OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY (SALTERS)

Chemistry of Natural Resources

2848

| Wednesday | **11 JANUARY 2006** | Morning | 1 hour 30 minutes |

Candidates answer on the question paper.
Additional materials:
 Data Sheet for Chemistry (Salters)
 Scientific calculator

Candidate Name	

Centre Number					

Candidate Number				

TIME   1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

• Write your name, Centre Number and Candidate number in the boxes above.

• Answer **all** the questions.

• Read each question carefully and make sure you know what you have to do before starting your answer.

• Write your answers, in blue or black ink, in the spaces provided on the question paper. Pencils may be used for diagrams and graphs **only**.

• Do not write in the bar code. Do not write in the grey area between the pages.

• **DO NOT** WRITE IN THE AREA **OUTSIDE** THE BOX BORDERING EACH PAGE. ANY WRITING IN THIS AREA WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

• The number of marks is given in brackets [ ] at the end of each question or part question.

• You will be awarded marks for quality of written communication where this is indicated in the question.

• You may use a scientific calculator.

• You may use the *Data Sheet for Chemistry (Salters)*.

• You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	24	
2	31	
3	20	
4	15	
TOTAL	90	

This question paper consists of 12 printed pages.

391484201

[Turn over

Answer **all** the questions.

1 Copper matte, Cu_2S, is produced in the extraction of copper from chalcopyrite. It is tapped off and run into a furnace where it is 'blown' with air to produce blister copper.

(a) (i) Use this information to complete the flow diagram by writing suitable labels on the two dotted lines.

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                                    ┌─────────────┐
                                    │ ............│
                                    └──────┬──────┘
                                           │
                                           ▼
┌──────────────┐    ┌──────────────┐    ╱─────────╲    ┌────────────────────┐
│ chalcopyrite │───▶│ copper matte │───▶│ furnace │───▶│ .................. │
└──────────────┘    └──────────────┘    ╲─────────╱    └────────────────────┘
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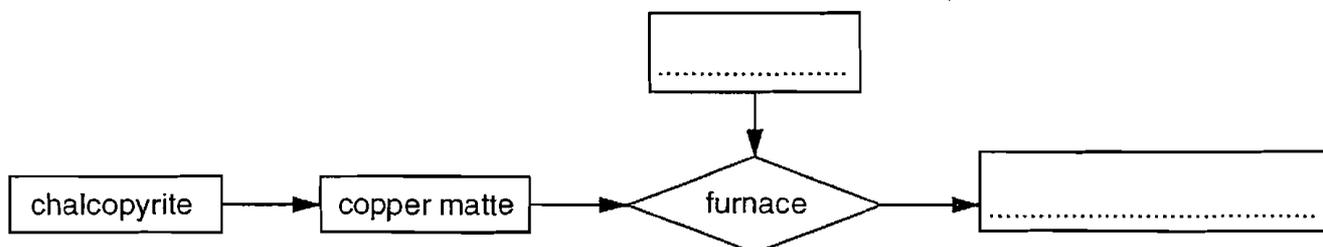
[2]

(ii) In what physical state is the *copper matte* when it is tapped off?

.... [1]

(iii) Blister copper is 99% pure metal.

Calculate the number of parts per million of **impurity** in blister copper.

answer = ... ppm [1]

(iv) Blister copper undergoes a further stage of treatment. Suggest what this is.

.... [1]

(b) (i) The equation for the reaction in the air blow is shown below. Two of the oxidation states are shown.

Fill in the remaining oxidation states on the dotted lines below the atoms.

$$Cu_2S \quad + \quad O_2 \quad \rightarrow \quad 2Cu \quad + \quad SO_2$$

.... −2 .... −2 [4]

(ii) What **type** of reaction is this?

.... [1]

(iii) Give the systematic name of Cu_2S.

.... [1]

(c) **(i)** Complete the electron configuration for a copper **atom.**

$$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$$
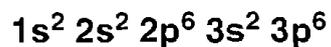
[2]

(ii) In which **block** öf the Periodic Table is copper found?

.... [1]

(d) A sample of rainwater collected near the copper extraction plant was analysed for its acid content by titration with sodium hydroxide. $25.0\,cm^3$ of this rainwater required $21.2\,cm^3$ of $0.00100\,mol\,dm^{-3}$ sodium hydroxide solution.

The equation for the titration reaction is shown below.

$$H^+ + OH^- \longrightarrow H_2O$$
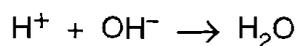
(i) Name a suitable indicator for this titration.

.... [1]

(ii) Calculate the number of moles of NaOH required for the titration.

answer = ... moles [2]

(iii) What is the number of moles of H^+(aq) in $25.0\,cm^3$ rainwater?

answer = ... moles [1]

(iv) Calculate the concentration of H^+(aq) in $mol\,dm^{-3}$ in the rainwater.

concentration of H^+ = ... $mol\,dm^{-3}$ [1]

[Turn over

(e) In this question, one mark is available for the quality of spelling, punctuation and grammar.

In a modern copper extraction plant, steps are taken to prevent atmospheric pollution.

- Name the possible atmospheric pollutant and describe the damage it could cause.

- Suggest a way of turning this pollutant into a useful substance.

....

....

....

....

....

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....

.... [4]

Quality of Written Communication [1]

[Total: 24]

2 The polymer commonly known as PVC exists in two forms. Plasticised PVC is used where flexibility is required. Unplasticised PVC, uPVC, is rigid at room temperature and is used to make things such as guttering for houses.

(a) Suggest **one** other use of uPVC, connected with a house.

.... [1]

(b) PVC is manufactured by polymerising 'vinyl chloride'. Vinyl chloride is produced in a two stage synthesis as outlined below.

stage 1 $\qquad CH_2 = CH_2 \ + \ Cl_2 \ \xrightarrow{FeCl_3} \ ClCH_2CH_2Cl$

stage 2 $\qquad ClCH_2CH_2Cl \ \xrightarrow{heat} \ CH_2 = CHCl \ + \ HCl$

$\qquad$ **vinyl chloride**

(i) Give the systematic name for **vinyl chloride**.

.... [1]

(ii) Underline **two** of the following words to describe the reaction in **stage 1**.

addition   electrophilic   elimination   nucleophilic   radical   substitution

[2]

(iii) Select **one** word from the list to describe the reaction in **stage 2**.

.... [1]

(iv) What **type** of polymerisation is the polymerisation of vinyl chloride?

.... [1]

(c) PVC owes many of its properties to the intermolecular forces between the polymer chains.

(i) Name the strongest type of intermolecular force that is present in PVC.

.... [1]

(ii) Use the diagram below to show how these intermolecular forces hold the PVC chains together.

$$-CH_2 - CH - CH_2 - CH - CH_2 -$$
$$\qquad\qquad | \qquad\qquad\quad |$$
$$\qquad\qquad Cl \qquad\qquad\; Cl$$

$$-CH_2 - CH - CH_2 - CH - CH_2 -$$
$$\qquad\qquad | \qquad\qquad\quad |$$
$$\qquad\qquad Cl \qquad\qquad\; Cl$$

[2]

[Turn over

(d) Bumpers and spoilers on cars are made from *plasticised* PVC. One way of making PVC more plastic is to incorporate another monomer unit into the polymerisation process. A monomer used in this way is ethenyl ethanoate.

$$H_2C=CH-OCOCH_3$$
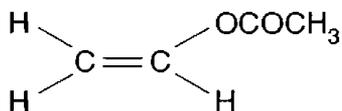
ethenyl ethanoate

(i) Draw out a section of the polymer formed from vinyl chloride and ethenyl ethanoate. Include **two** units of vinyl chloride and **one** unit of ethenyl ethanoate.

[2]

(ii) What term is used to describe such a polymer that has more than one monomer in its structure?

.... [1]

(e) When ethenyl ethanoate is incorporated, the polymer becomes more flexible. This is because the polymer chains do not pack together so well.

Explain why this leads to greater flexibility.

....

....

....

....

....

.... [3]

(f) Vinyl chloride will also undergo the following sequence of reactions.

$$CH_2 = CHCl \rightarrow CH_3CH_2Cl \rightarrow CH_3CH_2OH \rightarrow CH_3CHO$$
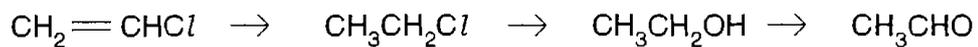
vinyl chloride   **chloroethane**   **ethanol**   **compound A**

(i) Name the reagent and conditions needed to turn **vinyl chloride** into **chloroethane**.

....

.... [2]

(ii) Classify **ethanol** as primary, secondary or tertiary, giving a reason.

....

.... [2]

(iii) Name the functional group in **compound A**.

.... [1]

(iv) Give the reagents and conditions for the conversion of **ethanol** to **compound A** in the laboratory.

....

....

.... [3]

(g) In a laboratory experiment, 10 g of **vinyl chloride**, CH_2CHCl, produced 1.5 g of **ethanol**, CH_3CH_2OH. Calculate the percentage yield of the conversion by following the method below.

A_r: C, 12; O, 16; H, 1.0; Cl, 35.5

(i) Work out the M_r values for **vinyl chloride** and for **ethanol**.

M_r vinyl chloride = ... M_r ethanol = ... [1]

(ii) Work out the number of moles in

- 10 g vinyl chloride

- 1.5 g ethanol.

moles vinyl chloride =............................... moles ethanol = ... [1]

(iii) Work out the number of moles of ethanol that would be expected if **all** the vinyl chloride were converted to ethanol.

moles ethanol = ... [1]

(iv) Work out the percentage yield.

Use the relationship $\dfrac{\text{moles of product formed}}{\text{moles of product expected}} \times 100$.

Give your answer to **two** significant figures.

yield = ...% [2]

(h) Much ethanol is made industrially from ethene.

(i) Give the reagents and conditions by which ethanol is made from ethene.

....

.... [2]

(ii) Suggest a reason, other than cost, why ethanol is **not** manufactured from vinyl chloride.

....

.... [1]

[Total: 31]

3 It has been proposed that the substance 'n-propyl bromide', $CH_3CH_2CH_2Br$, could be used as a suitable substitute for certain CFCs.

(a) **(i)** To which homologous series does n-propyl bromide belong?

.... [1]

(ii) In the box below, draw the **full structural** formula and give the systematic name of the **isomer** of n-propyl bromide.

systematic name:

[2]

(b) One possible use of n-propyl bromide is as a substitute for the chlorofluorocarbon CFC-113.

This CFC was used as a cleaning solvent for metals and electronic components.

(i) Give **one** use to which CFCs were put, other than cleaning solvents.

.... [1]

(ii) In this question, one mark is available for the quality of use and organisation of scientific terms.

Explain how the release of CFCs at the Earth's surface damages the ozone layer and suggest why n-propyl bromide might be less of a threat.

....

....

....

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.... [5]

Quality of Written Communication [1]

[Turn over

(iii) Suggest **two** factors (apart from ozone depleting potential) that must be taken into account when considering n-propyl bromide as a replacement for CFC-113.

....

.... [2]

(c) You have to prepare a sample of n-propyl bromide, $CH_3CH_2CH_2Br$, by reacting an alcohol with hydrogen bromide.

(i) Give the formula of the alcohol you would use.

.... [1]

(ii) Write a balanced chemical equation for the reaction. Include state symbols.

[2]

(iii) The liquid product is washed with various solutions and then dried. Name the drying agent you would use.

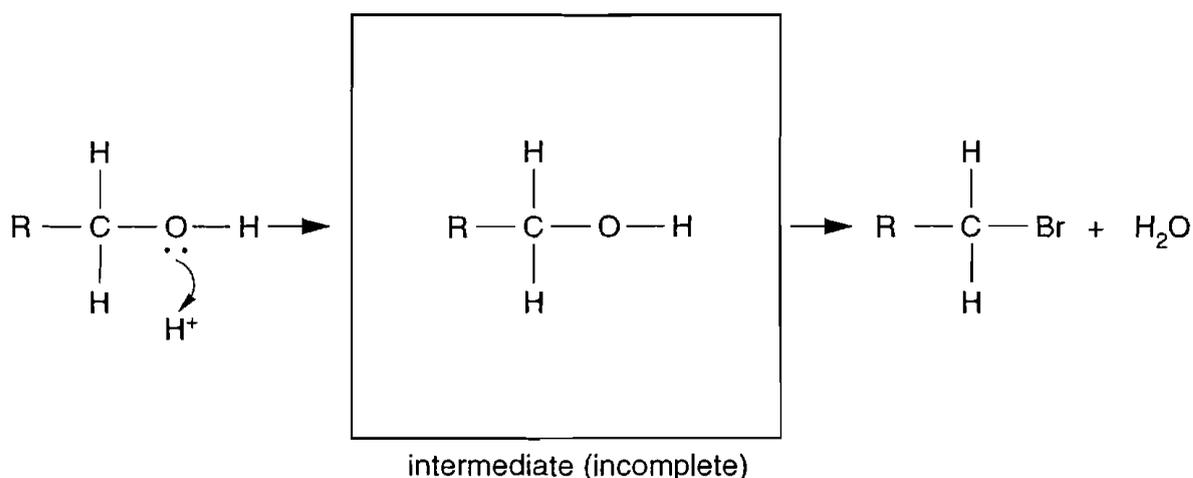..

.... [1]

(iv) Name the technique that is used finally to purify the product.

.... [1]

(v) The reaction has a nucleophilic substitution mechanism. Part of this is shown below.

Describe the mechanism by

- completing the intermediate

- showing the electron pair movements that occur when the intermediate is attacked by a bromide ion.

intermediate (incomplete)

[3]

[Total: 20]

4 There is considerable concern over rising carbon dioxide levels which most scientists think are causing global warming. This concern has prompted the British Government to charge less in road tax for cars that produce less CO_2.

(a) Cars are now more fuel efficient than they used to be and so they produce less carbon dioxide. Suggest **one** feature that has made cars more fuel efficient.

....

.... [1]

(b) Electricity generation is also a source of much carbon dioxide. Name **one** way of generating electricity that does not use fossil fuels.

....

.... [1]

(c) **(i)** Radiation that hits the Earth is re-emitted as infrared radiation. Where does the radiation that hits the Earth come from? Where does this radiation fit in the electromagnetic spectrum?

....

.... [2]

(ii) What happens to carbon dioxide molecules when they absorb infrared radiation and how does this result in a warming of the troposphere?

....

....

.... [2]

(d) The Earth's oceans act in a way that regulates the increase in carbon dioxide levels in the troposphere. The following equations describe the main reactions that occur.

$$CO_2(g) \rightleftharpoons CO_2(aq) \qquad\qquad \textbf{equation 4.1}$$

$$CO_2(aq) + H_2O(l) \rightleftharpoons H^+(aq) + HCO_3^-(aq) \qquad\qquad \textbf{equation 4.2}$$

(i) Use Le Chatelier's principle to explain the effect that increased carbon dioxide levels in the troposphere will have on the HCO_3^- concentration in the oceans.

....

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....

.... [3]

(ii) Explain the meaning of the term *dynamic equilibrium*.

....

....

.... [2]

(iii) Suggest and explain why the balance between gaseous $CO_2(g)$ and $CO_2(aq)$ in the oceans is not a true dynamic equilibrium.

....

.... [1]

(e) Carbon dioxide and silicon dioxide are both common in nature. Carbon and silicon are both in the same group of the Periodic Table and both form oxides of formula XO_2.

Explain why silicon dioxide is a solid at room temperature while carbon dioxide is a gas.

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.... [3]

[Total: 15]

END OF QUESTION PAPER