Paper Reference(s)

6246/02

Edexcel GCE

Chemistry

Advanced Level

Unit Test 6B (Synoptic)

Wednesday 28 January 2004 – Afternoon

Time: 1 hour 30 minutes

Materials required for examination
Answer Book (AB08)

Items included with question papers
Nil

Instructions to Candidates

In the boxes on the Answer Book provided, write the name of the examining body (Edexcel), your centre number, candidate number, the subject title, the paper reference, your surname, initials and signature.
The paper reference is shown above.
Answer Question 1 in section A and TWO Questions from section B in the Answer Book provided.
Additional Answer Sheets may be used.
Show all steps in any calculations and state the units.
Calculators may be used.

Information for Candidates

The total mark for this paper is 50. The marks for individual questions and parts of questions are shown in round brackets, e.g.: **(2)**.
A Periodic Table is printed on the back cover of this question paper.

Advice to Candidates

You are reminded of the importance of clear English and careful presentation in your answers.

Printer's Log. No.
N16453A

Turn over

W850/R6246/57570 6/7/7/5/1600

Edexcel
Success through qualifications

Section A

1. The enthalpy of neutralisation, ΔH_{neut}, of an acid by a base can be measured as follows:

- measure the temperature of 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid each minute for four minutes;
- on minute 5 add 50.0 cm^3 of 1.10 mol dm^{-3} sodium hydroxide solution;
- record the temperature of the mixture each minute from minute 6 to minute 9;
- plot a graph of temperature against time and use this graph to obtain a value for the temperature change at minute 5;
- use the temperature change, together with the concentrations of the solutions, to obtain the standard enthalpy of neutralisation in kJ mol^{-1}.

(a) Suggest why, in this experiment, the concentration of the sodium hydroxide solution is higher than that of the hydrochloric acid.

(1)

(b) In the experiment above the observed temperature change was 6.90 °C. Calculate the enthalpy of neutralisation, ΔH_{neut}, for the reaction between hydrochloric acid and aqueous sodium hydroxide.

The heat capacity of the reaction mixture is 4.18 J $°C^{-1}$ cm^{-3}.

(3)

(c) Suggest why the use of a graphical method can lead to a more accurate value for the enthalpy of neutralisation.

(2)

(d) If the experiment is repeated using ethanoic acid instead of hydrochloric acid, the value of ΔH_{neut} is 97 % of that for hydrochloric acid with sodium hydroxide.

(i) Why is ΔH_{neut} for ethanoic acid/sodium hydroxide less exothermic than that for hydrochloric acid/sodium hydroxide?

(1)

(ii) Ethanoic acid is only about 1% dissociated, whereas hydrochloric acid is completely dissociated. By considering what happens to ions as they are formed in aqueous solution, suggest why ΔH_{neut} for ethanoic acid/sodium hydroxide is only slightly less exothermic than the value for hydrochloric acid/sodium hydroxide, in spite of the very different degrees of dissociation of the acids.

(3)

(Total 10 marks)

TOTAL FOR SECTION A: 10 MARKS

Section B

Answer **TWO** questions from this section.

2. (a) Chlorine can be produced by the electrolysis of concentrated sodium chloride solution, brine, in a membrane cell.

(i) Give the half-equations for the processes that occur at the anode and at the cathode of the electrolytic cell. Name the other important product from this process.

(3)

(ii) Use the equations and the $E^{\ominus}$ values below to predict what happens if chlorine and aqueous sodium hydroxide solution are mixed, and write the overall ionic equation for the reaction.

	$E^{\ominus}/V$
$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$	+1.36
$OCl^- + H_2O + 2e^- \rightleftharpoons Cl^- + 2OH^-$	+0.89

(3)

(iii) Name and explain the type of reaction occurring in (ii).

(2)

(b) The most common chlorine-containing polymer is poly(chloroethene), usually known as PVC.

(i) Suggest the mechanism for the polymerisation of chloroethene, $CH_2{=}CHCl$, to give PVC using an initiator that you may represent as the free radical R•. Write enough of the mechanism to give a four-carbon chain, and show a termination step.

(4)

(ii) Most PVC is used for durable products, but some is waste. Suggest a use for PVC and comment on the difficulties that might arise from the disposal of PVC in landfill sites and by incineration.

(4)

(c) The chlorination of ethane in ultra-violet light has a free radical chain mechanism. The first step is:

$$Cl_2 \rightarrow 2Cl\bullet$$

The next step could be either:

$$CH_3CH_3 + Cl\bullet \rightarrow CH_3CH_2Cl + H\bullet \quad \text{(step I)}$$

or

$$CH_3CH_3 + Cl\bullet \rightarrow CH_3CH_2\bullet + HCl \quad \text{(step II)}$$

Use the mean bond enthalpy data given below to show which of these two steps, I or II, is the more likely.

	bond enthalpy /kJ mol^{-1}
C—H	+413
C—Cl	+346
H—Cl	+432

(4)

(Total 20 marks)

3. Aluminium chloride can be obtained in two forms: anhydrous, often represented as $AlCl_3$, and a hydrate, $AlCl_3.6H_2O$.

(a) If anhydrous aluminium chloride is heated it sublimes at 185 °C. In a closed vessel the gas is an equilibrium mixture of substances with molecular formulae $AlCl_3$ and Al_2Cl_6.

$$Al_2Cl_6(g) \rightleftharpoons 2AlCl_3(g)$$

(i) At a given temperature a vessel of volume 10.0 dm^3 contained initially 2.0 moles of Al_2Cl_6. When equilibrium was achieved 0.50 mol of Al_2Cl_6 remained.

Write an expression for K_c for the equilibrium and calculate its value under the stated conditions.

(4)

(ii) Draw a three-dimensional diagram of the Al_2Cl_6 molecule. Indicate the nature of the bonds on the diagram.

(3)

(b) Anhydrous aluminium chloride is used as a catalyst in Friedel-Crafts reactions, such as that between benzene and chloroethane.

(i) Write the overall equation for this reaction.

(1)

(ii) Give the mechanism for the reaction, including the formation of the electrophile.

(4)

(iii) By comparing the bonding in ethene and in benzene, explain why ethene usually undergoes addition reactions whereas benzene usually undergoes substitution reactions.

(3)

(c) (i) Suggest why heating hydrated aluminium chloride gives hydrogen chloride gas, and identify the residue.

(2)

(ii) Dissolving the hydrate in water does not cause liberation of HCl gas but gives an acidic solution. Explain why the solution is acidic.

(3)

(Total 20 marks)

4. (a) Explain in terms of bonding why the boiling temperature of water is anomalous compared with the other hydrides of Group 6.

(4)

(b) Water is an important solvent.

(i) Use a Hess's Law cycle to illustrate the energy changes that may determine whether or not an ionic compound dissolves in water.

(4)

(ii) Explain why propan-1,2,3-triol mixes with water in all proportions but propane is virtually insoluble in water.

(4)

(c) Many salts crystallise from aqueous solution with water of crystallisation incorporated into their crystals. One such salt is copper(II) sulphate pentahydrate, $CuSO_4.5H_2O$. The crystals are blue.

(i) If $CuSO_4.5H_2O$ crystals are heated, steam is evolved and the crystals become white, giving anhydrous copper(II) sulphate. Why do the crystals lose their colour?

(3)

(ii) If a little water is added to cold anhydrous copper(II) sulphate, the blue colour is restored and the mixture becomes hot. Explain the origin of the heat.

(2)

(d) In some circumstances it is important that water is not present – for example, in the preparation of Grignard reagents.

(i) Give an equation for the reaction of the Grignard reagent methylmagnesium bromide, CH_3MgBr, with water.

(1)

(ii) State TWO precautions that you would take to prevent water from being able to react with a Grignard reagent.

(2)

(Total 20 marks)

TOTAL FOR SECTION B: 40 MARKS

TOTAL FOR PAPER: 50 MARKS

END