RECOGNISING ACHIEVEMENT

Oxford Cambridge and RSA Examinations

Advanced Subsidiary GCE

CHEMISTRY (SALTERS)

CHEMISTRY OF NATURAL RESOURCES

2848

Specimen Paper

Candidates answer on the question paper.
Additional materials:
Data Booklet for Chemistry (Salters)
To be brought by candidate: electronic calculator

TIME 1½ hours

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

There should be ample space for your answers. If you need more space for answers or rough work you may use the blank spaces at the end of questions or any blank pages. Rough work that is not to be marked should be crossed out.

You will be awarded marks for the quality of your written communication where an answer requires a piece of extended writing.

INFORMATION FOR CANDIDATES

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

A copy of the Periodic Table and other tables of information are provided on a data sheet for use with this examination; other necessary data are given as required in the questions.

You may use an electronic calculator.

1 In 1930 the American, Thomas Midgeley, inhaled a lungful of the CFC with formula CCl_2F_2 and used it to blow out a candle. He did this to demonstrate a new refrigerant which was both non-flammable and non-toxic.

(a) What does CFC stand for?

..... **[1]**

(b) State **two** other uses (as well as refrigerants) to which CFCs have been put.

.....

..... **[2]**

(c) In the stratosphere, CFCs are broken down to give chlorine atoms. The following two reactions then occur:

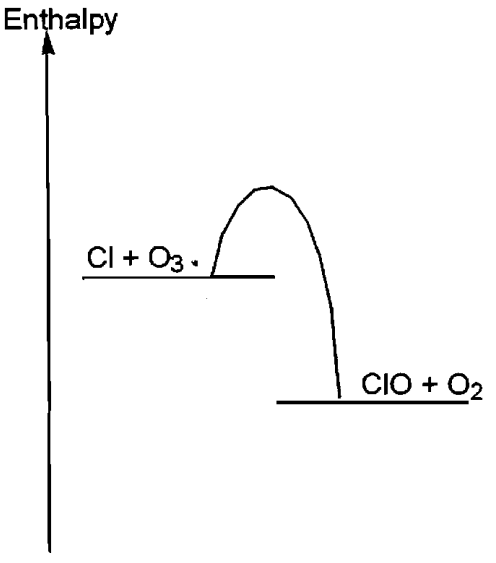
$Cl^{\bullet} + O_3 \rightarrow ClO^{\bullet} + O_2$ **Equation 1.1**

$ClO^{\bullet} + O \rightarrow Cl^{\bullet} + O_2$ **Equation 1.2**

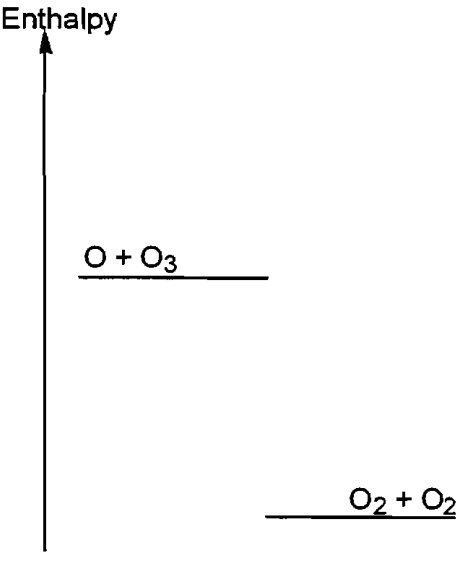
Equations 1.1 and 1.2 can be combined to give an overall equation for the reaction:

$O + O_3 \rightarrow 2O_2$ **Equation 1.3**

(i) Chlorine atoms act as **catalysts** for the reaction in **Equation 1.3**. Complete the diagram below to show the enthalpy profile of the reaction in **Equation 1.3** and mark on this diagram the **activation enthalpy** for the reaction.



Reaction in **Equation 1.1**



Reaction in **Equation 1.3**

[2]

(ii) Use **Equations 1.1-1.3** and the enthalpy diagrams in **(c) (i)** to explain how chlorine atoms act as catalysts for the reaction in **Equation 1.3**.

.....

.....

.....

..... **[4]**

(d) Chlorine atoms are sometimes described as radicals. Explain what the term **radical** means.

.....

..... **[1]**

(e) Suggest a reason why Midgeley was unaware of the drawbacks associated with CFCs.

.....

..... **[1]**

(f) Chemists are now looking for compounds to replace CFCs. Describe **two** properties which these compounds should have, as well as being non-toxic and non-flammable.

.....

..... [2]

(g) A variety of halogenoalkanes similar to Midgeley's original compound has been synthesised to see whether they might be useful. For example, CF_2I_2 has been synthesised.

(i) Give a reason why CF_2I_2 reacts faster than CCl_2F_2 with sodium hydroxide solution.

.....

..... [1]

(ii) When CF_2I_2 reacts with sodium hydroxide, iodide ions are formed in the alkaline solution. In order to test for the presence of these ions, dilute nitric acid has first to be added to neutralise the alkali. If you were doing this test, state:

the substance you would add to test for the iodide ions;

.....

..... [1]

the positive result of the test;

.....

..... [1]

and write an ionic equation (with state symbols) for the reaction.

.....

..... [2]

Total 18 marks

2 Many copper minerals are found in hydrothermal deposits where they were formed by crystallisation from very hot solutions which were trapped underground at high pressures.

(a) One such copper mineral is chalcopyrite, $CuFeS_2$, which contains both copper and iron in the +2 oxidation state. The mineral is smelted in modern works by heating with air:

$$CuFeS_2 + 10.5O_2 \rightarrow 4Cu + 2FeO + Fe_2O_3 + 8SO_2 \qquad \textbf{Equation 2.1}$$

(i) Write the electron configurations, in terms of *s*, *p* and *d* electrons for

a copper atom ..... **[2]**

a Cu^{2+} ion ..... **[1]**

(ii) Copper is reduced in this reaction. Complete the chart of oxidation states below to show two elements that are **oxidised** in the reaction.

Element		**from**	**to**
Copper	reduced	+2	0
.....	oxidised	.....	.....
.....	oxidised	.....	.....

[4]

(iii) Calculate the percentage of copper by mass in a sample of rock containing 0.50% by mass of chalcopyrite, assuming this is the only source of copper in the rock.

(A_r: Cu, 64; Fe, 56; S, 32)

[3]

(iv) Suggest an environmental problem which arises as a result of your answer to **(iii)**.

.....

.....

..... **[2]**

(b) Water draining from the waste heaps around a copper mine is often blue due to the presence of hydrated copper(II) ions. If this water runs over iron metal (such as discarded tools or railings) a redox reaction occurs. The iron becomes coated with a brown layer of copper and hydrated iron(II) ions are released in to the water.

(i) Write **half-equations** for the oxidation and reduction processes in this redox reaction.

oxidation ..... **[1]**

reduction ..... **[1]**

(ii) Write an equation (with state symbols) for the overall reaction.

..... **[2]**

(iii) The copper(II) ions in solution are said to be **hydrated**. Draw a labelled diagram of a hydrated copper(II) ion to show what this means.

[3]

(c) The rate of the reaction in **Equation 2.1** changes if the $CuFeS_2$ is ground up and if the temperature is raised. In each case, state whether the rate increases or decreases and explain your answer in terms of collisions of reactant particles and the activation enthalpy of the reaction.

(i) The effect of grinding up the $CuFeS_2$

.....

.....

..... [3]

(ii) The effect of raising the temperature

.....

.....

..... [3]

Total 25 marks

3 A manufacturer makes poly(propene) from propene monomer, $CH_3CH=CH_2$. The polymer produced has an average relative molecular mass of 1.0×10^6.

(a) Draw the full structural formula for propene.

[1]

(b) The reactions of alkenes, such as propene, with bromine can be used as a simple test for the alkene functional group.

(i) Describe how you would carry out this simple test on a liquid alkene and say what you would expect to see.

.....

.....

..... **[2]**

(ii) Which structural feature of propene is responsible for its reaction with bromine? Explain how the structural feature is involved in the first stage of the reaction mechanism.

.....

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.....

.....

..... **[4]**

(iii) Circle **two** words in the list below that describe the mechanism of the reaction between propene and bromine:

electrophilic radical nucleophilic addition substitution.

[2]

(c) (i) Draw a full structural formula which indicates clearly the structure of the repeating unit in poly(propene).

[2]

(ii) How many monomer units are joined together to give poly(propene) with a relative molecular mass of 1.0×10^6?

(A_r: C, 12; H, 1)

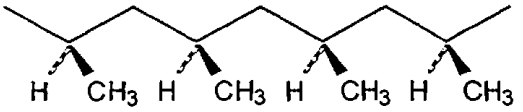
[2]

(d) Why is the mass referred to as an **average** relative molecular mass?

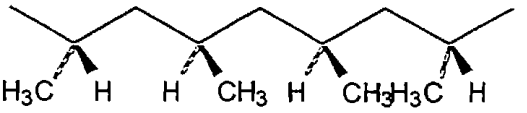
.....

..... [1]

(e) Poly(propene) can exist in two forms:



isotactic



atactic

(i) Explain with reasons which of the two forms of poly(propene) you would expect to be more crystalline.

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..... **[2]**

(ii) Explain why the more crystalline form can be used to make strong fibres for carpets.

.....

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..... **[2]**

Total 18 marks

4 Some students were investigating butter which had been allowed to 'go off'. They were able to obtain an impure sample of the substance responsible for the unpleasant smell. When they distilled this sample, they obtained a colourless liquid that boiled at around 160 °C. Further investigations showed that this liquid was butanoic acid, C_3H_7COOH.

In the space below, draw a labelled diagram of the apparatus you would use to carry out a distillation to purify the impure liquid initially obtained by the students and, at the same time, measure its boiling point accurately.

[4]

5 When oxygen is in short supply, human muscle cells can break down glucose by a process which involves the following sequence of molecules, among others:

$C_6H_{12}O_6 \rightarrow CH_2OH–CHOH–CHO \rightarrow CH_3–CO–COOH \rightarrow CH_3–CHOH–COOH$

glucose **glyceraldehyde** **pyruvic acid** **lactic acid**

The lactic acid can cause pain in muscles ('a stitch').

(a) Circle a secondary alcohol group in one of the above formulae.

[1]

(b) Draw a full structural formula for **glyceraldehyde**.

[2]

(c) Eventually, lactic acid is transported to the liver where it is oxidised back to pyruvic acid.

(i) Give the reagents and conditions you would use to oxidise lactic acid to pyruvic acid in the laboratory.

.....

..... **[3]**

(ii) State the colour change you would expect to see as this reaction proceeds.

From ..... **to** ..... **[2]**

(d) In the laboratory, the concentration of a solution of lactic acid can be found be titration with sodium hydroxide solution. The equation for the reaction is shown below:

$$CH_3–CHOH–COOH(aq) + NaOH(aq) \rightarrow CH_3–CHOH–COONa(aq) + H_2O(l).$$

25.0 cm^3 of a solution of lactic acid were titrated with a 0.0500 mol dm^{-3} solution of sodium hydroxide; 22.2 cm^3 of the sodium hydroxide solution were required. Calculate the concentration (in mol dm^{-3}) of the lactic acid solution.

[3]

(e) A student set out to show that a sample of lactic acid was pure using thin layer chromatography.

Draw a diagram and describe the steps taken. Show the expected result.

[5]

Total 16 marks

6 Carbon dioxide is used to add the 'fizz' to fizzy drinks. It is dissolved in water under pressure and when the pressure is released the 'fizz' appears.

(a) Carbon dioxide molecules contain covalent bonds. Explain carefully what you understand by the term **covalent bond.**

.....

.....

..... [3]

(b) **(i)** Use your knowledge of the bonding in carbon dioxide, the electronegativities of carbon and oxygen, and the shape of the molecule, to explain why carbon dioxide has no overall dipole. (Electronegativities: carbon, 2.5; oxygen, 3.5)

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.....

..... [3]

(ii) Name the type of bonding found **between molecules** in carbon dioxide.

..... [1]

(c) In a stoppered bottle of fizzy drink, the following chemical equilibrium exists:

$$CO_2(g) \rightleftharpoons CO_2(aq) \qquad \textbf{Equation 6.1}$$

(i) Chemical equilibria are sometimes described as dynamic equilibria. Draw a labelled diagram of the surface of the solution in a stoppered bottle of fizzy drink and use it to illustrate what you understand by the term **dynamic equilibrium** for the reaction in **Equation 6.1**.

[4]

(ii) When the stopper is removed from a bottle of fizzy drink it goes 'flat' because much of the dissolved carbon dioxide comes out of solution. Use your understanding of chemical equilibrium to explain why this happens.

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..... **[3]**

(d) The concentration of carbon dioxide in the atmosphere is gradually increasing. There are concerns that this will enhance the 'greenhouse effect' and contribute to global warming. In the space below, draw a labelled diagram to explain the **greenhouse effect** in the Earth's atmosphere and how it causes the atmosphere to warm up.

Note: In this question 1 mark is available for the quality of written communication.

[6]

(e) Silicon is in the same group of the Periodic Table as carbon, yet its oxide, SiO_2 is a covalent network structure, with each silicon atom covalently bonded to four oxygen atoms and each oxygen atom covalently bonded to two silicon atoms.

(i) Draw a diagram to illustrate this structure which shows the 3-dimensional arrangement of bonds around the silicon atom.

[1]

(ii) Use your answer to part (i) for SiO_2 and your answers to (b) for CO_2 to explain why CO_2 is a gas a room temperature whereas SiO_2 is a high-melting solid.

Note: In this question 1 mark is available for the quality of written communication.

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..... [5]

Total 26 marks