

Combined Science

Paper 2

Higher Tier

Total Marks

Thursday 14 May 2020 – Morning

Time: 1 hour 10 minutes plus your additional time allowance

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

Calculator, ruler

YOU WILL BE GIVEN

Nil

INSTRUCTIONS

Answer ALL questions.

Answer the questions in the spaces provided – there may be more space than you need.

Calculators may be used.

Any diagrams may NOT be accurately drawn, unless otherwise indicated.

You must SHOW ALL YOUR WORKING OUT with YOUR ANSWER CLEARLY IDENTIFIED at the END OF YOUR SOLUTION.

INFORMATION

The total mark for this paper is 60.

The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.

In questions marked with an ASTERISK (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

A periodic table is provided.

ADVICE

Read each question carefully before you start to answer it.

Try to answer every question.

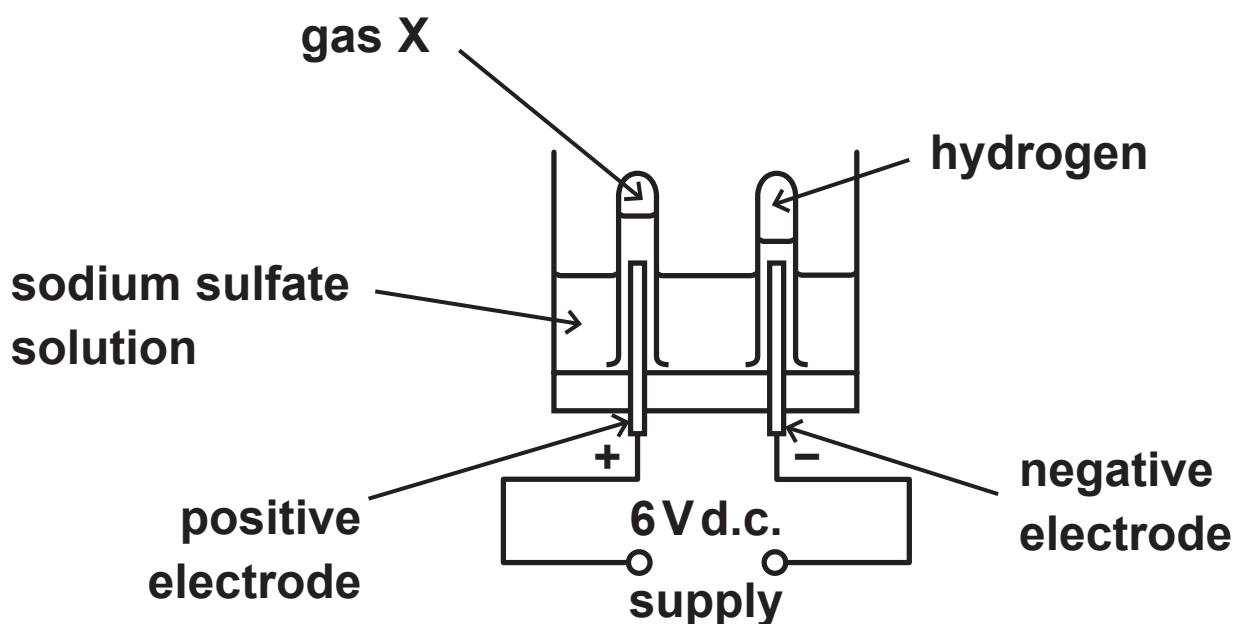
Check your answers if you have time at the end.

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

- 1 Figure 1 shows the apparatus that can be used to electrolyse sodium sulfate solution using inert electrodes.

FIGURE 1



(continued on the next page)

1 continued.

(a) Hydrogen is produced at the negative electrode during electrolysis.

**(i) Describe the test to show the gas is hydrogen.
(2 marks)**

(continued on the next page)

1 continued.

(ii) What is the name of gas X that forms at the positive electrode? (1 mark)

- ☐ **A ammonia**
- ☐ **B oxygen**
- ☐ **C nitrogen**
- ☐ **D sulfur dioxide**

**(iii) State what is meant by the term
ELECTROLYSIS. (2 marks)**

(continued on the next page)

1 continued.

- (b) The sodium sulfate solution was made by dissolving 28.4 g of sodium sulfate in water to make 250 cm³ of solution.

Calculate the concentration of this solution in g dm⁻³.

Give your answer to three significant figures.
(3 marks)

concentration = _____ g dm⁻³

(continued on the next page)

1 continued.

(c) The ions present in sodium sulfate are

sodium	Na^+
sulfate	SO_4^{2-}

Write the formula of sodium sulfate using this information. (1 mark)

(TOTAL FOR QUESTION 1 = 9 MARKS)

- 2 The word equation for the reaction between copper carbonate and dilute sulfuric acid is



- (a) (i) Complete the balanced equation for this reaction. (2 marks)



- (ii) Calculate the relative formula mass of copper carbonate, CuCO_3 .

(relative atomic masses: C = 12.0, O = 16.0, Cu = 63.5) (2 marks)

relative formula mass of CuCO_3 =

(continued on the next page)

Turn over

2 continued.

(iii) What is the chemical test to show that a gas is carbon dioxide? (1 mark)

- ☐ **A bubble the gas through limewater, limewater turns cloudy**
- ☐ **B put damp blue litmus paper in the gas, litmus paper turns red**
- ☐ **C put a lighted splint into the gas, the splint is extinguished**
- ☐ **D measure the pH of the gas, pH = 4**

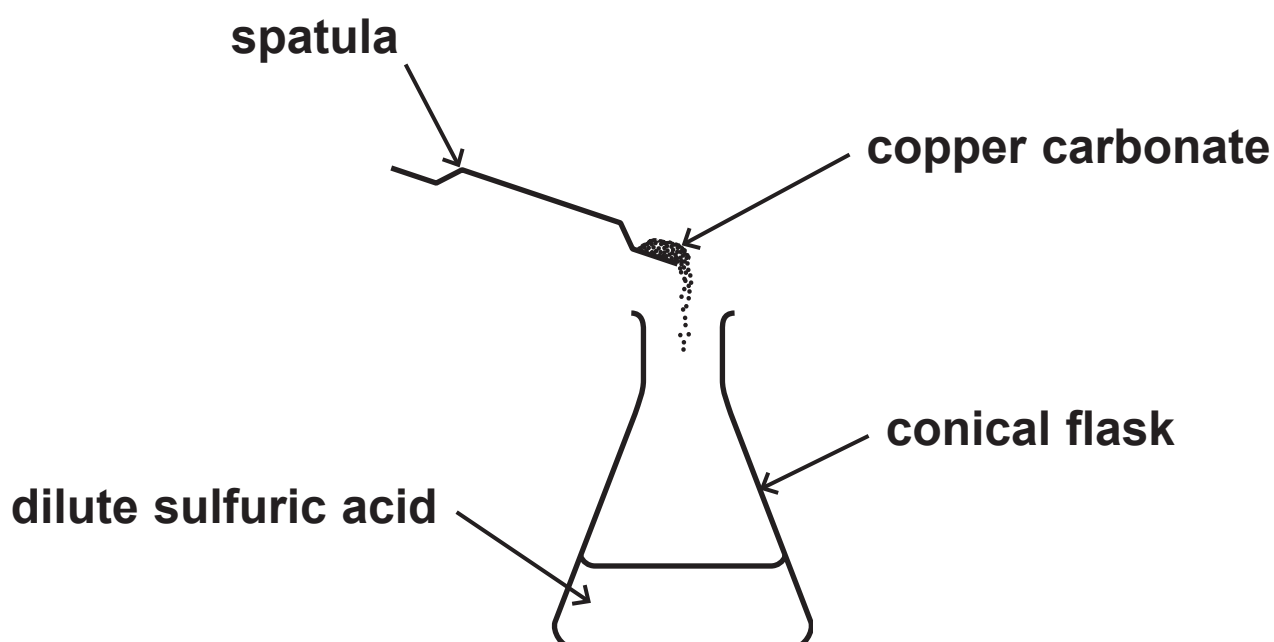
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2 continued.

(b) Figure 2 shows a conical flask containing dilute sulfuric acid.

**Copper carbonate is added to the acid in the flask.
The copper carbonate is added one spatula
measure at a time until the reaction has finished.**

FIGURE 2



(continued on the next page)

2 continued.

State TWO observations that would show the reaction has finished. (2 marks)

1 _____

2 _____

(continued on the next page)

2 continued.

- (c) The electronic configuration of carbon is 2·4
The electronic configuration of oxygen is 2·6**

**Draw a dot and cross diagram for a molecule of
carbon dioxide.**

Show outer electrons only. (2 marks)

(TOTAL FOR QUESTION 2 = 9 MARKS)

- 3 (a) A sample of rock salt contains a mixture of sodium chloride and some insoluble substances.**

The rock salt is added to water and the mixture stirred.

The mixture is then filtered to obtain a filtrate of sodium chloride solution.

- (i) Draw a labelled diagram of the apparatus used to filter the mixture and collect the sodium chloride solution. (2 marks)**

3 continued.

(ii) Describe how a sample of pure, dry sodium chloride crystals can be obtained from the filtrate. (3 marks)

(continued on the next page)

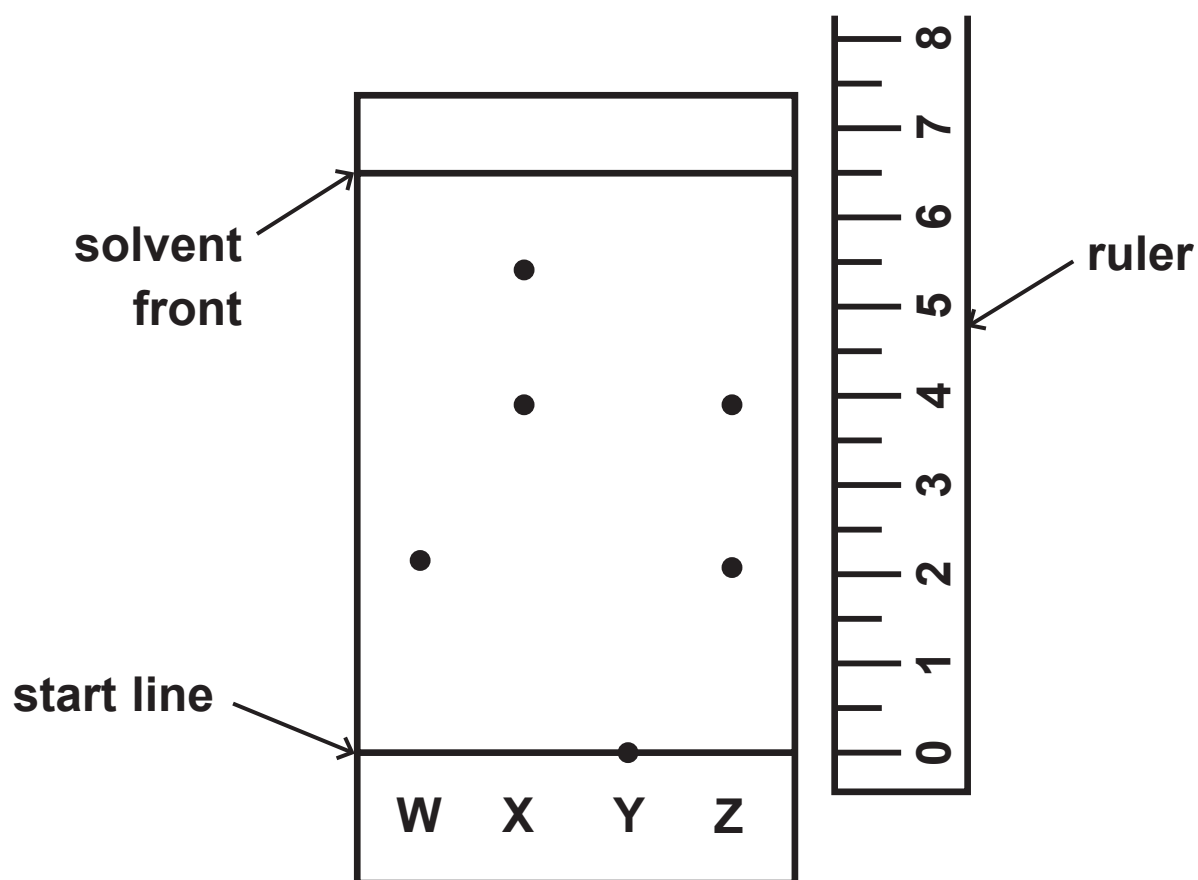
3 continued.

(b) Inks contain coloured dyes.

Samples of four inks, W, X, Y and Z, were separated using paper chromatography.

Figure 3 shows the chromatogram obtained.

FIGURE 3



(continued on the next page)

3 continued.

- (i) In the experiment, the solvent front moved 6.5 cm.**

Calculate the R_f value of the dye that is present in both inks X and Z. (1 mark)

$R_f =$ _____

- (ii) State what could be changed in the experiment to make the R_f value more accurate. (1 mark)**

(continued on the next page)

3 continued.

(iii) In this experiment, ink sample Y did not move from the start line.

Explain a change to the experiment that would be needed to separate the dyes in ink sample Y. (2 marks)

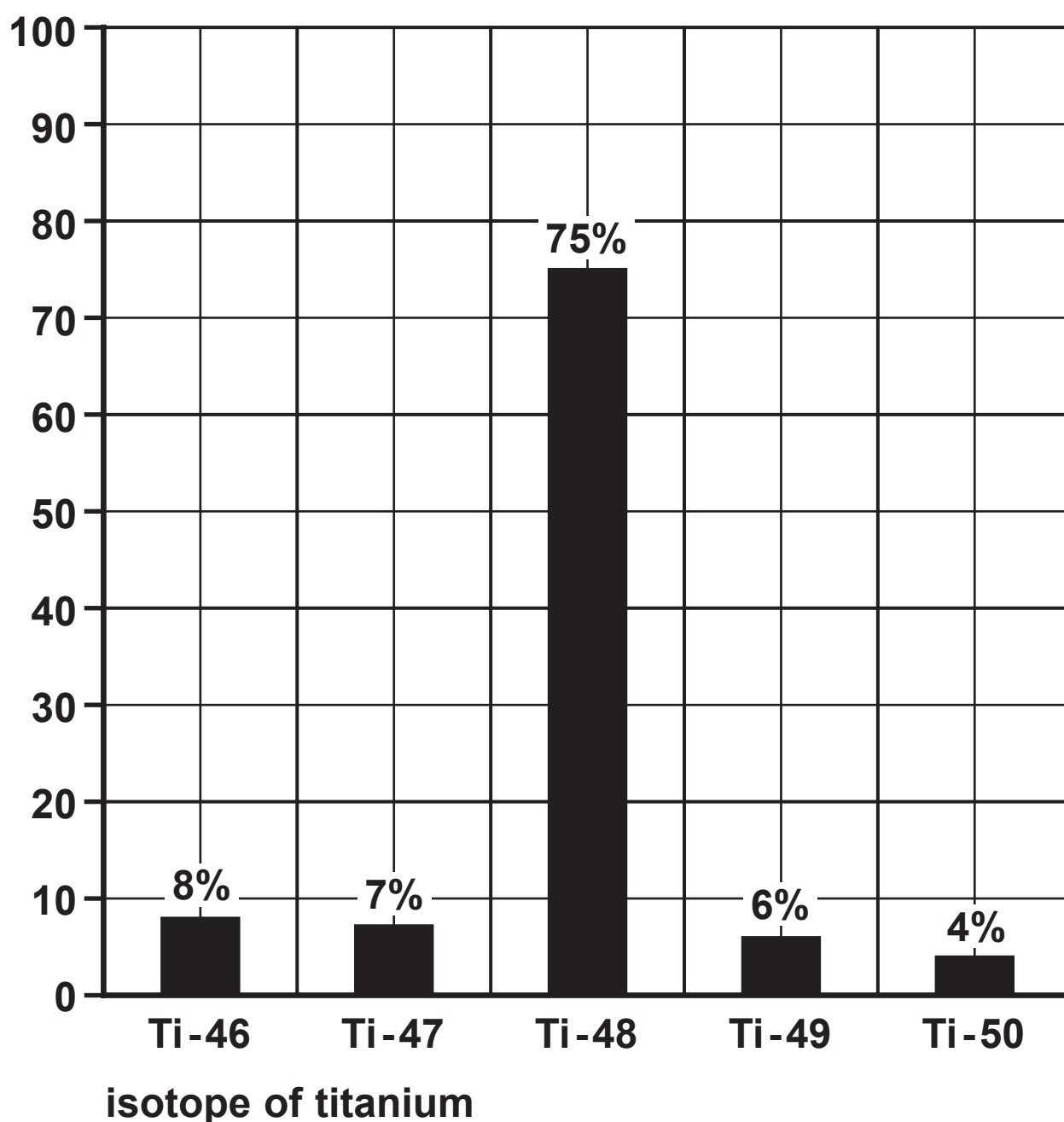
(TOTAL FOR QUESTION 3 = 9 MARKS)

4 Titanium and iron are examples of transition metals.

(a) Figure 4 shows the percentage abundance of each isotope in a sample of titanium.

FIGURE 4

percentage
abundance



(continued on the next page)

Turn over

4 continued.

Calculate the relative atomic mass of titanium in this sample. (3 marks)

relative atomic mass = _____

(continued on the next page)

Turn over

4 continued.

(b) Iron, when heated in air, reacts with oxygen to form iron oxide.

**(i) This reaction is an example of
(1 mark)**

☐ **A crystallisation**

☐ **B distillation**

☐ **C neutralisation**

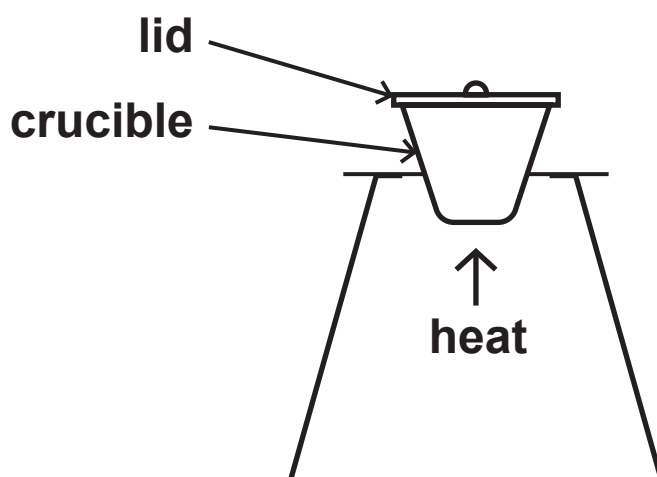
☐ **D oxidation**

(continued on the next page)

4 continued.

- (ii) The equipment shown in Figure 5 can be used to find the mass of oxygen that combines with iron.

FIGURE 5



Describe how the equipment shown in Figure 5 could be used to find the mass of oxygen that combines with 0.500 g of iron wool in a crucible and lid of known mass.
(3 marks)

4 continued.

(continued on the next page)

4 continued.

(c) 2.24 g of iron combines with 0.96 g of oxygen to form an oxide of iron.

Determine the formula of this oxide of iron and use it to complete the balanced equation.

(relative atomic masses: Fe = 56.0, O = 16.0)

You must show your working. (4 marks)

(continued on the next page)

4 continued.

balanced equation for the reaction is

_____ Fe + _____ O₂

→ _____

(TOTAL FOR QUESTION 4 = 11 MARKS)

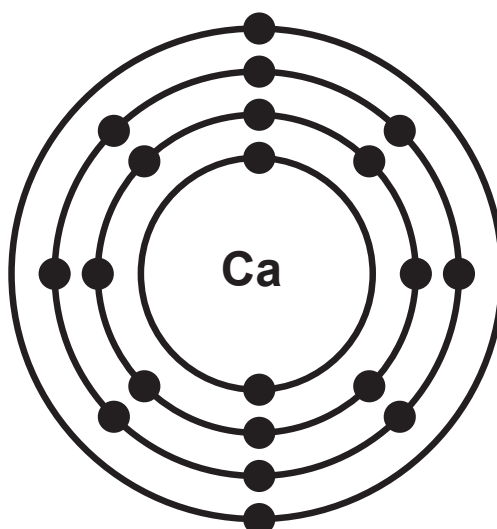
- 5 (a) Calcium has an atomic number of 20.
A calcium atom has a mass number of 40.

(i) Which row of the table shows the number of protons and number of neutrons in this atom of calcium? (1 mark)

	NUMBER OF PROTONS	NUMBER OF NEUTRONS
<input type="checkbox"/> A	20	20
<input type="checkbox"/> B	40	20
<input type="checkbox"/> C	20	60
<input type="checkbox"/> D	60	20

(ii) Figure 6 shows the arrangement of electrons in an atom of calcium.

FIGURE 6



5 continued.

Explain, using the information in Figure 6, in which period of the periodic table calcium can be found. (2 marks)

(continued on the next page)

5 continued.

(b) Calcium and potassium react with water in similar ways.

(i) One similarity in the reactions is that hydrogen gas is produced.

State ONE other similarity in the products of the reactions of calcium and potassium with water. (1 mark)

(ii) Potassium is higher in the reactivity series than calcium and reacts more vigorously with water than calcium reacts with water.

State why potassium is higher in the reactivity series and reacts more vigorously with water than calcium. (1 mark)

(continued on the next page)

5 continued.

*(c) Calcium chloride can be prepared by the reaction of calcium with chlorine gas.

Figure 7 shows some properties of calcium, chlorine and calcium chloride.

FIGURE 7

SUBSTANCE	RELATIVE MELTING POINT	ABILITY TO CONDUCT ELECTRICITY	
		WHEN SOLID	WHEN MOLTEN
calcium	high	good	good
chlorine	low	poor	poor
calcium chloride	high	poor	good

(continued on the next page)

5 continued.

Explain, in terms of bonding and structure, why the properties of the product, calcium chloride, are different from the properties of the reactants, calcium and chlorine. (6 marks)

5 continued.

[illegible]

5 continued.

[illegible]

5 continued.

[illegible]

5 continued.

(TOTAL FOR QUESTION 5 = 11 MARKS)

6 (a) Dilute hydrochloric acid is a strong acid.

(i) Explain why dilute hydrochloric acid is described as a strong acid. (2 marks)

(ii) 1 cm^3 of hydrochloric acid of pH 2 is made up to a volume of 10 cm^3 with distilled water.

State the pH of the new solution. (1 mark)

pH = _____

(continued on the next page)

6 continued.

- (b) Magnesium oxide reacts with dilute hydrochloric acid to produce magnesium chloride solution and water.**



**Write the ionic equation for this reaction.
(3 marks)**

- (c) In an experiment magnesium hydroxide powder is added in 0.1 g portions to 25 cm³ of dilute hydrochloric acid until the magnesium hydroxide is just in excess.**

Universal indicator paper can be used to test the pH of the solution after each addition of magnesium hydroxide.

- (i) Give the name of an alternative piece of equipment that can be used to measure pH.
(1 mark)**
-

(continued on the next page)

6 continued.

(ii) State and explain how the pH changes as the magnesium hydroxide is added to the dilute hydrochloric acid. (4 marks)

[illegible]

(TOTAL FOR QUESTION 6 = 11 MARKS)

TOTAL FOR PAPER = 60 MARKS