glass rod in any reaction that occurs?

.....

.....

[6]

[Total: 15]