OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY (SALTERS) 2848

CHEMISTRY OF NATURAL RESOURCES

Wednesday **17 JANUARY 2001** Afternoon 1 1/2 hours

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

Candidate Name	Centre Number	Candidate Number

TIME 1 1/2 hours

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

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 the quality of written communication where this is indicated in the question.
- You may use an scientific calculator.
- You are advised to show all the steps in any calculations.
- You may use a Data Sheet for Chemistry (Salters).

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	31	
2	18	
3	34	
5	15	
TOTAL		

This question paper consists of 16 printed pages.

Registered Charity Number:1066969
[Turn over

1 Many countries have banned the use of CFCs. Unfortunately, large stockpiles of some of these materials exist owing to their previous widespread use.

(a) CFC-12 (CF_2Cl_2) is a common CFC and was widely used as a refrigerant.

(i) Give the chemical name for CFC-12.

..... [1]

(ii) CFC-12 is a liquid at room temperature. What property of this liquid makes it suitable for use as a refrigerant?

.....

..... [1]

(iii) Describe **one** use, apart from refrigerants, to which CFCs were put.

.....

..... [2]

(b) Explain the effect of CFCs on the stratosphere which led to them being banned.

.....

..... [2]

(c) Chemists have found it difficult to find effective, yet economic, ways of destroying CFCs. However, one successful method is to pass the CFC vapour through a packed bed of the sodium salt of ethanedioic acid at 270 °C. The products are essentially harmless.

(i) The molecular formula of ethanedioic acid is $C_2H_2O_4$ and the molecule contains two carboxylic acid groups joined together. Draw its full structural formula.

[2]

(ii) The sodium salt of ethanedioic acid is made by reacting the acid with sodium hydroxide. This is an example of an acid-base reaction. Explain how ethanedioic acid acts as an acid in this reaction.

.....

..... [2]

(d) The 'essentially harmless products' of the reaction in **(c)** are the solids sodium chloride, sodium fluoride and carbon. Gaseous carbon dioxide is also produced.

(i) What type of bonding holds carbon atoms together in a giant (network) structure?

..... [1]

(ii) What type of bonding holds a sodium chloride lattice together?

..... [1]

(iii) Sodium fluoride has a similar structure to sodium chloride. Draw a 3-D diagram to show how the fluoride particles are arranged around **one** sodium particle in sodium fluoride. Label each particle in your diagram with the element's symbol and charge. State the number of fluoride particles around each sodium particle.

Number of fluoride particles around one sodium particle = ...

[4]

(iv) Carbon dioxide gas consists of linear molecules.

1. Use the electronegativity values given below to draw a diagram showing the partial charges on a carbon-oxygen bond.
[Electronegativity values: C,2.6; O,3.4]

2. Explain why carbon dioxide does not have a permanent dipole.

.....

..... [2]

(v) What type of intermolecular force exists between molecules of carbon dioxide?

..... [1]

(e) Absorption of radiation by a CFC-12 (CF_2Cl_2) molecule can lead to a C—Cl bond being broken homolytically.

(i) Draw the structures of the two chemical species produced.

[2]

(ii) What **type** of chemical species is produced when covalent bonds are broken homolytically?

..... [1]

(f) When CFC-12 (CF_2Cl_2) absorbs ultraviolet radiation having a frequency of approximately 1×10^{15} Hz a C—Cl bond is broken.

(i) The bond enthalpy of a C—Cl bond is +346 kJ mol^{-1}. Calculate the energy needed to break a single C—Cl bond.

[Avogadro constant = 6.02×10^{23} mol^{-1}.]

Answer ..... [2]

(ii) Use E = *h*v to calculate the frequency of radiation needed to break a single C–Cl bond.

[$h = 6.63 \times 10^{-34}$ J Hz^{-1}.]

Answer ..... [2]

(iii) State why radiation of this frequency will not break a C–F bond.

.....

..... [1]

(g) CFC–12 is a greenhouse gas.

(i) In which part of the atmosphere does the greenhouse effect take place?

..... [1]

(ii) A greenhouse gas, such as CFC-12, causes global warming. Explain this in terms of the behaviour of the gas molecules.

.....

.....

.....

..... [3]

[Total: 31]

2 Low density poly(ethene) (ldpe) was discovered by accident. Since then, chemists have been able to design catalysts which have led to the production of several improved types of poly(ethene). The first successful catalysts were discovered by Ziegler and Natta. The polymer then produced was called high density poly(ethene) (hdpe).

(a) (i) What name is given to the **type** of polymerisation by which both ldpe and hdpe are formed?

..... [1]

(ii) Draw a diagram to represent the structure of a length of poly(ethene) chain containing **three** monomer units.

[2]

(b) When a Ziegler-Natta catalyst is used to produce hdpe the catalyst is incorporated into the polymer chain. Suggest why it is strictly incorrect to use the term 'catalyst' in the production of hdpe.

.....

..... [1]

(c) (i) Describe how the polymer chains differ between hdpe and ldpe and how this affects the crystallinity of the polymer.

.....

.....

..... [2]

(ii) Explain why hdpe is denser and more rigid than ldpe.

.....

.....

..... [3]

(d) Recently a new type of catalyst has been developed for the polymerisation of ethene. The compounds used are called metallocenes. Poly(ethene) produced using a metallocene catalyst can be used as very thin films, which are impermeable to air and moisture.

(i) Suggest an important use for this type of film.

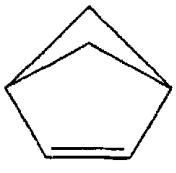
..... [1]

(ii) Using metallocenes it is now possible to make co-polymers of ethene and propene. What is a *co-polymer*?

.....

..... [1]

(e) Metallocenes can be used to make a co-polymer of ethene and norbornene. This copolymer is likely to be used for the next generation of compact discs. The skeletal formula of norbornene is shown below.

Norbornene 

(i) Give the molecular formula for norbornene.

..... [2]

(ii) Draw a section of the co-polymer chain involving one molecule of ethene and one molecule of norbornene.

[2]

(iii) Bromine can be used in a test to show that norbornene is an unsaturated compound. Describe the change that you would see during the test.

Observations: .....

..... [2]

(iv) The reaction of bromine with norbornene is an example of an electrophilic addition reaction. Give the formula of the electrophile in the reaction.

..... [1]

[Total: 18]

3 Many domestic bleaches are alkaline solutions containing sodium hypochlorite, NaOC*l*. One way of making these solutions is by dissolving chlorine in cold sodium hydroxide. **Equation 3.1** shows the reaction which takes place.

$$Cl_2(aq) + 2NaOH(aq) \rightleftharpoons NaCl(aq) + NaOCl(aq) + H_2O(l) \qquad \textbf{Equation 3.1}$$

(a) **(i)** The symbol $\rightleftharpoons$ in **Equation 3.1** means that the reaction reaches dynamic equilibrium. Explain the term *dynamic equilibrium.*

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.....

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..... [3]

(ii) What would be the effect on the equilibrium position of decreasing the sodium hydroxide concentration?

.....

..... [1]

(iii) Labels on bleaches state that chlorine is dangerous. Suggest and explain the reason why manufacturers of hypochlorite bleaches have to make sure that the pH of the bleach is high.

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..... [3]

(b) **(i)** Complete the table below by giving the oxidation state of chlorine in each substance.

Substance	Oxidation State
Cl_2	
ClO^-	
Cl^-	

[3]

(ii) What is both oxidised and reduced in the reaction given in **Equation 3.1**?

..... [1]

Solutions of sodium hypochlorite in water can react with organic matter to form trace amounts of compounds which are suspected carcinogens. One such compound is chloromethane, CH_3Cl. In the U.K. the government has set a limit of 1.0×10^{-4} ppm by mass for chloromethane in drinking water.

(c) What is the maximum mass of chloromethane allowed in 1000 g of drinking water?

Answer ..... [3]

(d) **(i)** Chloromethane reacts with warm aqueous alkali to form an alcohol. Give the **full structural formula** of the alcohol that would be formed.

[1]

(ii) Name the alcohol formed in the reaction in **(i)**.

..... [1]

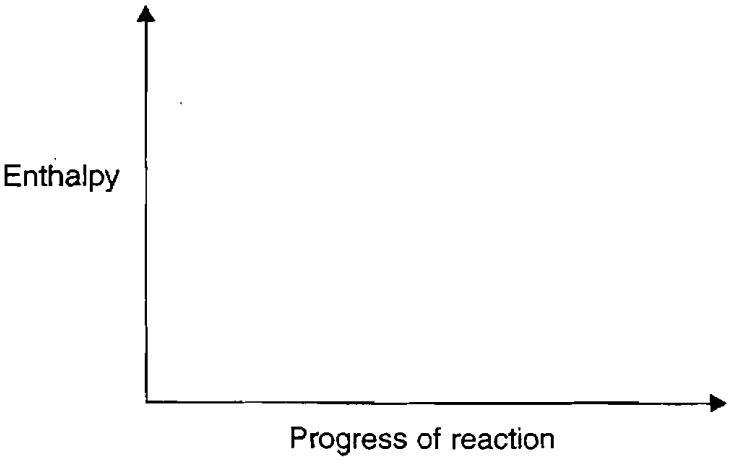
(iii) The reaction in **(i)** is an example of nucleophilic substitution.

1. Identify the nucleophile in the reaction.

..... [1]

2. The reaction is exothermic and takes place in a single step. Complete the enthalpy profile diagram shown below for the reaction. Label the following features,

reactants; products; enthalpy change for the reaction; activation enthalpy.



[4]

(e) The use of hypochlorite bleaches has been discouraged in schools, hospitals and workplaces. This is because there have been several accidents reported when staff cleaning toilets have used bleach and lime descalers together.

Some descalers contain hydrochloric acid. Using **Equation 3.1**, describe and explain why mixing descalers and bleaches can lead to accidents. (In this question 1 mark is available for the quality of written communication.)

$Cl_2(aq) + 2NaOH(aq) \rightleftharpoons NaCl(aq) + NaOCl(aq) + H_2O(l)$ **Equation 3.1**

.....

.....

.....

.....

.....

.....

..... [6]

(f) The amount of alkali in a sodium hypochlorite solution can be found by titration with a standard solution of hydrochloric acid.

(i) Describe how an acid-alkali titration is carried out using an indicator. (In this question 1 mark is available for the quality of written communication.)

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..... [6]

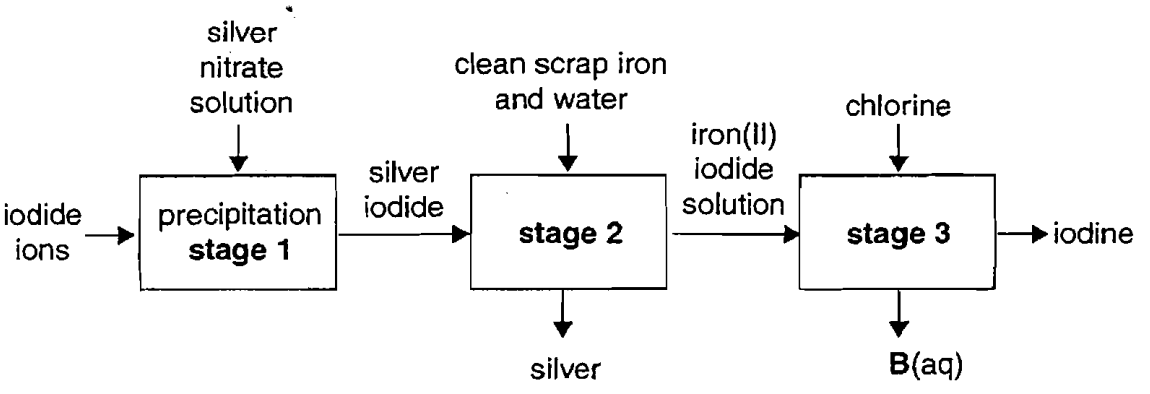
(ii) A student attempted this but had problems in finding the end point when titrating the sodium hypochlorite solution. Suggest a reason why the student had problems.

.....

..... [1]

[Total: 34]

5 Some sources of underground brine contain iodide ions in high enough concentrations to make them an economic source of iodine. The flow diagram below outlines the essentials of the extraction process.



(a) (i) Write an ionic equation (with state symbols) for the reaction between aqueous silver ions and aqueous iodide ions.

..... [2]

(ii) The concentration of iodide ions in the brine is 8.00×10^{-4} mol dm^{-3}.
Calculate the minimum volume of 0.100 mol dm^{-3} silver nitrate solution needed to precipitate out all the silver iodide from 1.00 dm^3 of this iodide solution.

Answer ..... [3]

(iii) What will be the maximum mass of silver iodide obtainable from 1.00 dm^3 of the iodide solution?
[A_r: Ag, 108; I, 127]

Answer ..... [2]

[Turn over

(b) (i) The silver metal from **stage 2** is recovered. Suggest how the chemical plant operators would use the silver metal in this process.

..... [1]

(ii) Identify the compound **B**(aq) produced as a waste product in **stage 3**.

..... [1]

(iii) The reactions occurring in **stages 2** and **3** are redox reactions.

- Complete the following equations for these reactions.
- Circle the oxidising agent in each case.
- Balance the completed equations.

stage 2 $Fe + Ag^+ \rightarrow .... + Ag$

stage 3 $Cl_2 + ... \rightarrow Cl^- + I_2$

[6]

[Total: 15]