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TURN OVER FOR QUESTION 1



SECTION A

1. Some metals in Groups 1 and 2 of the Periodic Table react with cold water to form a solution of the metal hydroxide and a gas.

(a) How many electrons are in the outer shell of the atoms of the metals in Group 1 and Group 2?

Group 1

Group 2

(2)

(b) (i) Write a **word** equation for the reaction between sodium and water.

.....

(1)

(ii) Describe **two** observations that you could make during this reaction.

1

2

(2)

(c) Litmus is used to test for one of the products of this reaction.

(i) What type of substance is litmus?

.....

(1)

(ii) How does it show that this product is present?

.....

(1)



(d) Magnesium reacts very slowly with cold water but more quickly when it is heated in steam, forming an oxide instead of a hydroxide.

(i) Write a chemical equation for the reaction of magnesium with steam.

.....
(1)

(ii) What colour is the oxide formed?

.....
(1)

(e) The reactivities of sodium, potassium and magnesium are different. State which of the three is the

most reactive

least reactive

(2)

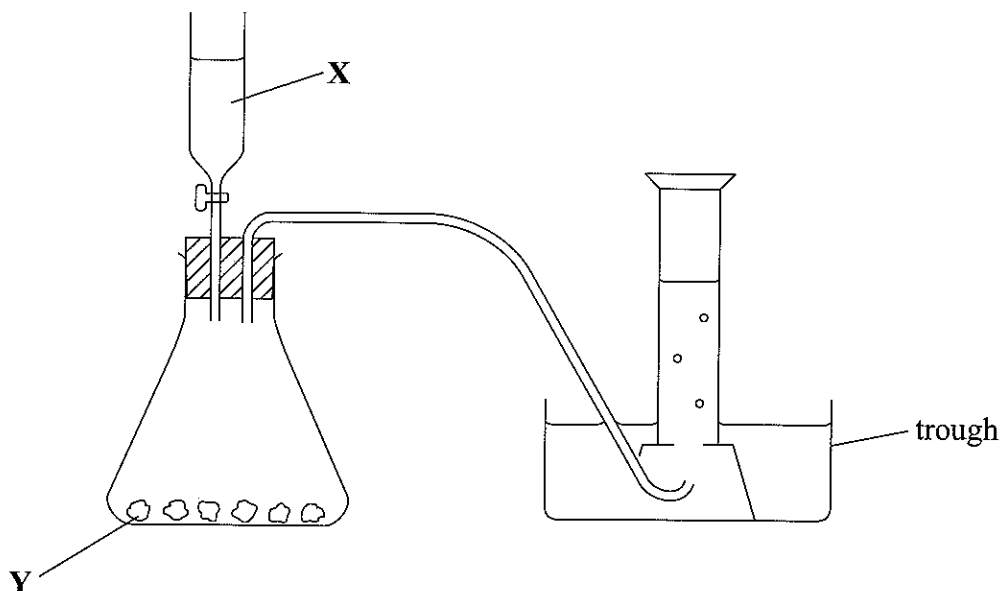
(Total 11 marks)

Q1

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2. The diagram shows apparatus for preparing carbon dioxide gas in the laboratory.



(a) Calcium chloride and water are also products of this reaction. Identify the reactants X and Y.

X

Y

(2)

(b) The diagram shows carbon dioxide gas being collected over water. Suggest one other way to collect the gas.

.....

(1)



(c) By the end of the experiment the water in the trough is acidic. A sample is tested with universal indicator.

(i) State the colour of universal indicator at the end of the test.

.....
(1)

(ii) Name the acid formed in the water and give its formula.

Name

Formula
(2)

(iii) Define an acid in terms of proton transfer.

.....
.....
(1)

(d) The melting point of calcium chloride is very much higher than that of water. State the type of bonding in

calcium chloride

water
(2)

(e) State one industrial use of carbon dioxide.

.....
(1)

(f) Explain why carbon dioxide used in industry is **not** obtained from air.

.....
(1)

(Total 11 marks)

Q2

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3. Crude oil is a source of useful chemicals.

(a) Complete the sentence.

Most of the compounds in crude oil are composed of the elements

..... and (1)

(b) During refining, crude oil is first separated into fractions.

(i) What is the name of the process used to obtain fractions from crude oil?

..... (1)

(ii) What is meant by the term **fraction**?

.....
..... (1)

(iii) Describe how the fractions are obtained.

.....
.....
.....
.....
.....
..... (3)



(c) Four of the fractions obtained from crude oil are

- diesel
- fuel oil
- gasoline
- kerosene

(i) Which of these four fractions catches fire most easily?

..... (1)

(ii) Which of these four fractions is least volatile?

..... (1)

(iii) Name two other fractions obtained from crude oil.

- 1
 - 2
- (2)

(d) Many substances obtained from the fractions are used as fuels. It is important that the combustion of fuels is complete.

(i) Name the gas produced when combustion is **incomplete**.

..... (1)

(ii) Explain why this gas can be dangerous.

.....
.....
..... (2)

(Total 13 marks)

Q3

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4. Aluminium is extracted from its oxide by electrolysis.

(a) Give two reasons why cryolite is used in the electrolysis of aluminium oxide.

- 1
 -
 - 2
 -
- (2)

(b) The same material is used for both the positive and negative electrodes.

(i) What is this material?

.....

(1)

(ii) Which gas is produced by electrolysis at the positive electrodes?

.....

(1)

(iii) Explain why these electrodes are replaced at regular intervals.

.....

(1)

(c) Explain why aluminium cannot be extracted using coke in a blast furnace.

.....

.....

(1)

(d) State **one** major cost involved in the extraction of aluminium but **not** in the extraction of iron.

.....

(1)



(e) The uses of aluminium are related to its properties. Complete the table by giving a **different** property for each use.

Use	Property
aeroplanes	
drinks cans	easily moulded
overhead power cables	
pans for cooking food	

(3)

(Total 10 marks)

Q4

TOTAL FOR SECTION A: 45 MARKS



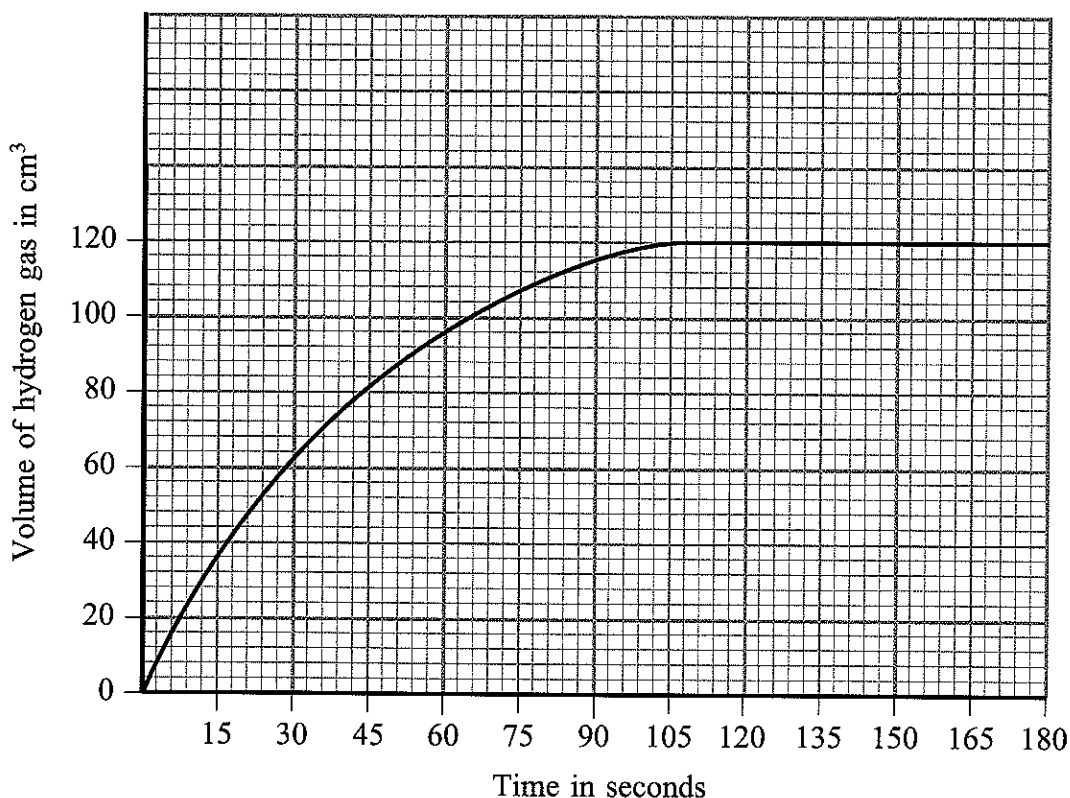
SECTION B

5. A student added a 20 cm length of magnesium ribbon to 50 cm³ of 0.1 mol dm⁻³ hydrochloric acid. The magnesium was in excess. Hydrogen gas and magnesium chloride were formed. The volume of hydrogen gas formed was measured every 15 seconds.

(a) Write a chemical equation, with state symbols, for this reaction.

.....
(3)

(b) The graph shows the results of the experiment.



- (i) The student repeated the original experiment using 50 cm³ of 0.1 mol dm⁻³ hydrochloric acid and the same mass of magnesium **powder**. On the graph, sketch a line to show the results obtained. Label your line A. (2)
- (ii) The student repeated the original experiment using 50 cm³ of 0.05 mol dm⁻³ hydrochloric acid and the same length of magnesium ribbon. On the graph, sketch a line to show the results obtained. Label your line B. (2)



(c) Explain why increasing the temperature of the acid makes the reaction faster.

.....
.....
.....
.....
.....

(3)

(d) Describe a test to show that the solution formed contains chloride ions.

Test

.....
.....

Result

.....

(3)

(Total 13 marks)

Q5

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6. (a) Chlorine is manufactured by the electrolysis of brine (concentrated sodium chloride solution). The electrolysis is carried out in a diaphragm cell using metal electrodes.

(i) Which metal is used for the anode?

.....
(1)

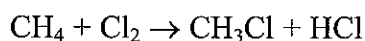
(ii) Which particles enable a metal to conduct electricity?

.....
(1)

(iii) Identify the particles which enable brine to conduct electricity.

.....
.....
(2)

(b) Chlorine reacts with methane. An equation for the reaction is



(i) What condition is normally used to start the reaction?

.....
(1)

(ii) What is seen when a strip of damp blue litmus paper is put into the reaction mixture **before** the reaction starts?

.....
(1)

(iii) What is seen when a strip of damp blue litmus paper is put into the reaction mixture **after** the reaction is complete?

.....
(1)



(c) When chlorine reacts with ethane the composition by mass of one of the compounds formed is 24.24% carbon, 4.04% hydrogen and 71.72% chlorine. The relative formula mass of this compound is 99.

(i) Calculate the empirical formula of the compound.

(3)

(ii) Calculate the molecular formula of the compound.

(1)

Q6

(Total 11 marks)



7. Ethanol can be made by fermentation or by the reaction of ethene with steam in the presence of a phosphoric acid catalyst.

Two companies want to produce ethanol for different purposes. The table gives some information about the companies.

	Company A	Company B
Location of company	In agricultural area.	Semi-desert area, near oil refinery.
Reason ethanol required	To obtain a dilute solution for conversion to vinegar.	As a solvent.

- (a) Which method of production should each company use? Give a reason for each choice.

Method used by company A

Reason

.....

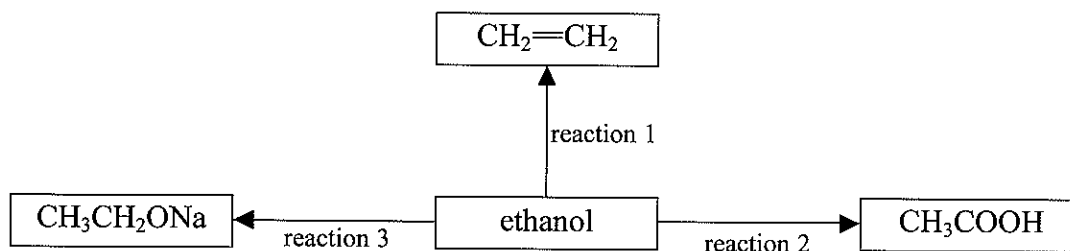
Method used by company B

Reason

.....

(4)

- (b) Ethanol can be converted to a number of other substances.



Give the name of the reagent used in each reaction.

Reaction 1

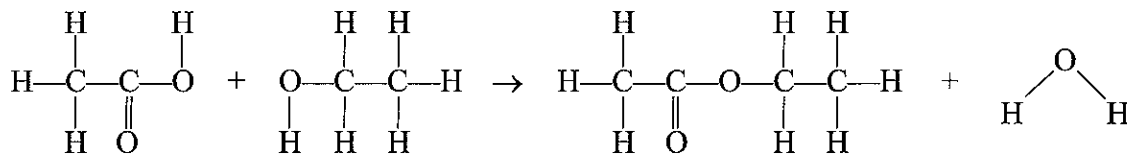
Reaction 2

Reaction 3

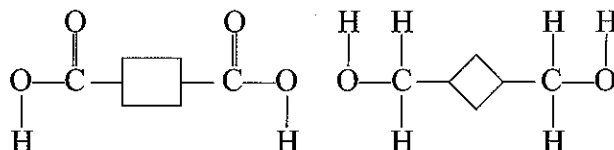
(3)



(c) Ethanol can be reacted with a carboxylic acid to form an ester. The equation shows the formation of the ester ethyl ethanoate.



A similar reaction is carried out using an alcohol and an acid, each containing two functional groups.



(i) Draw a diagram to show the structure of the polymer formed when these two compounds react together. You must make the repeat unit of the polymer clear.

(2)

(ii) What is the name of this type of polymer?

.....

(1)

(Total 10 marks)

Q7



8. Iron and zinc can be extracted in a blast furnace. For both metals the raw materials include coke and hot air.

(a) Give the chemical equation for the reaction that is the main source of heat in a blast furnace.

.....
(2)

(b) In a blast furnace the metal oxides are reduced by carbon monoxide, CO. Write chemical equations for the reduction of zinc oxide, ZnO, and iron(III) oxide, Fe₂O₃.

Zinc oxide

Iron(III) oxide

(3)

(c) In the extraction of iron, limestone is added to remove acidic impurities such as silicon dioxide, SiO₂. How does limestone remove silicon dioxide from the iron?

.....

(4)

(d) In the extraction of zinc there is no need to add limestone to remove silicon dioxide. The temperature inside a blast furnace is over 1500 °C. Use the data in the table to explain why the zinc produced does not contain any silicon dioxide.

Substance	Melting point (°C)	Boiling point (°C)
silicon dioxide	1610	2230
zinc	420	907
zinc oxide	1975	decomposes

.....

(3)



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(e) Blocks of zinc are sometimes attached to the bottom of steel ships. Explain why.

.....

.....

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.....

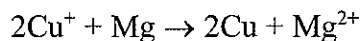
(3)

Q8

(Total 15 marks)



9. When copper(I) oxide is heated with magnesium a redox reaction occurs. The ionic equation for this reaction is



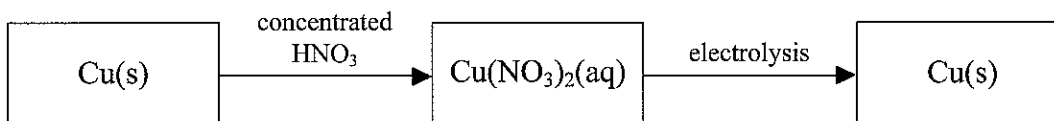
(a) Identify the oxidising agent in this reaction, explaining your choice.

Oxidising agent

Explanation

(2)

(b) The copper produced in this reaction is impure. It can be purified in two stages.

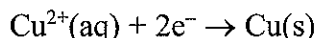


Describe what you would see when copper reacts with concentrated nitric acid.

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(2)

(c) In the electrolysis of copper nitrate solution, pure copper is deposited at the negative electrode.



A current of 32 amperes is passed for 5 minutes. Calculate the mass of pure copper formed.

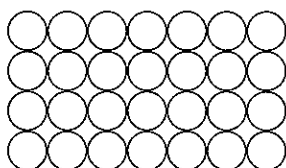
(1 faraday = 96 000 coulombs)

.....

(4)



(d) (i) Pure copper is very soft and malleable. The diagram shows the arrangement of the atoms in pure copper.



○ a copper atom

Explain why copper is very malleable.

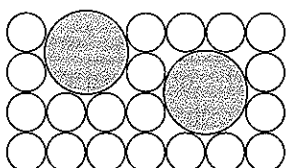
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.....

.....

(2)

(ii) Bronze is a mixture of tin and copper. Bronze is harder and less malleable than pure copper. The diagram shows the arrangement of atoms in bronze.



○ a copper atom

● a tin atom

Use the diagram to help you suggest why bronze is not as malleable as copper.

.....

.....

.....

(2)

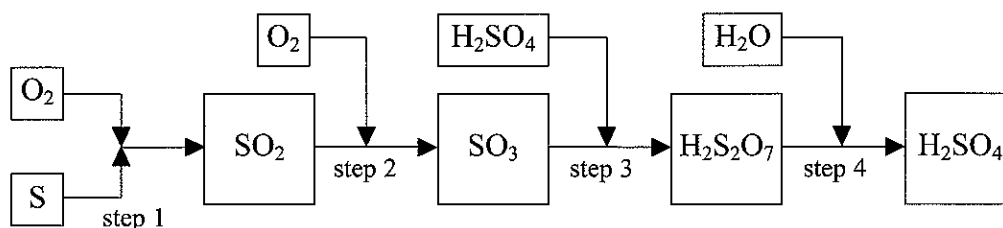
(Total 12 marks)

Q9

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10. The flow chart shows the steps in the manufacture of sulphuric acid.

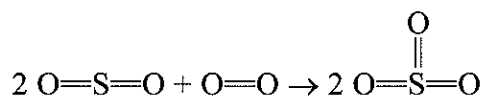


(a) Balance the equation to give the overall reaction that occurs.



(1)

(b) The following equation represents what happens in step 2.



The table shows some average bond dissociation energies.

Bond	Bond energy (kJ/mol)
O=O	496
S=O	493

(i) Calculate the energy change, ΔH , for the reaction in step 2.

Energy taken in to break bonds	Energy given out from making bonds

$\Delta H = \dots\dots\dots$

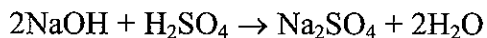
(3)



(ii) Draw a fully labelled energy profile for the reaction in step 2.

(3)

(c) Sodium hydroxide solution reacts with dilute sulphuric acid according to the equation



A 10.0 cm³ sample of dilute sulphuric acid was titrated with 0.100 mol dm⁻³ sodium hydroxide solution. It was found that 16.70 cm³ of the sodium hydroxide solution were needed to neutralise the acid.

(i) Outline how, in this titration, you would

- measure the volumes of the solutions used
- accurately determine the end-point.

.....

.....

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.....

.....

.....

.....

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.....

.....

.....

.....

(4)

QUESTION 10 CONTINUES ON NEXT PAGE



(ii) Calculate the amount, in moles, of sodium hydroxide in 16.70 cm^3 of $0.100 \text{ mol dm}^{-3}$ sodium hydroxide solution.

(1)

(iii) Calculate the amount, in moles, of sulphuric acid that reacts with this amount of sodium hydroxide.

(1)

(iv) Calculate the concentration, in mol dm^{-3} , of the sulphuric acid.

(1)

Q10

(Total 14 marks)

TOTAL FOR SECTION B: 75 MARKS

TOTAL FOR PAPER: 120 MARKS

END

