| Surname | | Other Names | |
|---|---|---|---|
| Centre Number | | | Candidate Number | | | | | | | | | |
| Candidate Signature | | | | | | | | | | | | |

Leave blank

General Certificate of Education
June 2002
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

# CHEMISTRY CHM2
# Unit 2 Foundation Physical and Inorganic Chemistry

Wednesday 29 May 2002 Morning Session

**In addition to this paper you will require:**
the AQA Periodic Table (Reference CHEM/PT/EX);
a calculator.

Time allowed: 1 hour 30 minutes

## Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in **Section A** and **Section B** in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

## Information

- The maximum mark for this paper is 90.
- Mark allocations are shown in brackets.
- This paper carries 30 per cent of the total marks for AS. For Advanced Level this paper carries 15 per cent of the total marks.
- You are expected to use a calculator where appropriate.
- The following data may be required.
  Gas constant $R = 8.31$ J mol$^{-1}$ K$^{-1}$
- Your answers to questions in **Section B** should be written in continuous prose, where appropriate. You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.

## Advice

- You are advised to spend about 1 hour on **Section A** and about 30 minutes on **Section B**.

| For Examiner's Use | | | |
|---|---|---|---|
| Number | Mark | Number | Mark |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| | | | |
| | | | |
| | | | |
| Total (Column 1) → | | | |
| Total (Column 2) → | | | |
| TOTAL | | | |
| Examiner's Initials | | | |

## SECTION A

Answer **all** questions in the spaces provided.

**1** (a) What is the meaning of the term *enthalpy change*?

.....

.....

.....

*(2 marks)*

(b) (i) Define the term *standard enthalpy of formation* of a compound.

.....

.....

.....

.....

(ii) Write an equation, including state symbols, for the formation from its elements of solid sodium sulphate, $Na_2SO_4$

.....

*(5 marks)*

(c) State Hess's Law.

.....

.....

*(1 mark)*

(d) Some standard enthalpy changes are difficult to measure directly but can be determined from standard enthalpies of combustion.
Maleic acid, $C_4H_4O_4$, reacts with oxygen to form carbon dioxide and water as shown by the following equation.

$$C_4H_4O_4(s) + 3O_2(g) \rightarrow 4CO_2(g) + 2H_2O(l)$$

Use the standard enthalpy of combustion data given below to calculate a value for the standard enthalpy change for the following reaction.

$$4C(s) + 2H_2(g) + 2O_2(g) \rightarrow C_4H_4O_4(s)$$

| | $C_4H_4O_4(s)$ | $C(s)$ | $H_2(g)$ |
|---|---|---|---|
| $\varnothing H_c^{\ominus}$/kJ mol$^{-1}$ | −1356 | −393.5 | −285.8 |

.....

.....

.....

.....

.....

.....

.....

.....

*(3 marks)*

11

**2** A 50.0 $cm^3$ sample of a 0.200 mol $dm^{-3}$ solution of silver nitrate was placed in a polystyrene beaker. An excess of powdered zinc was added to this solution and the mixture stirred. Zinc nitrate, $Zn(NO_3)_2$, and silver were formed and a rise in temperature of 3.20 °C was recorded.

(a) Write an equation for the reaction between silver nitrate and zinc.

.....

*(1 mark)*

(b) Calculate the number of moles of silver nitrate used in the experiment.

.....

.....

*(2 marks)*

(c) Calculate the heat energy evolved by the reaction in this experiment assuming that all the energy evolved is used to heat only the 50.0 g of water in the mixture.
(Specific heat capacity of water is 4.18 J $g^{-1}$ $K^{-1}$)

.....

.....

*(2 marks)*

(d) Calculate the heat energy change for the reaction per mole of zinc reacted.

.....

.....

*(2 marks)*

(e) Explain why the experimental value for the heat energy evolved in this experiment is less than the correct value.

.....

.....

*(1 mark)*

8

**3** (a) Concentrated sulphuric acid can be reduced by some solid sodium halides to $H_2S$

(i) Give the oxidation state of sulphur in $H_2S$

.....

(ii) Give **one** solid sodium halide which will reduce concentrated sulphuric acid, forming $H_2S$

.....

(iii) State **one** way in which the presence of $H_2S$ could be recognised.

.....

(iv) Write a half-equation for the formation of $H_2S$ from sulphuric acid.

.....

*(4 marks)*

(b) A different solid sodium halide reacts with concentrated sulphuric acid without reduction forming a halogen-containing product **X**.

(i) Suggest an identity for **X**.

.....

(ii) Identify the solid sodium halide which produces **X**.

.....

(iii) State the role of sulphuric acid in the formation of **X**.

.....

(iv) Write an equation for the reaction with concentrated sulphuric acid in which **X** is formed.

.....

*(4 marks)*

8

**4** (a) When using silver nitrate to test for the presence of chloride ions in an aqueous solution, it is important to add another reagent to prevent interference by any carbonate ions which would form a white precipitate of $Ag_2CO_3$

(i) Identify this other reagent.

.....

(ii) Write an equation to show how this other reagent reacts with sodium carbonate.

.....

*(2 marks)*

(b) The presence of some halide ions in solution can be detected using aqueous silver nitrate and aqueous ammonia.

(i) Identify a halide ion which, on addition of aqueous silver nitrate, forms a precipitate that is insoluble in concentrated aqueous ammonia.

.....

(ii) Identify a halide ion which cannot be detected using these reagents.

.....

*(2 marks)*

(c) A mixture of two precipitates, **P** and **Q**, was formed by adding aqueous silver nitrate to a solution containing two different halide ions. Precipitate **P** dissolved on addition of an excess of dilute aqueous ammonia. The remaining precipitate, **Q**, was filtered off.

(i) Identify the halide ion in **P**.

.....

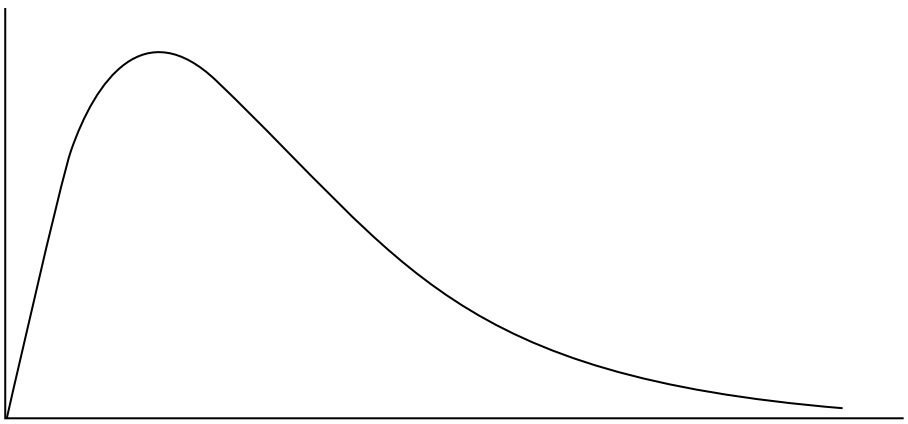
(ii) Precipitate **Q** was soluble in concentrated aqueous ammonia. Identify the halide ion in **Q**.

.....

*(2 marks)*

6

**5** (a) Below is a Maxwell–Boltzmann curve showing the distribution of molecular energies for a sample of gas at a temperature *T*.



(i) Label the axes on the diagram above.

(ii) What does the area under the curve represent?

.....

(iii) State why this curve starts at the origin.

.....

*(4 marks)*

(b) (i) State what is meant by the term *activation energy*.

.....

.....

(ii) The rate of a chemical reaction may be increased by an increase in reactant concentration, by an increase in temperature and by the addition of a catalyst.

State which, if any, of these changes involves a different activation energy. Explain your answer.

*Change(s)* .....

*Explanation* .....

.....

*(5 marks)*

9

**6** (a) In terms of electron transfer, what does the reducing agent do in a redox reaction?

.....

*(1 mark)*

(b) What is the oxidation state of an atom in an uncombined element?

.....

*(1 mark)*

(c) Deduce the oxidation state of nitrogen in each of the following compounds.

(i) $NCl_3$ .....

(ii) $Mg_3N_2$ .....

(iii) $NH_2OH$ .....

*(3 marks)*

(d) Lead(IV) oxide, $PbO_2$, reacts with concentrated hydrochloric acid to produce chlorine, lead(II) ions, $Pb^{2+}$, and water.

(i) Write a half-equation for the formation of $Pb^{2+}$ and water from $PbO_2$ in the presence of $H^+$ ions.

.....

(ii) Write a half-equation for the formation of chlorine from chloride ions.

.....

(iii) Hence deduce an equation for the reaction which occurs when concentrated hydrochloric acid is added to lead(IV) oxide, $PbO_2$

.....

*(3 marks)*

8

**7** (a) State why chlorine is added to drinking water.

.....

*(1 mark)*

(b) Write an equation for the reaction which occurs when chlorine is bubbled into water. Identify the substance which causes the resulting solution to be pale green.

*Equation* .....

*Identity of substance* .....

*(2 marks)*

(c) Write an equation for the reaction which occurs when chlorine is bubbled into an excess of cold aqueous sodium hydroxide.

.....

*(1 mark)*

(d) The amount of chlorine which has been added to water can be determined by treating a measured volume of the solution with an excess of potassium iodide and titrating the liberated iodine against a standard solution of sodium thiosulphate.

(i) Write an equation for the reaction between chlorine and potassium iodide.

.....

(ii) Write an equation for the reaction between iodine and sodium thiosulphate.

.....

(iii) An excess of potassium iodide was added to 1.00 $dm^3$ of water from a swimming pool. The liberated iodine reacted with 7.20 $cm^3$ of a 0.0150 mol $dm^{-3}$ solution of sodium thiosulphate. Calculate the mass of chlorine which had been added to each 1.00 $dm^3$ of swimming pool water.

.....

.....

.....

.....

.....

*(6 marks)*

10

LEAVE MARGIN BLANK

## SECTION B

Answer **both** the questions below in the space provided on pages 10 to 16 of this booklet.

**8** (a) In a blast furnace, iron can be extracted from an oxide ore which also contains silicon dioxide as an impurity. Identify the additional raw materials needed in the extraction process, state why they are needed and write equations for the reactions occurring. *(10 marks)*

(b) Iron produced in a blast furnace is impure. The iron contains carbon, sulphur and phosphorus. State how each of these impurities is removed. Explain why sulphur is removed before carbon and phosphorus. *(6 marks)*

(c) Although there are large reserves of iron and aluminium ores in the world, both metals are recycled.

(i) State **one** social benefit of recycling iron and state why it is particularly easy to separate iron from other scrap metal.

(ii) Give **one** main reason why it is much cheaper to recycle aluminium than it is to extract the metal from its ore. Give **one** major factor in the cost of recycling aluminium cans. *(4 marks)*

**9** Hydrogen is produced by the reaction between steam and methane when the following dynamic equilibrium is established.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \quad \varnothing H = +206\,kJ\,mol^{-1}$$

(a) Use Le Chatelier's principle to predict the separate effects of an increase in temperature and of an increase in pressure on the yield of hydrogen obtained in the above reaction. In each case, explain your answer. *(6 marks)*

(b) State how, and explain why, the use of a catalyst might or might not change the equilibrium yield of hydrogen, and also the amount of hydrogen produced, in a given time. *(4 marks)*

**END OF QUESTIONS**

.....

.....

.....

.....

.....

LEAVE MARGIN BLANK

LEAVE MARGIN BLANK

LEAVE MARGIN BLANK

LEAVE MARGIN BLANK

LEAVE MARGIN BLANK



Turn over ▶

LEAVE MARGIN BLANK