Edexcel GCSE Chemistry Paper 1 2022 Exam

Paper 1CH0/1H

Content **will be assessed** from the following topics:

- Topic 1 Key concepts in chemistry – Types of substance (1.32–1.42)
- Topic 1 Key concepts in chemistry – Calculations involving masses (1.43–1.53)
- Topic 3 Chemical changes – Acids and bases (3.1–3.14)
- Topic 3 Chemical changes – Electrolytic processes (3.22–3.31)
- Topic 4 Extracting metals and equilibria – Obtaining and using metals (4.1–4.12)
- Topic 5 Separate chemistry 1 – Quantitative analysis (5.8C–5.18C)
- Topic 5 Separate chemistry 1 – Dynamic equilibrium (5.19C–5.24C)

Core practical activities that **will be assessed**:

- Core Practical 3.6 Investigate the change in pH on adding powdered calcium hydroxide or calcium oxide to a fixed volume of dilute hydrochloric acid
- Core Practical 3.31 Investigate the electrolysis of copper sulfate solution with inert electrodes and copper electrodes
- Core Practical 5.9C Carry out an accurate acid-alkali titration, using burette, pipette and a suitable indicator

Topics **not assessed** in this paper:

- Topic 1 Key concepts in chemistry – Atomic structure (1.1–1.12)
- Topic 1 Key concepts in chemistry – The periodic table (1.13–1.20)
- Topic 2 States of matter and mixtures – States of matter (2.1–2.4)
- Topic 2 States of matter and mixtures – Methods of separating and purifying substances (2.5–2.12)
- Topic 4 Extracting metals and equilibria – Reversible reactions and equilibria (4.13–4.17)

Name: _____

Topic 1 Chemistry 2022 Exam

Date:

Time:

Total marks available:

Total marks achieved: _____

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Questions

Q1.

Covalent substances can be simple molecular covalent or giant covalent.

* Figure 8 shows the arrangement of carbon atoms in diamond, graphene and a fullerene (C_{60}).

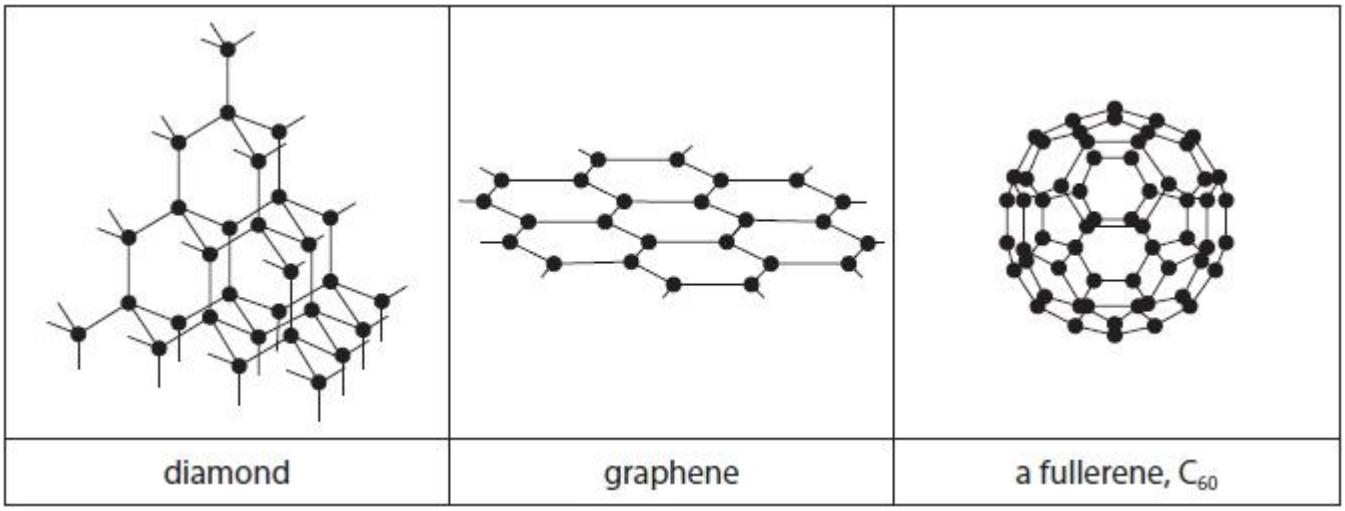

Figure 8

Consider these three substances.

Explain, in terms of their structures and bonding, their relative melting points, strengths and abilities to conduct electricity.

(Total for question = 6 marks)

Q2.

Alloy steels are made when iron is alloyed with other transition metals such as cobalt and chromium.

Metals have high melting points.

Explain, in terms of their structure and bonding, why metals have high melting points.

(2)

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(Total for question = 2 marks)

Q3.

Covalent substances can be simple molecular covalent or giant covalent.

(i) Ammonia is a simple molecular, covalent substance.

Which is the most likely set of properties for ammonia?

(1)

	melting point in °C	boiling point in °C	ability to conduct electricity in liquid state
☐ A	1713	2950	does not conduct
☐ B	−78	−33	does not conduct
☐ C	−39	357	conducts
☐ D	801	1413	conducts

(ii) Ammonia, NH_3, is made by reacting nitrogen with hydrogen.

Write the balanced equation for this reaction.

(2)

.....

(Total for question = 3 marks)

Q4.

When iron reacts with copper sulfate solution, solid copper is formed.

Two possible equations for this reaction are

A $CuSO_4 + Fe \rightarrow Cu + FeSO_4$

B $3CuSO_4 + 2Fe \rightarrow 3Cu + Fe_2(SO_4)_3$

It was found that 10.00 g of iron powder reacted with excess copper sulfate solution to produce 11.34 g of copper.

Carry out a calculation to decide which equation, **A** or **B**, represents the reaction taking place.

(relative atomic masses: Fe = 56.0, Cu = 63.5)

(2)

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(Total for question = 2 marks)

Q5.

A solution is made by dissolving calcium chloride in water.

11.1 g of calcium chloride are dissolved in water.

The volume of the solution is made up to 500 cm^3.

Calculate the concentration, in mol dm^{-3}, of calcium chloride, $CaCl_2$, in this solution.

(relative atomic masses: Cl = 35.5, Ca = 40.0)

(3)

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concentration = ...mol dm^{-3}

Q6.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Titanium and iron are examples of transition metals.

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

(i) This reaction is an example of

(1)

- ☐ **A** crystallisation
- ☐ **B** distillation
- ☐ **C** neutralisation
- ☐ **D** oxidation

(ii) The equipment shown in Figure 7 can be used to find the mass of oxygen that combines with iron.

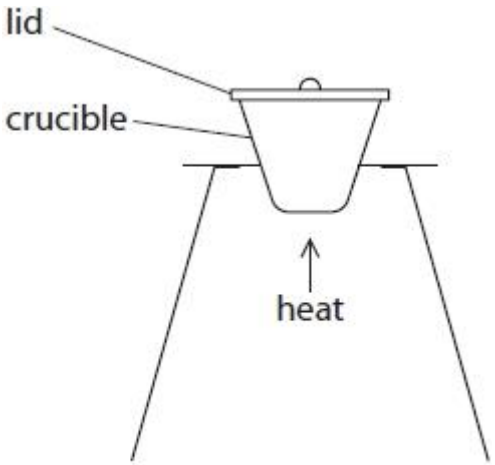

Figure 7

Describe how the equipment shown in Figure 7 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)

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(Total for question = 4 marks)

Q7.

Some properties of four solids, **A**, **B**, **C** and **D**, are shown in Figure 6.

The solids, in no particular order, are copper carbonate, copper oxide, magnesium metal and sodium hydroxide.

	A	B	C	D
colour of solid	black	silver	white	green
observation when solid is added to water	black solid remains	a few bubbles appear on surface of solid	solid dissolves and forms colourless solution	green solid remains
pH of mixture of solid added to water	7	8	13	7
observation when solid is added to dilute sulfuric acid	on warming, solid disappears to form blue solution	effervescence solid disappears to form colourless solution	solid disappears to form colourless solution	effervescence solid disappears to form blue solution

Figure 6

Identify the solids **A**, **B**, **C** and **D**, explaining how the information in Figure 6 supports the identification of each solid.

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(Total for question = 6 marks)

Q8.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 2.

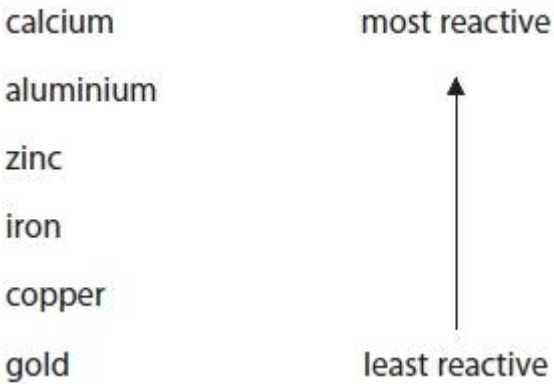

Figure 2

Iron ore contains iron oxide.

Iron is extracted from iron oxide by heating the oxide with carbon.

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$$\text{iron oxide} + \text{carbon} \rightarrow \text{iron} + \text{carbon dioxide}$$

(i) In this reaction

(1)

- ☒ **A** carbon is reduced
- ☒ **B** iron oxide is neutralised
- ☒ **C** iron oxide is reduced
- ☒ **D** iron is oxidised

(ii) The formula of the iron oxide is Fe_2O_3.

Calculate the maximum mass of iron that can be obtained from 240 tonnes of iron oxide, Fe_2O_3.
(relative atomic masses: O = 16, Fe = 56)

(3)

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mass of iron = ... tonnes

(Total for question = 4 marks)

Q9.

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

Figure 9 shows some properties of calcium, chlorine and calcium chloride.

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

Figure 9

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.

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(6)

(Total for question = 6 marks)

Q10.

Calcium carbonate decomposes on heating to form calcium oxide and carbon dioxide.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

Another sample of calcium carbonate is heated and the mass of solid remaining is measured each minute.

The results are shown in Figure 3.

time in minutes	0	1	2	3	4	5	6	7
mass of solid remaining in g	9.0	8.1	7.2	6.4	6.0	5.6	5.3	5.2

Figure 3

(i) Explain the trend shown by the data in Figure 3.

(2)

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(ii) It is impossible to be sure from this data that the reaction is complete.

State why.

(1)

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(Total for question = 3 marks)

Q11.

Calcium nitrate and calcium carbonate are both ionic compounds.

Calcium nitrate mixed with water behaves as an electrolyte.
Calcium carbonate mixed with water does not behave as an electrolyte.

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Explain, in terms of solubility and movement of ions, this difference in behaviour.

(2)

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(Total for question = 2 marks)

Q12.

Explain, in terms of its structure, how graphite conducts electricity.

(2)

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(Total for question = 2 marks)

Q13.

Diamond and carbon dioxide are both covalent substances.

(i) Draw a dot and cross diagram to show the covalent bonding in a molecule of carbon dioxide, CO_2.

Show outer electrons only.

(2)

(ii) Diamond has a very high melting point.

Explain why the melting point of diamond is very high.

(2)

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(Total for question = 4 marks)

Q14.

Titanium and iron are examples of transition metals.

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)

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balanced equation for the reaction is

..... Fe + ...O_2 → .....

(Total for question = 4 marks)

Q15.

In an experiment to determine the empirical formula of magnesium oxide, the mass of oxygen combined with a known mass of magnesium must be found.

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Describe an experiment to determine the mass of oxygen that combines with a known mass of magnesium, in a crucible and lid of known mass.

(3)

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(Total for question = 3 marks)

Q16.

A nickel sulfate solution is made by dissolving 23.5 g of nickel sulfate to make 250 cm^3 of solution.

Calculate the concentration of the solution in g dm^{-3}.

(2)

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concentration = ... g dm^{-3}

(Total for question = 2 marks)

Q17.

When copper sulfate solution reacts with sodium hydroxide solution, a precipitate of copper hydroxide and a solution of sodium sulfate are formed.

The equation is

$$CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$$

10 cm^3 samples of copper sulfate solution were placed in five test tubes. Different volumes of sodium hydroxide solution were added to these test tubes. The volumes of sodium hydroxide solution added were 1 cm^3, 2 cm^3, 3 cm^3, 4 cm^3 and 5 cm^3.

In each test tube a precipitate of copper hydroxide was formed. The precipitate was allowed to settle and the height of the precipitate was measured with a ruler as shown in Figure 1.

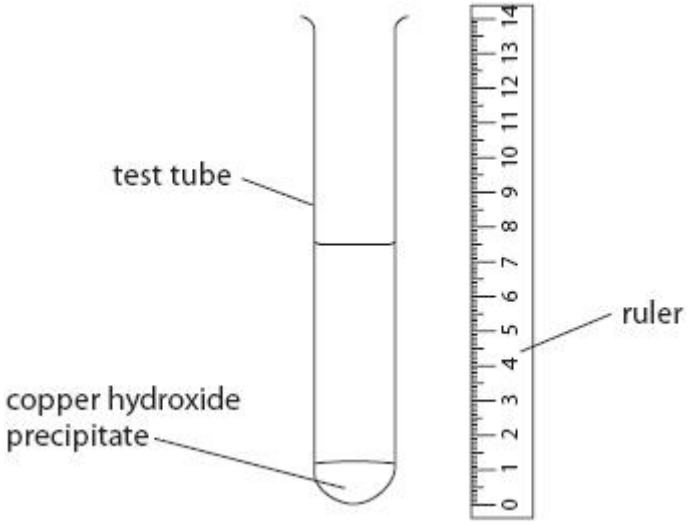

Figure 1

The results are shown in Figure 2.

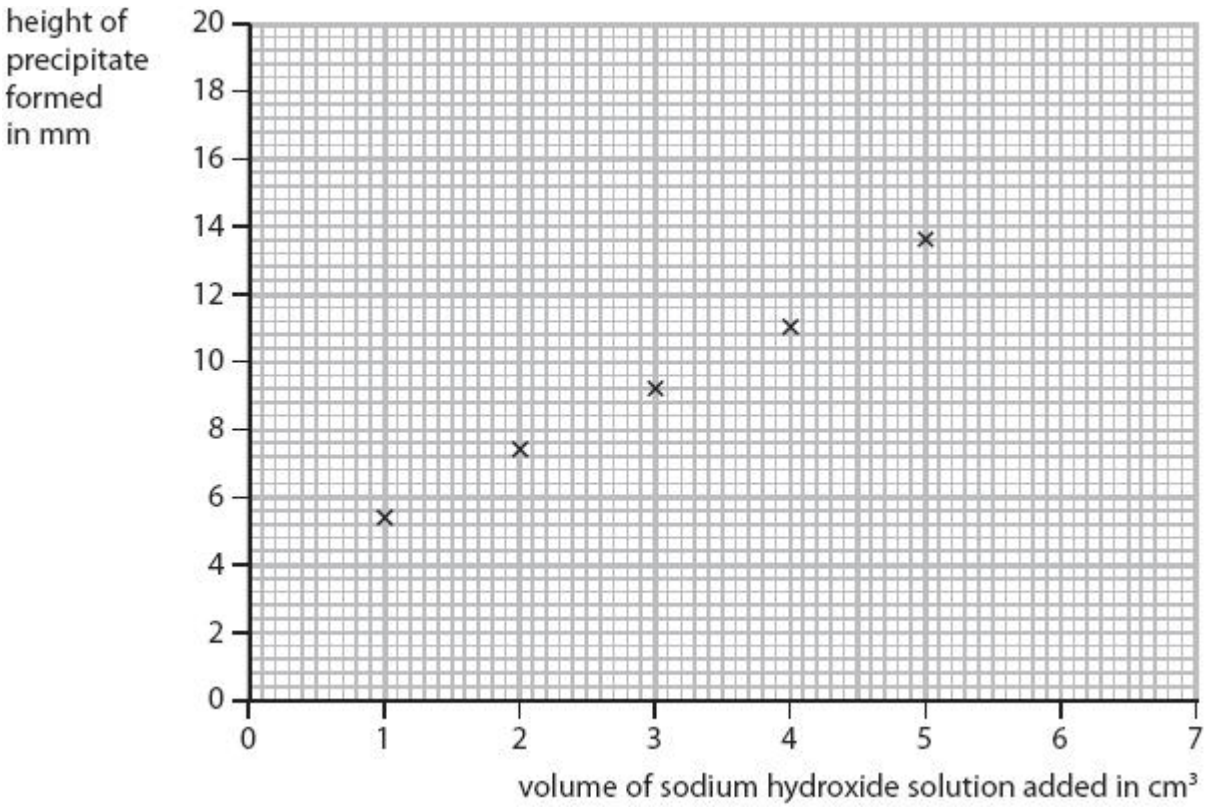

Figure 2

(i) Draw the line of best fit to complete the graph.

(1)

(ii) Predict the height of precipitate that would be formed if 6 cm^3 of sodium hydroxide solution was added to 10 cm^3 of copper sulfate solution.

This mixture would contain excess copper sulfate solution.

(2)

..... mm

(Total for question = 3 marks)

Q18.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

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

$$\text{copper carbonate} + \text{sulfuric acid} \rightarrow \text{copper sulfate} + \text{carbon dioxide} + \text{water}$$

(i) Complete the balanced equation for this reaction.

(2)

$$CuCO_3 + \text{.....} \rightarrow \text{.....} + CO_2 + H_2O$$

(ii) Calculate the relative formula mass of copper carbonate, $CuCO_3$.
(relative atomic masses: C = 12.0, O = 16.0, Cu = 63.5)

(2)

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relative formula mass of $CuCO_3$ = ...

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

(1)

- ☐ **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

(Total for question = 5 marks)

Q19.

Calculate the mass, in g, of a hydrogen atom, using the data below.

(relative atomic mass: H = 1.00;

Avogadro constant = 6.02×10^{23})

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(3)

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mass of hydrogen atom = ... g

(Total for question = 3 marks)

Q20.

Calcium carbonate decomposes on heating to form calcium oxide and carbon dioxide.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

(i) Calculate the relative formula mass of calcium carbonate, $CaCO_3$.
(relative atomic masses: C = 12, O = 16, Ca = 40)

(2)

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relative formula mass = ...

(ii) Calculate the atom economy for the formation of calcium oxide in this reaction.

$$CaCO_3 \rightarrow CaO + CO_2$$

You must show your working.
(relative atomic masses: C = 12, O = 16, Ca = 40;
relative formula mass: calcium oxide = 56)

(2)

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atom economy = ... %

(Total for question = 4 marks)

Q21.

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Pieces of zinc react with copper sulfate solution.
Zinc sulfate solution is colourless.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

The copper sulfate solution used has a concentration of 15.95 g dm^{-3}.

Calculate the number of moles of copper sulfate, $CuSO_4$, in 50.00 cm^3 of this solution.
(relative atomic masses: O = 16, S = 32, Cu = 63.5)

(3)

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number of moles of copper sulfate = ... mol

(Total for question = 3 marks)

Q22.

Some food colourings are a mixture of soluble, coloured substances.
Mixtures of soluble substances can be separated by paper chromatography.

A food colouring has a molecular formula $C_{16}H_{12}N_2O$.

(i) Calculate the number of moles of this food colouring, $C_{16}H_{12}N_2O$, in a 0.50 g sample.
(relative atomic masses: H = 1, C = 12, N = 14, O = 16)

(2)

number of moles = ...

(ii) Calculate the number of molecules in 2 moles of the food colouring, $C_{16}H_{12}N_2O$.
(Avogadro constant = 6.02×10^{23})

(1)

number of molecules = ...

(Total for question = 3 marks)

Q23.

Alloys of gold are often used to make jewellery.
The purity of gold is measured in carats.
Different alloys of gold have different carats.

A gold ring contains 3.94 g of gold.

Calculate the number of gold atoms in the ring.
(relative atomic mass: Au = 197,
Avogadro constant = 6.02×10^{23})

Show your working.

(2)

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number of gold atoms = ...

(Total for question = 2 marks)

Q24.

Calculate the number of atoms combined in one mole of copper iodide, CuI_2.
(Avogadro constant = 6.02×10^{23})

(2)

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number of atoms = ...

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(Total for question = 2 marks)

Q25.

Pieces of zinc react with copper sulfate solution.
Zinc sulfate solution is colourless.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

In another experiment, 0.043 mol of copper sulfate, $CuSO_4$, is used.

Calculate, to one decimal place, the minimum mass of zinc that must be added to react with all the copper sulfate.
(relative atomic mass: Zn = 65)

(2)

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mass = ... g

(Total for question = 2 marks)

Q26.

In Figure 1, the letters **A**, **E**, **G**, **J**, **X** and **Z** show the positions of six elements in the periodic table.

These letters are not the symbols of the atoms of these elements.

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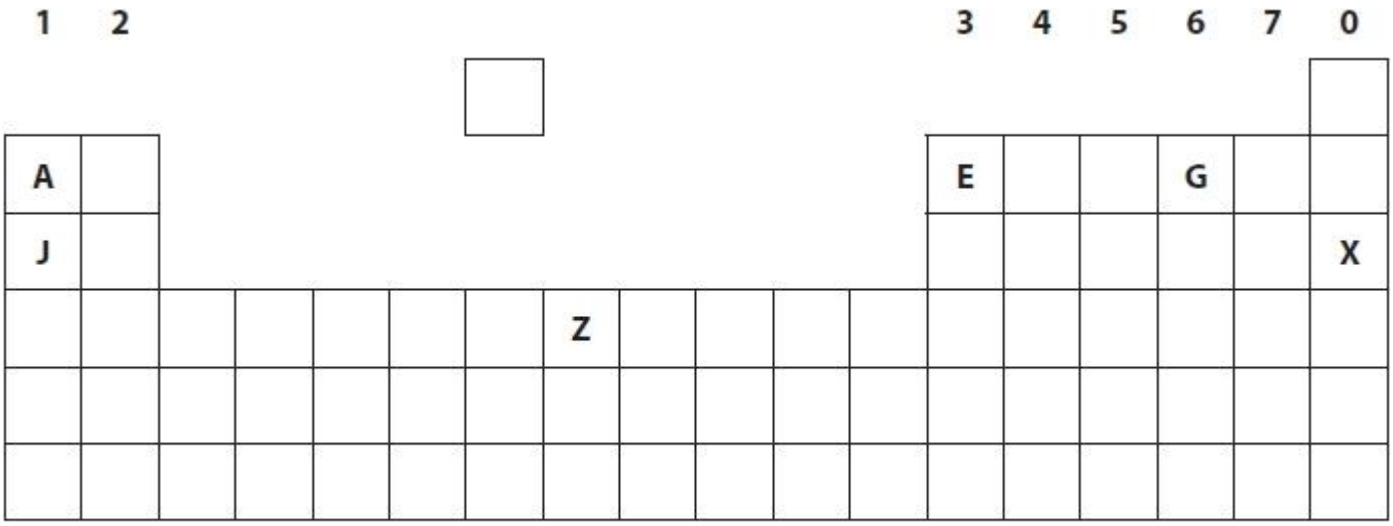

Figure 1

In an experiment, 3.5 g of element **A** reacted with 4.0 g of element **G** to form a compound.

Calculate the empirical formula of this compound.
(relative atomic masses: **A** = 7, **G** = 16)

You must show your working.

(3)

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empirical formula of this compound = ...

(Total for question = 3 marks)

Q27.

A sample of aluminium chloride was analysed.
It was found that 0.270 g of aluminium was combined with 1.065 g of chlorine in this chloride.

Calculate the empirical formula of aluminium chloride.
(relative atomic masses: Al = 27, Cl = 35.5)

You must show your working.

(3)

empirical formula of aluminium chloride = ...

(Total for question = 3 marks)

Q28.

When copper sulfate solution reacts with sodium hydroxide solution, a precipitate of copper hydroxide and a solution of sodium sulfate are formed.

The equation is

$$CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$$

The copper sulfate solution had been prepared by dissolving 6.36 g of solid copper sulfate in water and making the volume up to 250 cm^3.

Calculate the concentration of the copper sulfate solution in g dm^{-3}.

Give your answer to three significant figures.

(3)

concentration of copper sulfate solution = ... g dm^{-3}

(Total for question = 3 marks)

Q29.

Figure 3 shows the apparatus that can be used to electrolyse sodium sulfate solution using inert electrodes.

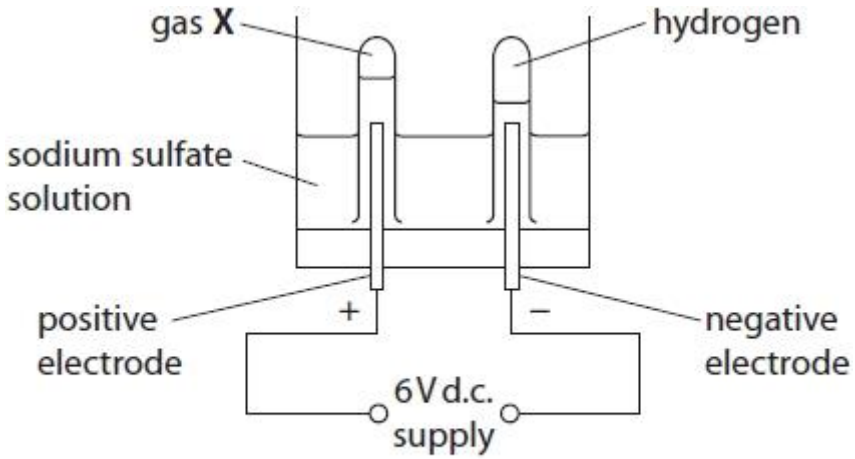

Figure 3

The sodium sulfate solution was made by dissolving 28.4 g of sodium sulfate in water to make 250 cm^3 of solution.

Calculate the concentration of this solution in g dm^{-3}.

Give your answer to three significant figures.

(3)

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..... g dm^{-3}

(Total for question = 3 marks)

Name: _____

Topic 3 Chemistry 2022 Exam

Date:

Time:

Total marks available:

Total marks achieved: _____

Questions

Q1.

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

Acids are neutralised by metal hydroxides to form

(1)

- ☒ **A** salt only
- ☒ **B** salt and hydrogen only
- ☒ **C** salt and oxygen only
- ☒ **D** salt and water only

(ii) Acids can also be neutralised by metal carbonates.

Dilute sulfuric acid is neutralised by copper carbonate as shown in the word equation.

copper carbonate + sulfuric acid → copper sulfate + carbon dioxide + water

Copper carbonate is a green powder.
Describe what you would **see** when copper carbonate powder is added to dilute sulfuric acid.

(2)

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.....

Q2.

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

Acids are neutralised by metal hydroxides to form

(1)

- ☒ **A** salt only
- ☒ **B** salt and hydrogen only
- ☒ **C** salt and oxygen only
- ☒ **D** salt and water only

(ii) Acids can also be neutralised by metal carbonates.

Dilute sulfuric acid is neutralised by copper carbonate as shown in the word equation.

copper carbonate + sulfuric acid → copper sulfate + carbon dioxide + water

Copper carbonate is a green powder.
Describe what you would **see** when copper carbonate powder is added to dilute sulfuric acid.

(2)

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Q3.

An experiment is planned to record the change in pH as a powdered base is added to 50 cm^3 dilute hydrochloric acid.

The method suggested is

step 1 add dilute hydrochloric acid up to the 50 cm^3 mark on a beaker;
step 2 add one spatula of the base and stir;
step 3 measure the pH of the mixture;
step 4 repeat steps 2 and 3 until the pH stops changing.

(i) State how you could change the method so that the amounts of dilute hydrochloric acid and of the base can be measured more accurately.

(2)

dilute hydrochloric acid

.....

.....

base

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(ii) During the experiment the pH changes from 2 to 10.
If phenolphthalein indicator is added at the beginning of the experiment, a colour change occurs as the base is added.

State the colour change that occurs.

(1)

colour at start .....

colour at end .....

(iii) Explain, in terms of the particles present, why the pH increases during the experiment.

(2)

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(Total for question = 5 marks)

Q4.

An experiment is planned to record the change in pH as a powdered base is added to 50 cm^3 dilute hydrochloric acid.

The method suggested is

step 1 add dilute hydrochloric acid up to the 50 cm^3 mark on a beaker
step 2 add one spatula of the base and stir
step 3 measure the pH of the mixture
step 4 repeat steps 2 and 3 until the pH stops changing.

(i) State how you could change the method so that the amounts of dilute hydrochloric acid and of the base can be measured more accurately.

(2)

dilute hydrochloric acid

.....

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base

.....

.....

(ii) During the experiment the pH changes from 2 to 10.

If phenolphthalein indicator is added at the beginning of the experiment, a colour change occurs as the base is added.
State the colour change that occurs.

(1)

colour at start .....
colour at end .....

(iii) Explain, in terms of the particles present, why the pH increases during the experiment.

(2)

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(Total for question = 5 marks)

Q5.

Calcium nitrate solution can be made by adding solid calcium carbonate to dilute nitric acid in a beaker.

The solid calcium carbonate is added until some remains at the bottom of the beaker.

(i) After this reaction the liquid in the beaker is

(1)

- ☒ **A** acidic
- ☒ **B** alkaline
- ☒ **C** neutral
- ☒ **D** pure water

(ii) Explain why the calcium carbonate is added until some solid remains at the bottom of the beaker.

(2)

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(iii) Write the balanced equation for the reaction between calcium carbonate and nitric acid to form calcium nitrate, $Ca(NO_3)_2$.

(3)

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(Total for question = 6 marks)

Q6.

A student has been asked to investigate how the pH changes when calcium oxide is added, a little at a time, to dilute hydrochloric acid.

Describe how the student should carry out this investigation.

(3)

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(Total for question = 3 marks)

Q7.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

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

$$\text{copper carbonate} + \text{sulfuric acid} \rightarrow \text{copper sulfate} + \text{carbon dioxide} + \text{water}$$

(i) Complete the balanced equation for this reaction.

(2)

$$CuCO_3 + \text{.....} \rightarrow \text{.....} + CO_2 + H_2O$$

(ii) Calculate the relative formula mass of copper carbonate, $CuCO_3$.
(relative atomic masses: C = 12.0, O = 16.0, Cu = 63.5)

(2)

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.....

relative formula mass of $CuCO_3$ = ...

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

(1)

- ☒ **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

(Total for question = 5 marks)

Q8.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new

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

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(i) Complete the balanced equation for this reaction.

(2)

$$CuCO_3 + \text{.....} \rightarrow \text{.....} + CO_2 + H_2O$$

(ii) Calculate the relative formula mass of copper carbonate, CuCO3 .
(relative atomic masses: C = 12.0, O = 16.0, Cu = 63.5)

(2)

.....

.....

.....

relative formula mass of $CuCO_3$ = ...

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

(1)

- ☒ **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

(Total for question = 5 marks)

Q9.

Molten lead bromide is electrolysed.

The products of this electrolysis are

(1)

- ☒ **A** hydrogen and bromine
- ☒ **B** hydrogen and oxygen
- ☒ **C** lead and bromine
- ☒ **D** lead and oxygen

(Total for question = 1 mark)

Q10.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Molten lead bromide is electrolysed.

The products of this electrolysis are

(1)

- ☒ **A** hydrogen and bromine
- ☒ **B** hydrogen and oxygen
- ☒ **C** lead and bromine
- ☒ **D** lead and oxygen

(Total for question = 1 mark)

Q11.

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)

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

(3)

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(Total for question = 5 marks)

Q12.

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)

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

(3)

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(Total for question = 5 marks)

Q13.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Figure 3 shows the apparatus that can be used to electrolyse sodium sulfate solution using inert electrodes.

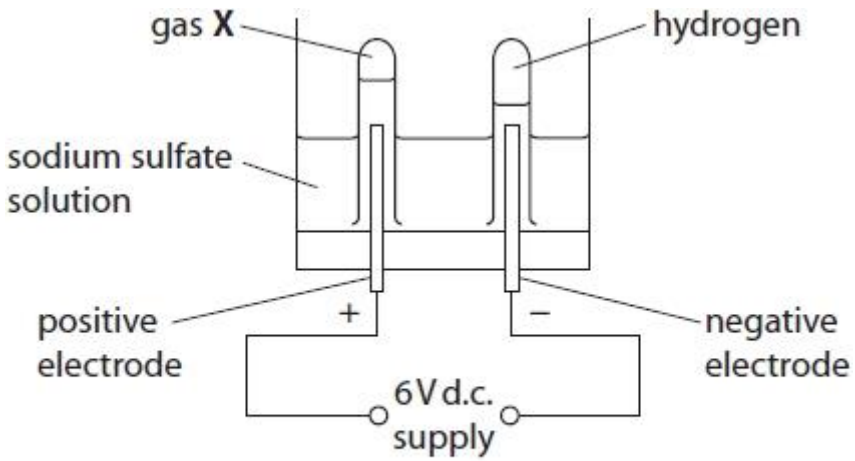

Figure 3

Hydrogen is produced at the negative electrode during electrolysis.

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

(2)

.....

.....

.....

.....

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

(1)

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

(iii) State what is meant by the term **electrolysis**.

(2)

.....

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.....

(Total for question = 5 marks)

Q14.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

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

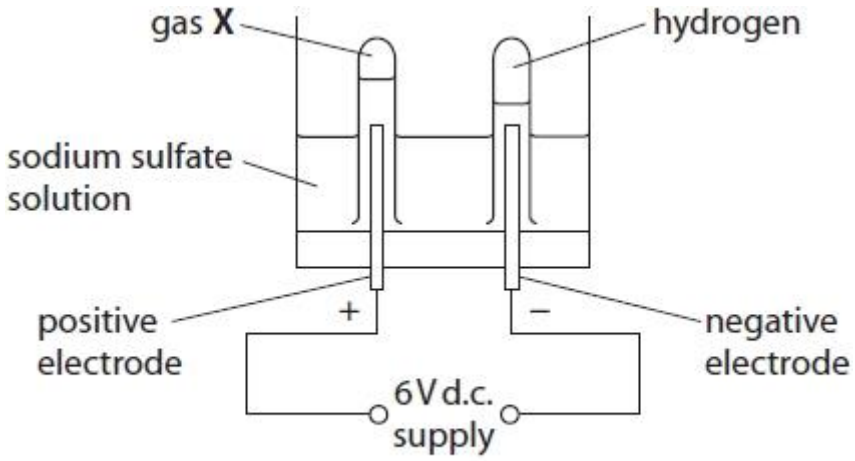

Figure 1

Hydrogen is produced at the negative electrode during electrolysis.

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

(2)

.....

.....

.....

.....

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

(1)

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

(iii) State what is meant by the term **electrolysis**.

(2)

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(Total for question = 5 marks)

Q15.

Figure 5 shows the apparatus that can be used to electrolyse sodium chloride solution in the laboratory.

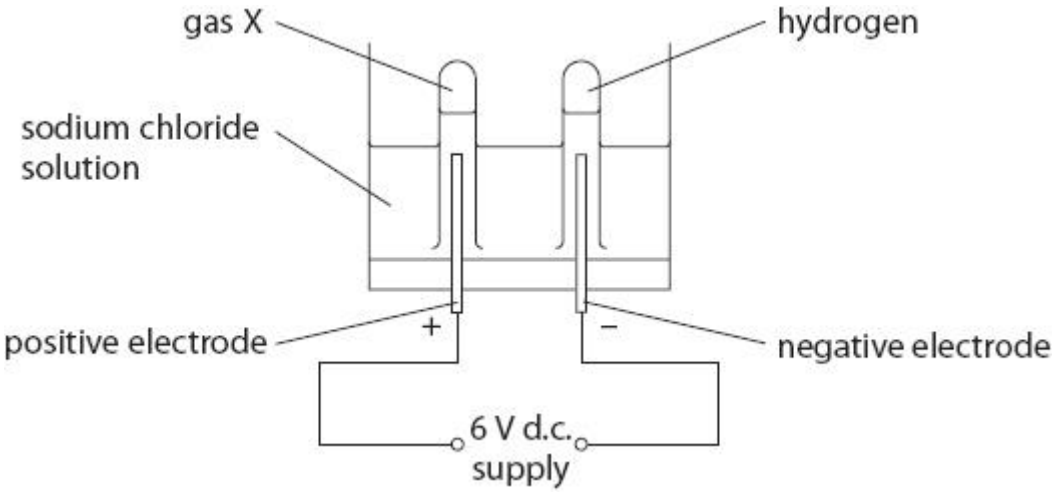

Figure 5

Gases are produced at both electrodes.

(i) State the name of the yellow-green gas X formed at the positive electrode.

(1)

.....

(ii) Describe the test to show that the gas formed at the negative electrode is hydrogen.

(2)

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(Total for question = 3 marks)

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Q16.

Copper sulfate solution was electrolysed using copper electrodes.

(i) Draw a labelled diagram to show the apparatus that is used to carry out this electrolysis in the laboratory.

(2)

(ii) Before the electrolysis, the masses of the electrodes were determined.

After the electrolysis, the electrodes were washed and dried and their masses re-determined.
Figure 6 shows these masses and the resulting changes in masses of the electrodes.

	mass of electrode before electrolysis in g	mass of electrode after electrolysis in g	change in mass of electrode in g
anode	11.27	10.42	−0.85
cathode	11.32	12.17	+0.85

Figure 6

Explain these results.

(4)

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(Total for question = 6 marks)

Q17.

Copper sulfate solution was electrolysed using copper electrodes.

(i) Draw a labelled diagram to show the apparatus that is used to carry out this electrolysis in the laboratory.

(2)

(ii) Before the electrolysis, the masses of the electrodes were determined.

After the electrolysis, the electrodes were washed and dried and their masses re-determined.
Figure 6 shows these masses and the resulting changes in masses of the electrodes.

	mass of electrode before electrolysis in g	mass of electrode after electrolysis in g	change in mass of electrode in g
anode	11.27	10.42	−0.85
cathode	11.32	12.17	+0.85

Figure 6

Explain these results.

(4)

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(Total for question = 6 marks)

Q18.

Molten zinc chloride is an electrolyte.

(i) Which row shows the products formed at the anode and at the cathode when molten zinc chloride is electrolysed?

(1)

	product at anode	product at cathode
☐ **A**	oxygen	zinc
☐ **B**	chlorine	hydrogen
☐ **C**	chlorine	zinc
☐ **D**	oxygen	hydrogen

(ii) Which of the following is the reason why molten zinc chloride is an electrolyte?

(1)

- ☐ **A** it contains molecules that can move
- ☐ **B** it has a giant structure
- ☐ **C** it contains delocalised electrons
- ☐ **D** it contains ions that can move

(Total for question = 2 marks)

Q19.

Molten zinc chloride is an electrolyte.

(i) Which row shows the products formed at the anode and at the cathode when molten zinc chloride is electrolysed?

(1)

	product at anode	product at cathode
☐ A	oxygen	zinc
☐ B	chlorine	hydrogen
☐ C	chlorine	zinc
☐ D	oxygen	hydrogen

(ii) Which of the following is the reason why molten zinc chloride is an electrolyte?

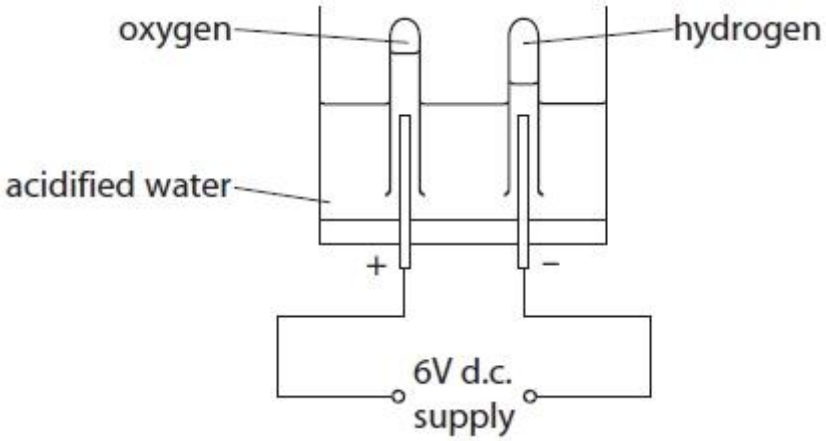
(1)

- ☐ **A** it contains molecules that can move
- ☐ **B** it has a giant structure
- ☐ **C** it contains delocalised electrons
- ☐ **D** it contains ions that can move

(Total for question = 2 marks)

Q20.

Water, acidified with a small amount of dilute sulfuric acid, can be decomposed by electrolysis using the apparatus shown.



(i) State the form of energy used to carry out the electrolysis.

(1)

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(ii) During the electrolysis, hydrogen is formed at one of the electrodes.

Describe a test to show that this gas is hydrogen.

(2)

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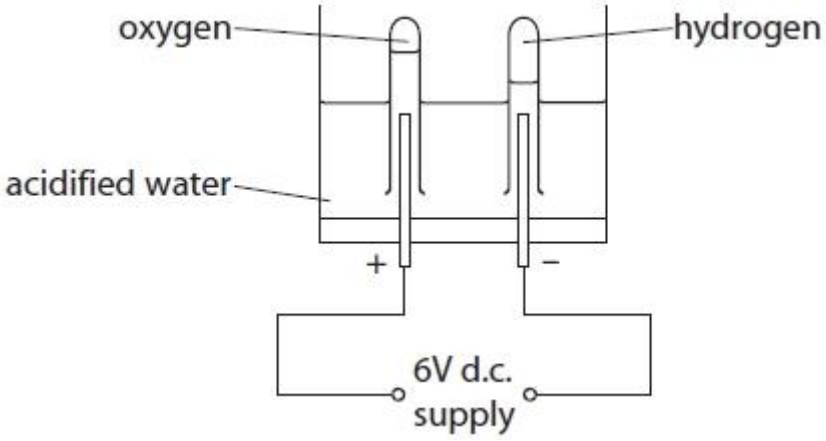
Q21.

Water, acidified with a small amount of dilute sulfuric acid, can be decomposed by electrolysis using the apparatus shown.



(i) State the form of energy used to carry out the electrolysis.

(1)

.....

(ii) During the electrolysis, hydrogen is formed at one of the electrodes.

Describe a test to show that this gas is hydrogen.

(2)

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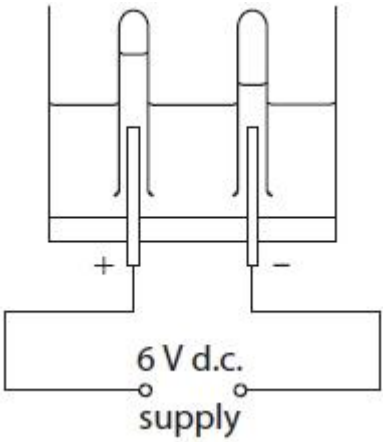
Q22.

Sodium sulfate solution is electrolysed in the apparatus shown.



Sodium sulfate solution contains sodium ions, Na^+, sulfate ions, SO_4^{2-}, hydrogen ions, H^+, and hydroxide ions, OH^-.

Hydrogen is produced at one electrode and oxygen is produced at the other electrode.

Explain how these products are formed from the ions in the electrolysis process, indicating how you would identify the products.

You may give ionic equations in your answer.

(6)

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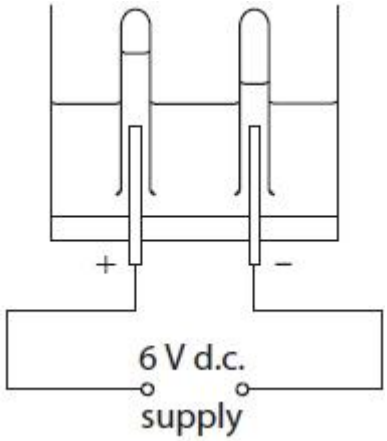
Q23.

Sodium sulfate solution is electrolysed in the apparatus shown.



Sodium sulfate solution contains sodium ions, Na^+, sulfate ions, SO_4^{2-}, hydrogen ions, H^+, and hydroxide ions, OH^-.

Hydrogen is produced at one electrode and oxygen is produced at the other electrode.

Explain how these products are formed from the ions in the electrolysis process, indicating how you would identify the products.

You may give ionic equations in your answer.

(6)

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.....

Q24.

A solution of sodium chloride contains the four ions shown in the box.

Na^+	Cl^-	OH^-	H^+

(a) The sodium chloride solution is electrolysed.

Give the formulae of the **two** ions that will be attracted to the positively charged electrode.

(1)

.....

(b) Complete the sentence by putting a cross (☒) in the box next to your answer.

When molten lead bromide is electrolysed the products are

(1)

☒ **A** lead and hydrogen

☒ **B** hydrogen and bromine

☒ **C** hydrogen and oxygen

☒ **D** lead and bromine

(c) During electrolysis, oxidation takes place at the anode and reduction takes place at the cathode.

Explain, in terms of electrons, what is meant by **oxidation** and **reduction**.

(2)

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(d) Explain why some metal objects are electroplated.

(2)

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Q25.

A solution of sodium chloride contains the four ions shown in the box.

Na^+	Cl^-	OH^-	H^+

(a) The sodium chloride solution is electrolysed.

Give the formulae of the **two** ions that will be attracted to the positively charged electrode.

(1)

.....

(b) Complete the sentence by putting a cross (☒) in the box next to your answer.

When molten lead bromide is electrolysed the products are

(1)

☐ **A** lead and hydrogen

☐ **B** hydrogen and bromine

☐ **C** hydrogen and oxygen

☐ **D** lead and bromine

(c) During electrolysis, oxidation takes place at the anode and reduction takes place at the cathode.

Explain, in terms of electrons, what is meant by **oxidation** and **reduction**.

(2)

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(d) Explain why some metal objects are electroplated.

(2)

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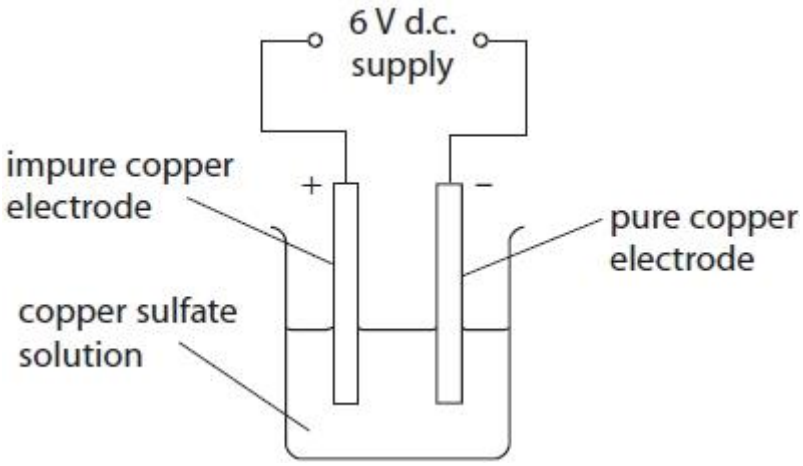
Q26.

Impure copper is purified by electrolysis using the apparatus shown.



(i) Give the name of the electrode which is made of pure copper.

(1)

.....

(ii) Describe how each electrode will have changed at the end of the electrolysis process.

(2)

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.....

(iii) Complete the sentence by putting a cross (☒) in the box next to your answer.

$$Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$$

This half equation shows the process of

(1)

☒ **A** displacement

☒ **B** oxidation

☒ **C** redox

☒ **D** reduction

(iv) Copper sulfate solution is the electrolyte used in this electrolysis process.

Explain how copper sulfate solution conducts electricity.

(2)

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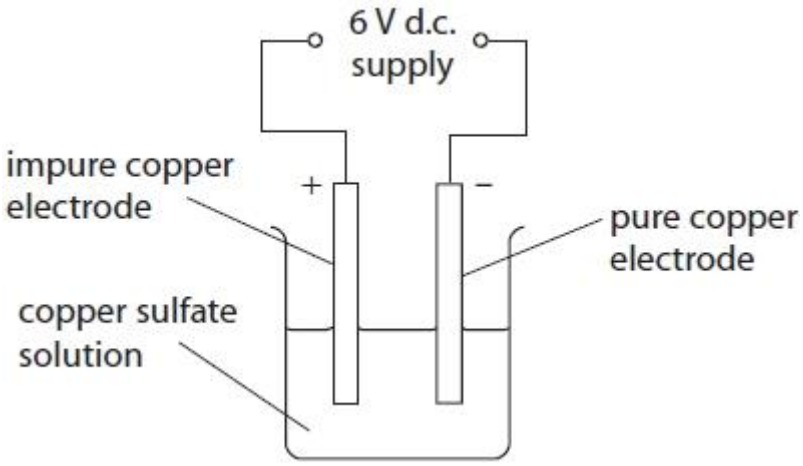
Q27.

Impure copper is purified by electrolysis using the apparatus shown.



(i) Give the name of the electrode which is made of pure copper.

(1)

.....

(ii) Describe how each electrode will have changed at the end of the electrolysis process.

(2)

.....

.....

.....

.....

(iii) Complete the sentence by putting a cross (☒) in the box next to your answer.

$$Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$$

This half equation shows the process of

(1)

☒ **A** displacement

☒ **B** oxidation

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☒ **C** redox

☒ **D** reduction

(iv) Copper sulfate solution is the electrolyte used in this electrolysis process.

Explain how copper sulfate solution conducts electricity.

(2)

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Q28.

Calcium nitrate solution can be made by adding solid calcium carbonate to dilute nitric acid in a beaker.

The solid calcium carbonate is added until some remains at the bottom of the beaker.

(i) After this reaction the liquid in the beaker is

(1)

☒ **A** acidic

☒ **B** alkaline

☒ **C** neutral

☒ **D** pure water

(ii) Explain why the calcium carbonate is added until some solid remains at the bottom of the beaker.

(2)

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(iii) Write the balanced equation for the reaction between calcium carbonate and nitric acid to form calcium nitrate, $Ca(NO_3)_2$.

(3)

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(Total for question = 6 marks)

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Q29.

When a solution of sodium sulfate, Na_2SO_4, is electrolysed, the products formed at the electrodes are hydrogen and oxygen.

Explain the formation of the products at the electrodes.

(4)

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(Total for question = 4 marks)

Q30.

A solution of hydrochloric acid has a pH of 1.

Explain the pH change when 10 cm^3 of this acid is diluted with water to make 100 cm^3 of solution.

(2)

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(Total for question = 2 marks)

Q31.

Dilute hydrochloric acid is a strong acid.

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

(2)

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.....

(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)

pH = ...

(Total for question = 3 marks)

Q32.

Dilute hydrochloric acid is a strong acid.

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

(2)

.....

.....

.....

(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)

pH = ...

(Total for question = 3 marks)

Q33.

Acids are a hazard if a high concentration of hydrogen ions is present.

Hydrochloric acid is a strong acid, ethanoic acid is a weak acid.

Figure 5 shows the labels on bottles of dilute hydrochloric acid and concentrated ethanoic acid.

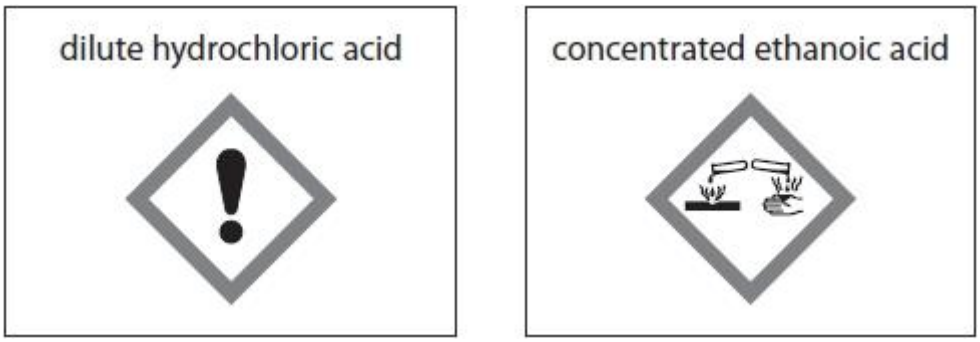

Figure 5

Explain why the hazard of the dilute hydrochloric acid is lower than the hazard of concentrated ethanoic acid, even though hydrochloric acid is a strong acid and ethanoic acid is a weak acid.

(4)

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(Total for question = 4 marks)

Q34.

Figure 2 shows the apparatus that can be used to electrolyse sodium chloride solution in the laboratory.

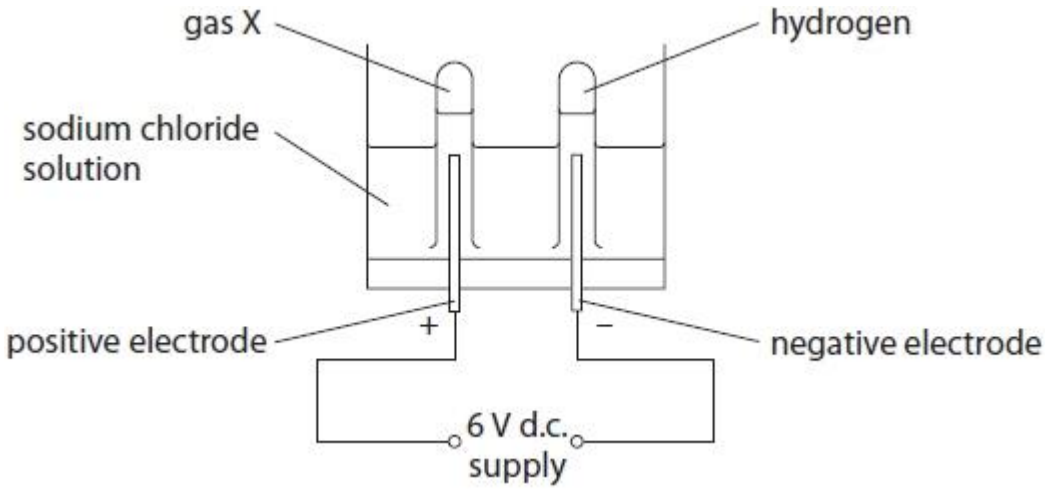

Figure 2

Some of the solution remaining after the electrolysis was tested with litmus paper.
The paper turned blue.

Explain why the litmus paper turned blue.

(2)

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(Total for question = 2 marks)

Q35.

Figure 2 shows the apparatus that can be used to electrolyse sodium chloride solution in the laboratory.

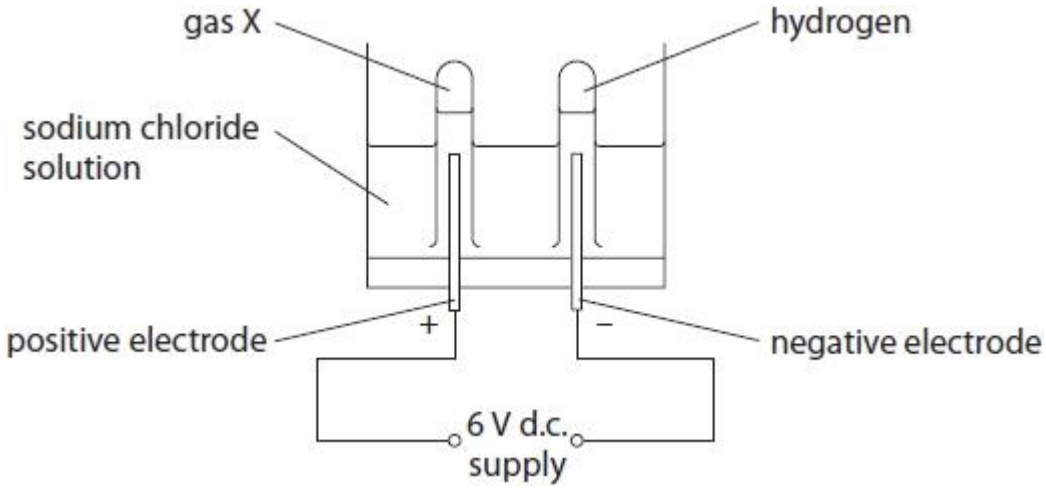

Figure 2

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Explain why sodium chloride solution can conduct electricity.

(2)

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(Total for question = 2 marks)

Q36.

Potassium hydroxide reacts with hydrochloric acid to form potassium chloride and water.

potassium hydroxide + hydrochloric acid → potassium chloride + water

A student carried out a titration to find the exact volume of dilute hydrochloric acid that reacted with 25.0 cm^3 of potassium hydroxide solution.

There were five steps in the titration.
The steps shown are not in the correct order.

step J pour the potassium hydroxide solution into a conical flask and add a few drops of indicator to this solution

step K fill a burette with the dilute hydrochloric acid and record the initial reading from the burette

step L use a measuring cylinder to obtain 25 cm^3 of potassium hydroxide solution

step M take a final reading from the burette and calculate the volume of the dilute hydrochloric acid reacted

step N run the dilute hydrochloric acid from the burette into the conical flask until the indicator changes colour

A student was then asked to produce a pure sample of solid potassium chloride.

After finding the volume of acid reacted in step M, the student added this volume of acid to a fresh 25.0 cm^3 sample of the potassium hydroxide solution.
This mixture was then evaporated.

(i) Explain why this new mixture was evaporated rather than the original mixture from the titration, to produce a
pure sample of solid potassium chloride.

(2)

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(ii) After evaporation, the mass of the potassium chloride was determined.

The theoretical yield of the experiment was 0.70 g.
The actual yield was 0.84 g.
This gave a percentage yield greater than 100%.
Calculate the percentage yield of this experiment.

(2)

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.....

.....

percentage yield = ...

(iii) Suggest a reason why the actual yield was greater than the theoretical yield.

(1)

.....

.....

.....

(iv) The equation for the reaction between potassium hydroxide solution and dilute hydrochloric acid is

$$KOH + HCl \rightarrow KCl + H_2O$$

Calculate the atom economy for the production of potassium chloride from potassium hydroxide and hydrochloric acid.
(relative formula masses: KOH = 56.0, HCl = 36.5, KCl = 74.5, H_2O = 18.0)
Give your answer to one decimal place.

(4)

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atom economy = ... %

(Total for question = 9 marks)

Q37.

When sodium sulfate solution is electrolysed, using inert electrodes, hydrogen is formed at the cathode.

Write the half equation for the formation of hydrogen gas, H_2, from hydrogen ions, H^+.

(2)

.....

(Total for question = 2 marks)

Q38.

When sodium sulfate solution is electrolysed, using inert electrodes, hydrogen is formed at the cathode.

Write the half equation for the formation of hydrogen gas, H_2, from hydrogen ions, H^+.

(2)

.....

(Total for question = 2 marks)

Q39.

In an experiment magnesium hydroxide powder is added in 0.1 g portions to 25 cm^3 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)

.....

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

(4)

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(Total for question = 5 marks)

Q40.

In an experiment magnesium hydroxide powder is added in 0.1 g portions to 25 cm^3 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)

.....

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

(4)

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(Total for question = 5 marks)

Q41.

Figure 5 shows the apparatus that can be used to electrolyse sodium chloride solution in the laboratory.

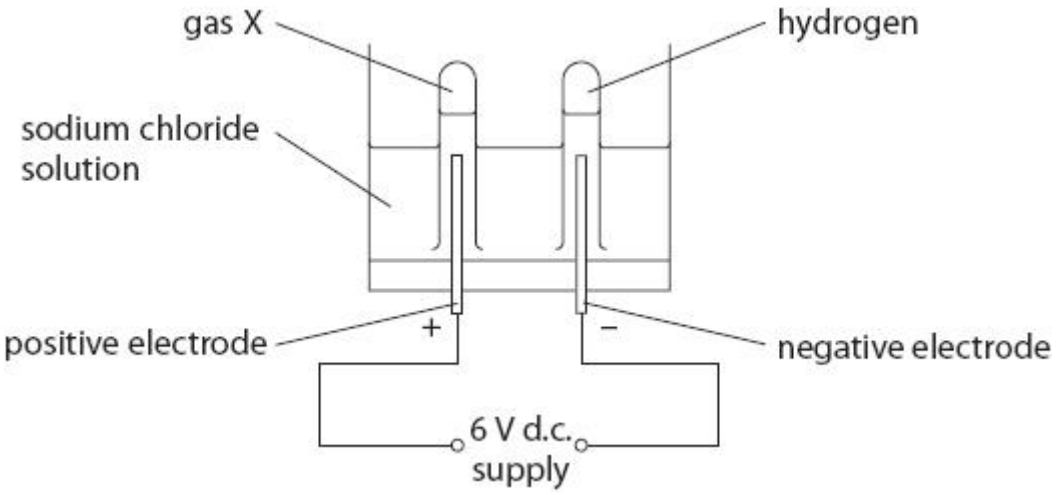

Figure 5

Write the half equation for the formation of hydrogen gas from hydrogen ions at a negative electrode.

(2)

.....

(Total for question = 2 marks)

Q42.

Figure 2 shows the apparatus that can be used to electrolyse sodium chloride solution in the laboratory.

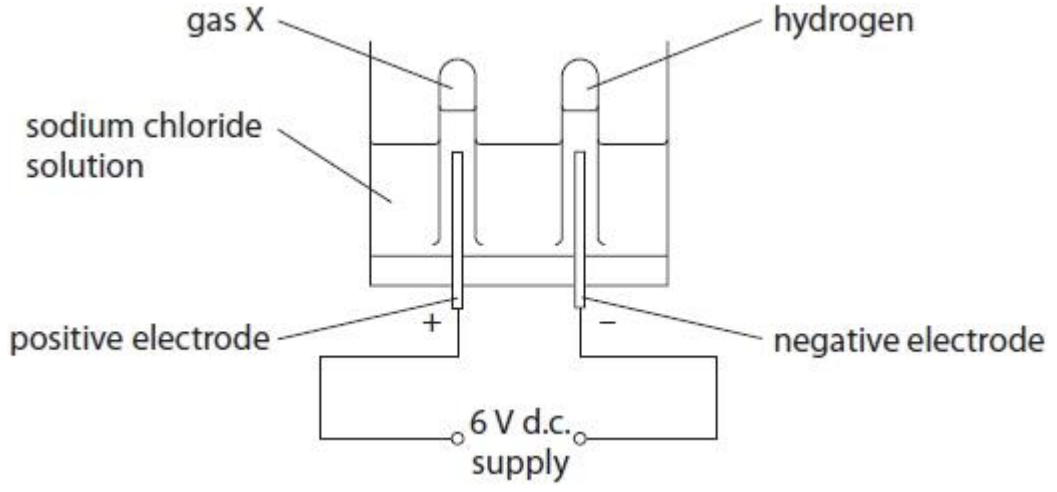

Figure 2

Write the half equation for the formation of hydrogen gas from hydrogen ions at a negative electrode.

(2)

.....

(Total for question = 2 marks)

Q43.

The hydrogen ion concentration in a solution is decreased by a factor of 10.
State how the pH of this solution changes.

(1)

.....

(Total for question = 1 mark)

Q44.

The hydrogen ion concentration in a solution is decreased by a factor of 10.
State how the pH of this solution changes.

(1)

.....

(Total for question = 1 mark)

Q45.

Which material is most suitable to make the electrodes for the electrolysis of a dilute acid?

(1)

- ☒ **A** zinc
- ☒ **B** sulfur
- ☒ **C** iron
- ☒ **D** graphite

(Total for question = 1 mark)

Q46.

Electrodes are placed in three different solutions, **J**, **K** and **L**.

A 6 V direct current source is connected to the electrodes.

Any products formed at the electrodes are identified.

The results are given in Figure 12.

solution	solution conducts electricity	product at cathode	product at anode
J	yes	copper	chlorine
K	yes	hydrogen	oxygen
L	no	none	none

Figure 12

Explain which solutions are electrolytes.

(2)

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.....

(Total for question = 2 marks)

Q47.

A student carried out an experiment to see how reactive different metals are when they are placed in dilute hydrochloric acid.

A sample of each metal was placed in a separate test tube of acid.

In the experiment, the student used the same amount of each metal in a finely powdered form.

State **two** factors, concerning the hydrochloric acid, which should also be controlled to produce valid results.

(2)

1 .....

.....

2 .....

.....

(Total for question = 2 marks)

Q48.

Objects made from transition metals are sometimes coated with a thin layer of another transition metal to improve their appearance and to protect against corrosion.

Figure 10 shows equipment that can be used to electroplate an iron spoon with silver.

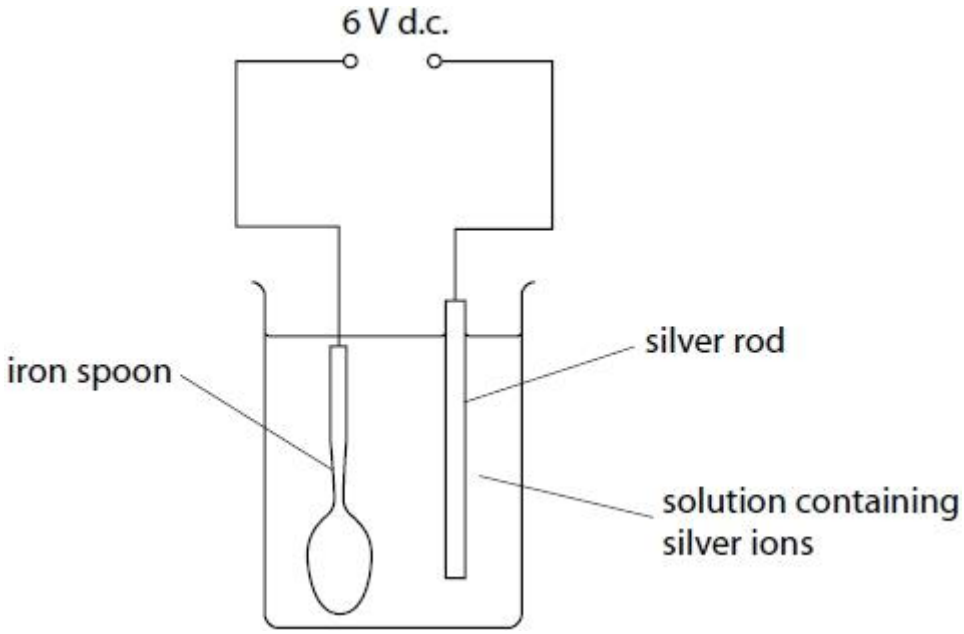

Figure 10

(i) Which row of the table correctly shows the charge on the silver rod electrode and the type of reaction occurring at this electrode?

(1)

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	charge	type of reaction
☐ A	negative	oxidation
☐ B	negative	reduction
☐ C	positive	oxidation
☐ D	positive	reduction

(ii) Silver metal is deposited on the spoon.

Which half-equation represents this reaction?

(1)

☐ **A** $Ag + e \rightarrow Ag^+$

☐ **B** $Ag \rightarrow Ag^+ + e^-$

☐ **C** $Ag^+ + e \rightarrow Ag$

☐ **D** $Ag^+ \rightarrow Ag + e^-$

(Total for question = 2 marks)

Q49.

The method used to prepare a salt depends on its solubility in water.

Complete Figure 9 by placing one tick in each row to show whether the salt is soluble or insoluble.

(2)

salt	soluble	insoluble
ammonium chloride		
lithium sulfate		
magnesium carbonate		

Figure 9

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(Total for question = 2 marks)

Q50.

Ethanol can be produced by a process called fermentation.
Carbon dioxide is formed during fermentation.

In the test for carbon dioxide, the gas is bubbled through limewater and a white precipitate forms.

What is the name of this white precipitate?

(1)

- ☒ **A** calcium oxide
- ☒ **B** calcium hydroxide
- ☒ **C** calcium hydrogencarbonate
- ☒ **D** calcium carbonate

(Total for question = 1 mark)

Q51.

A student has been asked to investigate how the pH changes when calcium oxide is added, a little at a time, to dilute hydrochloric acid.

Describe how the student should carry out this investigation.

(3)

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.....

(Total for question = 3 marks)

Q52.

A strong acid reacts with a strong alkali to form a neutral solution.

Write the ionic equation for this reaction.

(2)

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(Total for question = 2 marks)

Q53.

Calcium nitrate is a soluble salt.

Using the rules of solubility, suggest the name of a solution that will react with calcium nitrate solution to form an insoluble solid.

(1)

.....

(Total for question = 1 mark)

Q54.

Excess solid nickel carbonate is added to dilute sulfuric acid in a beaker.

$$\text{nickel carbonate} + \text{sulfuric acid} \rightarrow \text{nickel sulfate} + \text{carbon dioxide} + \text{water}$$

Nickel sulfate is formed in solution.

Describe how a sample of pure, dry nickel sulfate crystals can be obtained from the mixture of nickel sulfate solution and excess solid nickel carbonate in the beaker.

(3)

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(Total for question = 3 marks)

Q55.

Excess solid nickel carbonate is added to dilute sulfuric acid in a beaker.

$$\text{nickel carbonate} + \text{sulfuric acid} \rightarrow \text{nickel sulfate} + \text{carbon dioxide} + \text{water}$$

Nickel sulfate is formed in solution.

Describe how a sample of pure, dry nickel sulfate crystals can be obtained from the mixture of nickel sulfate solution and excess solid nickel carbonate in the beaker.

(3)

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(Total for question = 3 marks)

Q56.

* Salts of metals can be made by reacting one of the metal's compounds with the appropriate acid.

Plan an experiment to prepare pure, dry crystals of magnesium sulfate, $MgSO_4$, by reacting a suitable magnesium compound with a suitable acid.

You may use equations if you wish.

(6)

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(Total for question = 6 marks)

Q57.

A student carried out an experiment to see how reactive different metals are when they are placed in dilute hydrochloric acid.

A sample of each metal was placed in a separate test tube of acid.

When zinc reacts with dilute hydrochloric acid, a gas is given off and zinc chloride is formed.

(i) Which gas is given off?

- ☒ **A** carbon dioxide
- ☒ **B** chlorine
- ☒ **C** hydrogen
- ☒ **D** oxygen

(1)

(ii) What is the formula of zinc chloride?

- ☒ **A** ZnCl
- ☒ **B** Zn_2Cl
- ☒ **C** $ZnCl_2$
- ☒ **D** Zn_2Cl_2

(1)

(Total for question = 2 marks)

Q58.

Figure 2 shows the apparatus that can be used to electrolyse sodium chloride solution in the laboratory.

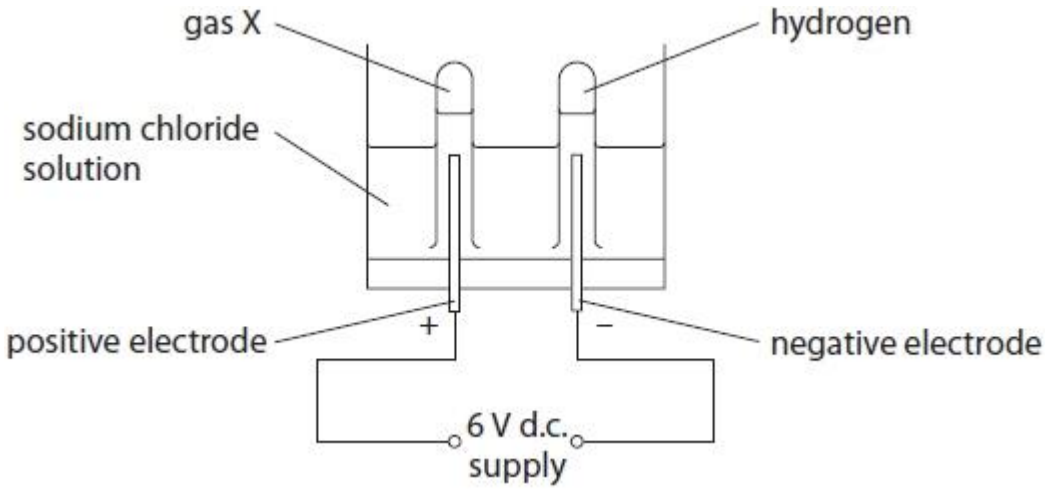

Figure 2

Gases are produced at both electrodes.

(i) State the name of the yellow-green gas X formed at the positive electrode.

(1)

.....

(ii) Describe the test to show that the gas formed at the negative electrode is hydrogen.

(2)

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(Total for question = 3 marks)

Q59.

X and **Y** are solutions of two different acids.
The concentration of acid in each solution, in mol dm^{-3}, is the same.
Solution **X** has a pH of 3.40 and solution **Y** has a pH of 4.40.

(i) State what could be used to measure these pH values of 3.40 and 4.40.

(1)

.....

.....

(ii) What is the concentration of hydrogen ions in solution **X** compared with that in solution **Y**?

(1)

☒ **A** ten times lower

☒ **B** lower by a factor of 3.30/4.40

☒ **C** higher by a factor of 4.40/3.30

☒ **D** ten times higher

(Total for question = 2 marks)

Q60.

Nitric acid can be titrated with a solution of ammonia.

(i) State the type of reaction occurring when nitric acid reacts with ammonia.

(1)

.....

(ii) What salt is formed in this reaction?

(1)

☒ **A** ammonia nitric

☒ **B** ammonia nitrate

☒ **C** ammonium nitric

☒ **D** ammonium nitrate

(Total for question = 2 marks)

Q61.

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

$$\text{copper carbonate} + \text{sulfuric acid} \rightarrow \text{copper sulfate} + \text{carbon dioxide} + \text{water}$$

Figure 4 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.

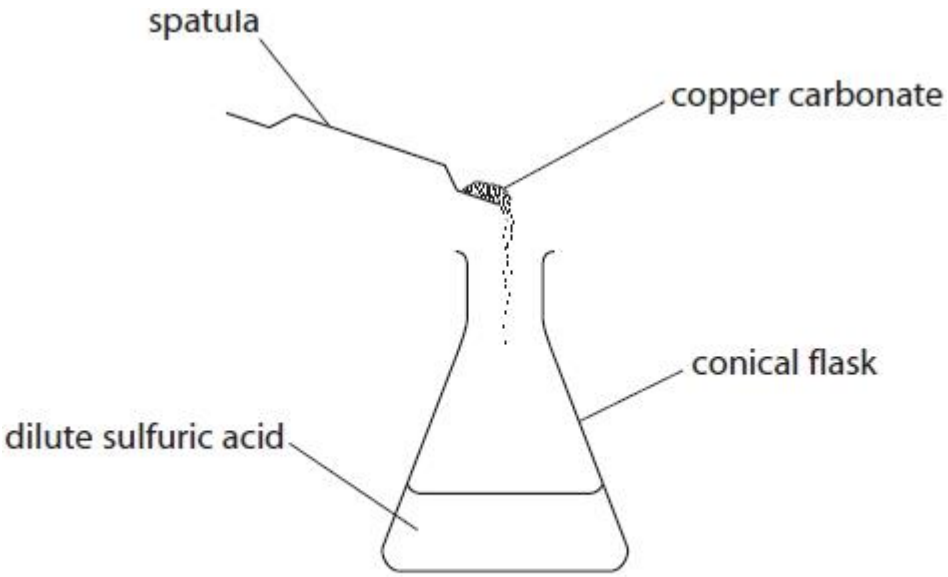

Figure 4

State **two** observations that would show the reaction has finished.

(2)

1 .....

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2 .....

.....

(Total for question = 2 marks)

Q62.

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.

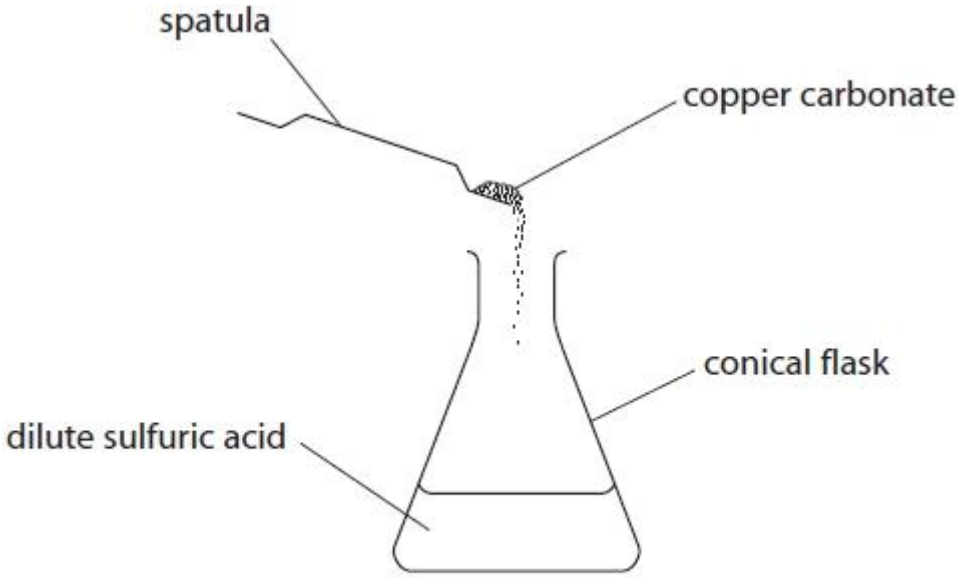

Figure 2

State **two** observations that would show the reaction has finished.

(2)

1 .....

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2 .....

.....

(Total for question = 2 marks)

Q63.

X and **Y** are solutions of two different acids.
The concentration of acid in each solution, in mol dm^{-3}, is the same.
Solution **X** has a pH of 3.40 and solution **Y** has a pH of 4.40.

(i) State what could be used to measure these pH values of 3.40 and 4.40.

(1)

.....

.....

(ii) What is the concentration of hydrogen ions in solution **X** compared with that in solution **Y**?

(1)

- ☒ **A** ten times lower
- ☒ **B** lower by a factor of 3.30/4.40
- ☒ **C** higher by a factor of 4.40/3.30
- ☒ **D** ten times higher

(Total for question = 2 marks)

Q64.

Water, acidified with sulfuric acid, is decomposed by electrolysis. The water is decomposed to produce hydrogen and oxygen.

(i) A sample of hydrogen is mixed with air and ignited.

State what would happen.

(1)

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(ii) Throughout the experiment the volume of hydrogen and the volume of oxygen are measured at two-minute intervals.

The results are shown in Figure 2.

time in minutes	volume of hydrogen in cm^3	volume of oxygen in cm^3
0	0	0
2	4	2
4	8	4
6	12	6
8	16	8

Figure 2

Describe, using the data in Figure 2, what the results show about the volumes of hydrogen and of oxygen produced in this experiment.

(2)

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(Total for question = 3 marks)

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Q65.

Water, acidified with sulfuric acid, is decomposed by electrolysis.
The water is decomposed to produce hydrogen and oxygen.

(i) A sample of hydrogen is mixed with air and ignited.

State what would happen.

(1)

.....

.....

.....

(ii) Throughout the experiment the volume of hydrogen and the volume of oxygen are measured at two-minute intervals.
The results are shown in Figure 2.

time in minutes	volume of hydrogen in cm^3	volume of oxygen in cm^3
0	0	0
2	4	2
4	8	4
6	12	6
8	16	8

Figure 2

Describe, using the data in Figure 2, what the results show about the volumes of hydrogen and of oxygen produced in this experiment.

(2)

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.....

(Total for question = 3 marks)

Q66.

Some acids such as hydrochloric acid are described as strong acids.

Some acids such as ethanoic acid are described as weak acids.

(i) Explain the difference between a strong acid and a weak acid.

(2)

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(ii) Give a reason why adding hydroxide ions to an acid solution leads to an increase in pH.

(1)

.....

.....

(Total for question = 3 marks)

Q67.

Calcium nitrate is a soluble salt.

Using the rules of solubility, suggest the name of a solution that will react with calcium nitrate solution to form an insoluble solid.

(1)

.....

(Total for question = 1 mark)

Q68.

Salts of metals can be prepared by reacting the metal with an acid to produce the salt and hydrogen.

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

(2)

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(ii) Nickel is a metal.

Explain how the structure of a nickel atom, Ni, changes when it forms a nickel ion, Ni^{2+}.

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(2)

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(Total for question = 4 marks)

Q69.

Salts of metals can be prepared by reacting the metal with an acid to produce the salt and hydrogen.

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

(2)

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.....

(ii) Nickel is a metal.

Explain how the structure of a nickel atom, Ni, changes when it forms a nickel ion, Ni^{2+}.

(2)

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(Total for question = 4 marks)

Q70.

A solution of hydrochloric acid has a pH of 1.

Explain the pH change when 10 cm^3 of this acid is diluted with water to make 100 cm^3 of solution.

(2)

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(Total for question = 2 marks)

Q71.

The concentration of a solution of an alkali can be determined by titration with an acid.

25.0 cm^3 portions of the solution of the alkali are transferred into a conical flask and titrated with the acid solution, using a suitable indicator.

(i) Describe how you would measure out and transfer 25.0 cm^3 of the solution of the alkali.

(2)

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(ii) Complete the sentence by putting a cross (☒) in the box next to your answer.

The burette readings of acid added were

	titration 1	titration 2	titration 3
final volume / cm^3	27.20	30.10	25.35
initial volume / cm^3	2.05	5.20	0.10
volume of acid added / cm^3	25.15	24.90	25.25

The volume of acid added that should be used in the calculation is

(1)

☒ **A** 24.90 cm^3

☒ **B** 25.00 cm^3

☒ **C** 25.10 cm^3

☒ **D** 25.20 cm^3

Q72.

The concentration of a solution of an alkali can be determined by titration with an acid.

25.0 cm^3 portions of the solution of the alkali are transferred into a conical flask and titrated with the acid solution, using a suitable indicator.

(i) Describe how you would measure out and transfer 25.0 cm^3 of the solution of the alkali.

(2)

.....

.....

.....

.....

.....

(ii) Complete the sentence by putting a cross (☒) in the box next to your answer.

The burette readings of acid added were

	titration 1	titration 2	titration 3
final volume / cm^3	27.20	30.10	25.35
initial volume / cm^3	2.05	5.20	0.10
volume of acid added / cm^3	25.15	24.90	25.25

The volume of acid added that should be used in the calculation is

(1)

☒ **A** 24.90 cm^3

☒ **B** 25.00 cm^3

☒ **C** 25.10 cm^3

☒ **D** 25.20 cm^3

Q73.

Acids are a hazard if a high concentration of hydrogen ions is present.

Hydrochloric acid is a strong acid, ethanoic acid is a weak acid.

Figure 9 shows the labels on bottles of dilute hydrochloric acid and concentrated ethanoic acid.

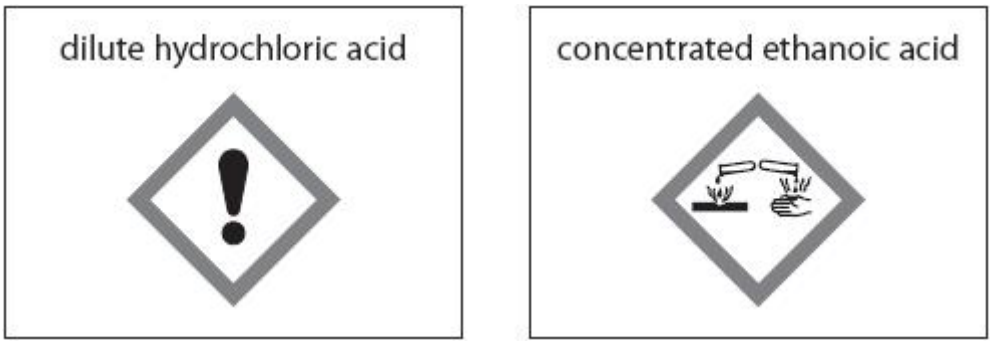

Figure 9

Explain why the hazard of the dilute hydrochloric acid is lower than the hazard of concentrated ethanoic acid, even though hydrochloric acid is a strong acid and ethanoic acid is a weak acid.

(4)

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(Total for question = 4 marks)

Q74.

Figure 5 shows the apparatus that can be used to electrolyse sodium chloride solution in the laboratory.

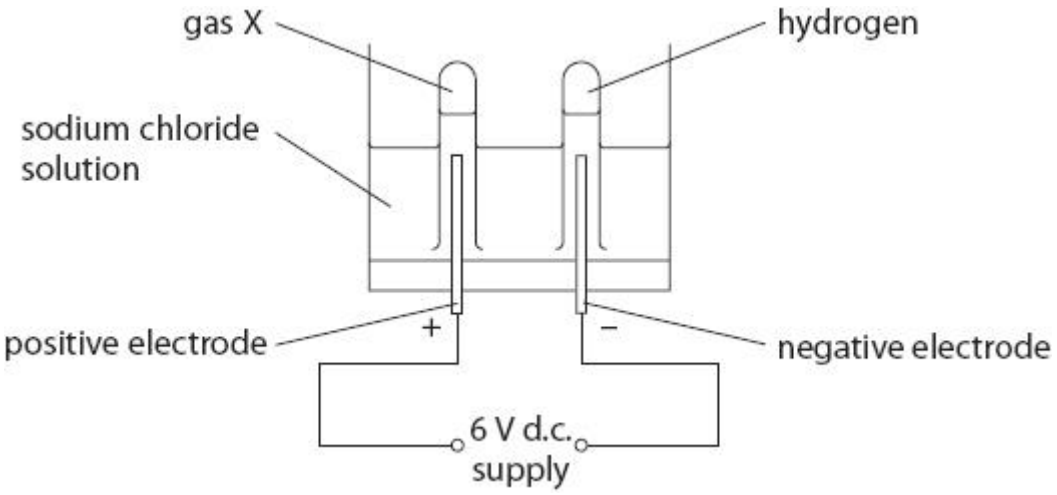

Figure 5

Some of the solution remaining after the electrolysis was tested with litmus paper.
The paper turned blue.

Explain why the litmus paper turned blue.

(2)

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.....

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.....

(Total for question = 2 marks)

Q75.

Figure 5 shows the apparatus that can be used to electrolyse sodium chloride solution in the laboratory.

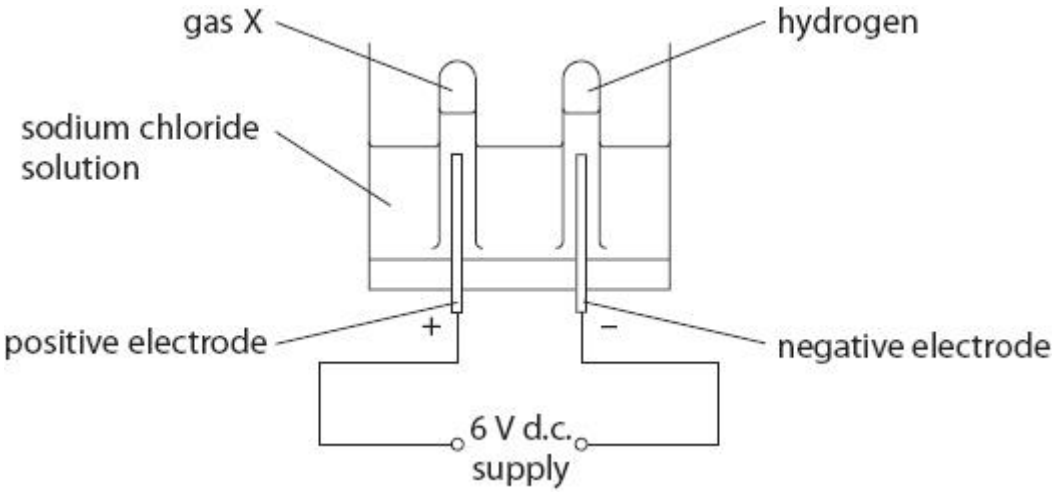

Figure 5

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Explain why sodium chloride solution can conduct electricity.

(2)

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(Total for question = 2 marks)

Q76.

Carbon dioxide can be formed by the reaction of calcium carbonate, $CaCO_3$, with dilute hydrochloric acid.

Write the balanced equation for this reaction.

(3)

.....

(Total for question = 3 marks)

Q77.

The salt zinc nitrate can be made by reacting zinc oxide, ZnO, with dilute nitric acid, HNO_3.

Write the balanced equation for this reaction.

(2)

.....

(Total for question = 2 marks)

Q78.

Copper is purified by the electrolysis of copper sulfate solution using an impure copper anode and a pure copper cathode.

Write the half-equation for the formation of a copper atom from a copper ion.

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(2)

.....

(Total for question = 2 marks)

Q79.

When molten zinc chloride is electrolysed, zinc ions, Zn^{2+}, form zinc atoms.

Write the half equation for this reaction.

(2)

.....

(Total for question = 2 marks)

Q80.

When molten zinc chloride is electrolysed, zinc ions, Zn^{2+}, form zinc atoms.

Write the half equation for this reaction.

(2)

.....

(Total for question = 2 marks)

Q81.

Magnesium oxide reacts with dilute hydrochloric acid to produce magnesium chloride solution and water.

$$MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$$

Write the ionic equation for this reaction.

(3)

.....

(Total for question = 3 marks)

Q82.

Magnesium oxide reacts with dilute hydrochloric acid to produce magnesium chloride solution and water.

$$MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$$

Write the ionic equation for this reaction.

(3)

.....

(Total for question = 3 marks)

Q83.

A strong acid reacts with a strong alkali to form a neutral solution.

Write the ionic equation for this reaction.

(2)

.....

(Total for question = 2 marks)

Name: _____

Topic 4 Chemistry 2022 Exam

Date:

Time:

Total marks available:

Total marks achieved: _____

Questions

Q1.

Acid solutions contain hydrogen ions.

Aluminium reacts with dilute hydrochloric acid to form a solution containing aluminium ions, Al^{3+}.

Complete the balanced ionic equation for this reaction.

(2)

..... + ... H^+ → ..... Al^{3+} + ...

(Total for question = 2 marks)

Q2.

Acid solutions contain hydrogen ions.

Aluminium reacts with dilute hydrochloric acid to form a solution containing aluminium ions, Al^{3+}.

Complete the balanced ionic equation for this reaction.

(2)

..... + ... H^+ → ..... Al^{3+} + ...

(Total for question = 2 marks)

Q3.

One way to extract metals from land contaminated with metal compounds is phytoextraction.
When plants grow they absorb metal ions through their roots.
The plants are harvested, dried and burned forming an ash.
The ash contains metal compounds.

Plants were grown in a piece of ground contaminated with nickel compounds.

(i) 1 kg of the ash from these plants contained 142.0 g of nickel compounds.

Calculate the percentage by mass of nickel compounds in the ash.

(3)

.....

.....

.....

.....

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percentage by mass = ...

(ii) Nickel is extracted from nickel compounds.

State an advantage of extracting nickel by phytoextraction rather than from its ore.

(1)

.....

.....

.....

(Total for question = 4 marks)

Q4.

One way to extract metals from land contaminated with metal compounds is phytoextraction.
When plants grow they absorb metal ions through their roots.
The plants are harvested, dried and burned forming an ash.
The ash contains metal compounds.

Plants were grown in a piece of ground contaminated with nickel compounds.

(i) 1 kg of the ash from these plants contained 142.0 g of nickel compounds.

Calculate the percentage by mass of nickel compounds in the ash.

(3)

.....

.....

.....

.....

percentage by mass = ...

(ii) Nickel is extracted from nickel compounds.

State an advantage of extracting nickel by phytoextraction rather than from its ore.

(1)

.....

.....

.....

(Total for question = 4 marks)

Q5.

Pieces of zinc react with copper sulfate solution.

Zinc sulfate solution is colourless.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

Describe what you would **see** when an excess of zinc is added to copper sulfate solution and the mixture left until the reaction is complete.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q6.

Pieces of zinc react with copper sulfate solution.
Zinc sulfate solution is colourless.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

Describe what you would **see** when an excess of zinc is added to copper sulfate solution and the mixture left until the reaction is complete.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q7.

Pieces of zinc react with copper sulfate solution.
Zinc sulfate solution is colourless.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

This reaction is described as a redox reaction.

Explain, in terms of electrons, which particles have been oxidised and which particles have been reduced in this reaction.

(4)

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.....

.....

.....

.....

(Total for question = 4 marks)

Q8.

Pieces of zinc react with copper sulfate solution.
Zinc sulfate solution is colourless.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

This reaction is described as a redox reaction.

Explain, in terms of electrons, which particles have been oxidised and which particles have been reduced in this reaction.

(4)

.....

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.....

.....

.....

.....

(Total for question = 4 marks)

Q9.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 2.

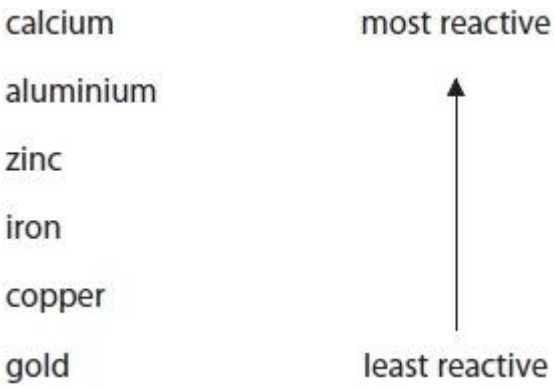

Figure 2

Aluminium cannot be extracted by heating its oxide with carbon.
Aluminium has to be extracted from its oxide by electrolysis.

Explain why.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q10.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 2.

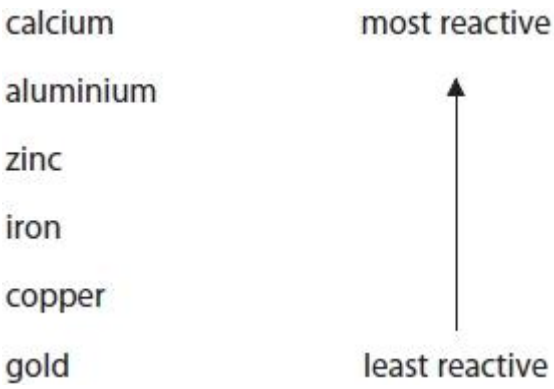

Figure 2

Aluminium cannot be extracted by heating its oxide with carbon.
Aluminium has to be extracted from its oxide by electrolysis.

Explain why.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q11.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 2.

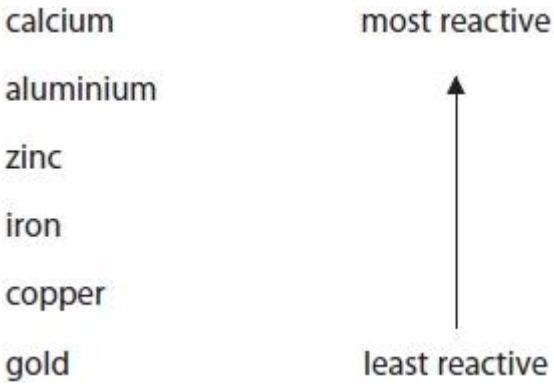

Figure 2

Iron ore contains iron oxide.

Iron is extracted from iron oxide by heating the oxide with carbon.

$$\text{iron oxide} + \text{carbon} \rightarrow \text{iron} + \text{carbon dioxide}$$

(i) In this reaction

(1)

- ☒ **A** carbon is reduced
- ☒ **B** iron oxide is neutralised
- ☒ **C** iron oxide is reduced
- ☒ **D** iron is oxidised

(ii) The formula of the iron oxide is Fe_2O_3.

Calculate the maximum mass of iron that can be obtained from 240 tonnes of iron oxide, Fe_2O_3.
(relative atomic masses: O = 16, Fe = 56)

(3)

.....

.....

.....

.....

.....

.....

mass of iron = ... tonnes

(Total for question = 4 marks)

Q12.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 2.

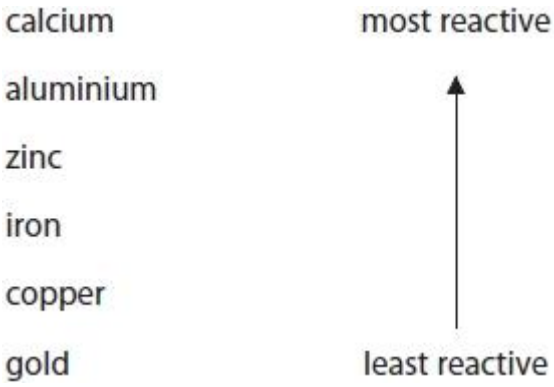

Figure 2

Iron ore contains iron oxide.

Iron is extracted from iron oxide by heating the oxide with carbon.

$$\text{iron oxide} + \text{carbon} \rightarrow \text{iron} + \text{carbon dioxide}$$

(i) In this reaction

(1)

- ☒ **A** carbon is reduced
- ☒ **B** iron oxide is neutralised
- ☒ **C** iron oxide is reduced
- ☒ **D** iron is oxidised

(ii) The formula of the iron oxide is Fe_2O_3.

Calculate the maximum mass of iron that can be obtained from 240 tonnes of iron oxide, Fe_2O_3.
(relative atomic masses: O = 16, Fe = 56)

(3)

.....

.....

.....

.....

.....

.....

mass of iron = ... tonnes

(Total for question = 4 marks)

Q13.

Iron is extracted from iron oxide, Fe_2O_3.

In the extraction process the iron oxide is heated with carbon to form iron and carbon dioxide.

Write the balanced equation for this reaction.

(3)

.....

Q14.

Iron is extracted from iron oxide, Fe_2O_3.

In the extraction process the iron oxide is heated with carbon to form iron and carbon dioxide.

Write the balanced equation for this reaction.

(3)

.....

Q15.

The list shows some metals in order of reactivity.

most reactive	sodium
	aluminium
	zinc
	iron
	copper
least reactive	gold

(a) Aluminium and iron are extracted by reduction of their oxides.

State what is meant by reduction.

(1)

.....

.....

(b) Electrolysis and heating with carbon are two methods of reduction.

Explain why aluminium needs to be extracted from its ore by electrolysis, rather than by heating with carbon.

(2)

.....

.....

.....

.....

.....

Q16.

The list shows some metals in order of reactivity.

most reactive	sodium
	aluminium
	zinc
	iron
	copper
least reactive	gold

(a) Aluminium and iron are extracted by reduction of their oxides.

State what is meant by reduction.

(1)

.....

.....

(b) Electrolysis and heating with carbon are two methods of reduction.

Explain why aluminium needs to be extracted from its ore by electrolysis, rather than by

heating with carbon.

(2)

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Q17.

Alloy steels are made when iron is alloyed with other transition metals such as cobalt and chromium.

Iron fences can be galvanised by coating them with a layer of zinc. When the layer of zinc is scratched exposing the iron to the weather, the iron does not rust.

Explain why the exposed iron does not rust.

(2)

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(Total for question = 2 marks)

Q18.

Part of the reactivity series is shown in Figure 8.

most reactive	magnesium
	aluminium
	iron
least reactive	silver

Figure 8

Iron is extracted from its ore by heating with carbon.
Aluminium is extracted from its ore using a different method.

(i) Give the name of the method used to extract aluminium.

(1)

.....

(ii) Explain why aluminium is extracted by a different method rather than heating the ore with carbon.

(2)

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.....

(Total for question = 3 marks)

Q19.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Titanium and iron are examples of transition metals.

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

(i) This reaction is an example of

(1)

- ☐ **A** crystallisation
- ☐ **B** distillation
- ☐ **C** neutralisation
- ☐ **D** oxidation

(ii) The equipment shown in Figure 7 can be used to find the mass of oxygen that combines with iron.

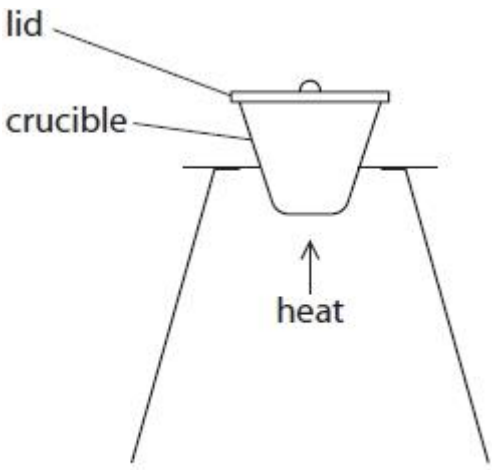

Figure 7

Describe how the equipment shown in Figure 7 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)

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(Total for question = 4 marks)

Q20.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

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

(i) This reaction is an example of

(1)

- ☐ **A** crystallisation
- ☐ **B** distillation
- ☐ **C** neutralisation
- ☐ **D** oxidation

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

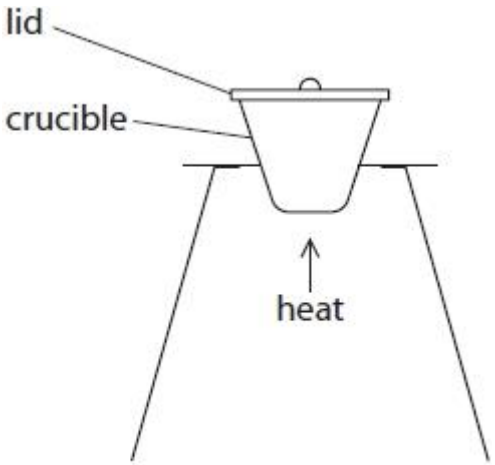

Figure 5

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)

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.....

.....

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.....

(Total for question = 4 marks)

Q21.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 2.

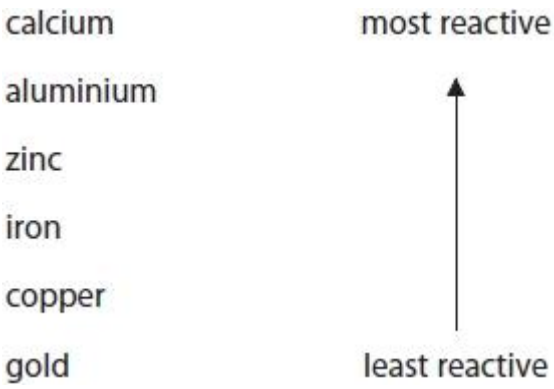


Figure 2

Predict the method that will have to be used to extract calcium from its ore.

(1)

.....

(Total for question = 1 mark)

Q22.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 2.

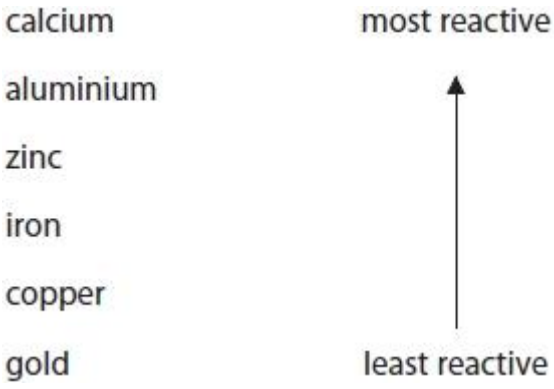


Figure 2

Predict the method that will have to be used to extract calcium from its ore.

(1)

.....

(Total for question = 1 mark)

Q23.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 2.

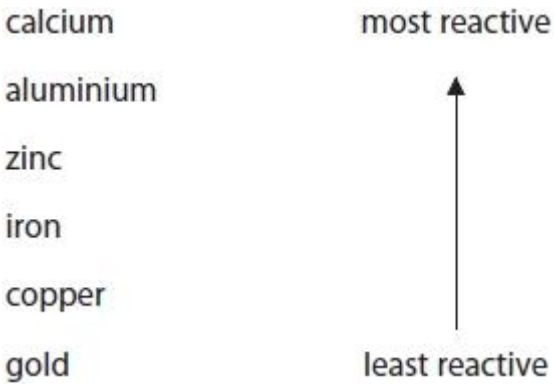


Figure 2

In recent years, researchers have been investigating alternative methods of extracting metals from soils.

Researchers have found that growing certain plants in appropriate areas can result in the phytoextraction of copper.

Describe how growing plants can result in the phytoextraction of copper.

(2)

.....

.....

.....

(Total for question = 2 marks)

Q24.

Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 2.

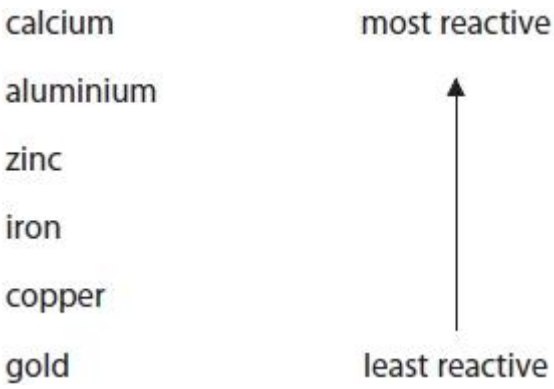


Figure 2

In recent years, researchers have been investigating alternative methods of extracting metals from soils.

Researchers have found that growing certain plants in appropriate areas can result in the phytoextraction of copper.

Describe how growing plants can result in the phytoextraction of copper.

(2)

.....

.....

.....

(Total for question = 2 marks)

Q25.

A student placed a piece of metal **P** in a test tube containing excess dilute sulfuric acid.
The student repeated this with three other metals, **Q**, **R** and **S**.
All the pieces of all four metals were the same size.

(i) The student recorded the observations until each metal had reacted with the acid for two minutes.

The observations are shown in Figure 9.

metal	observations
P	bubbles produced very slowly some metal remained
Q	bubbles produced quickly no metal remained
R	bubbles produced slowly no metal remained
S	bubbles produced very quickly no metal remained

Figure 9

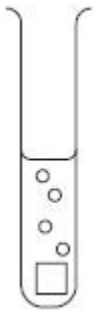
Use this information to put the four metals in order of reactivity from the least reactive to the most reactive.

(2)

least reactive | | | | | most reactive

(ii) Complete the diagram below to show how the student could add to the apparatus to measure the volume of gas produced in the two minutes.

(2)



(Total for question = 4 marks)

Q26.

A student placed a piece of metal **P** in a test tube containing excess dilute sulfuric acid.
The student repeated this with three other metals, **Q**, **R** and **S**.
All the pieces of all four metals were the same size.

(i) The student recorded the observations until each metal had reacted with the acid for two minutes.

The observations are shown in Figure 9.

metal	observations
P	bubbles produced very slowly some metal remained
Q	bubbles produced quickly no metal remained
R	bubbles produced slowly no metal remained
S	bubbles produced very quickly no metal remained

Figure 9

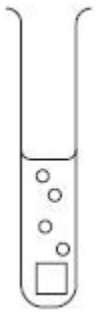
Use this information to put the four metals in order of reactivity from the least reactive to the most reactive.

(2)

least reactive | | | | | **most reactive**

(ii) Complete the diagram below to show how the student could add to the apparatus to measure the volume of gas produced in the two minutes.

(2)



(Total for question = 4 marks)

Q27.

Calcium and potassium react with water in similar ways.

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

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State **one** other similarity in the products of the reactions of calcium and potassium with water.

(1)

.....

(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)

.....

.....

(Total for question = 2 marks)

Q28.

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)

.....

(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)

.....

.....

(Total for question = 2 marks)

Q29.

Some nickel ores contain nickel sulfide.

(i) In the first stage of extracting nickel from nickel sulfide, the nickel sulfide, NiS, is heated in air to form nickel oxide, NiO, and sulfur dioxide.

Write the balanced equation for this reaction.

(2)

.....

.....

(ii) In the final stage of the extraction process, a nickel compound is electrolysed to produce pure nickel.

An advantage of producing a metal by electrolysis is that

(1)

- ☒ **A** electrolysis uses a large amount of electricity
- ☒ **B** the metal produced by electrolysis is very pure
- ☒ **C** electrolysis is a very cheap method of extraction
- ☒ **D** electrolysis is the only method of extracting unreactive metals

(Total for question = 3 marks)

Q30.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Some nickel ores contain nickel sulfide.

(i) In the first stage of extracting nickel from nickel sulfide, the nickel sulfide, NiS,

is heated in air to form nickel oxide, NiO, and sulfur dioxide.
Write the balanced equation for this reaction.

(2)

.....

.....

(ii) In the final stage of the extraction process, a nickel compound is electrolysed to produce pure nickel.

An advantage of producing a metal by electrolysis is that

(1)

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- ☒ **B** the metal produced by electrolysis is very pure
- ☒ **C** electrolysis is a very cheap method of extraction
- ☒ **D** electrolysis is the only method of extracting unreactive metals

(Total for question = 3 marks)

Name: _____

Topic 5 Chemistry 2022 Exam

Date:

Time:

Total marks available:

Total marks achieved: _____

Questions

Q1.

The concentration of dilute sulfuric acid can be determined by titration with sodium hydroxide solution of known concentration.

25.00 cm^3 of dilute sulfuric acid was measured out using a pipette and transferred to a conical flask.

A few drops of methyl orange indicator were added to the acid in the conical flask. Sodium hydroxide solution was added to the acid from a burette until the indicator changed colour.

The titration was repeated until two concordant results were obtained.

The accurate result was the average of the two concordant results.

A brief report of the practical method has been given above.
Further detail can be added to this method to ensure that anyone following the method will obtain an accurate result.

Explain **two** details that could be added to this practical method to ensure an accurate result is obtained.

(4)

1 .....

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.....

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2 .....

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.....

(Total for question = 4 marks)

Q2.

* Large amounts of ethanol are produced in the chemical industry by fermentation and by hydration of ethene.

Figure 8 summarises the two processes for making ethanol on a large scale.

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	fermentation of glucose	hydration of ethene
equation	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$	$C_2H_4 + H_2O \rightarrow C_2H_5OH$
raw materials	plants	crude oil
raw material renewable	yes	no
temperature	30 – 40 °C	300 °C
pressure	1 atmosphere	65 atmospheres
rate of reaction	slow	fast
purity of product	needs to be fractionally distilled to concentrate the ethanol	pure

Figure 8

Using this information, discuss the possible advantages and disadvantages of producing ethanol by fermentation rather than by hydration of ethene.

(6)

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(Total for question = 6 marks)

Q3.

Many metals corrode.

An experiment is carried out to see if magnesium ribbon wrapped around a piece of iron rod has an effect on the rate at which the iron rod rusts.

The apparatus is shown in Figure 4.

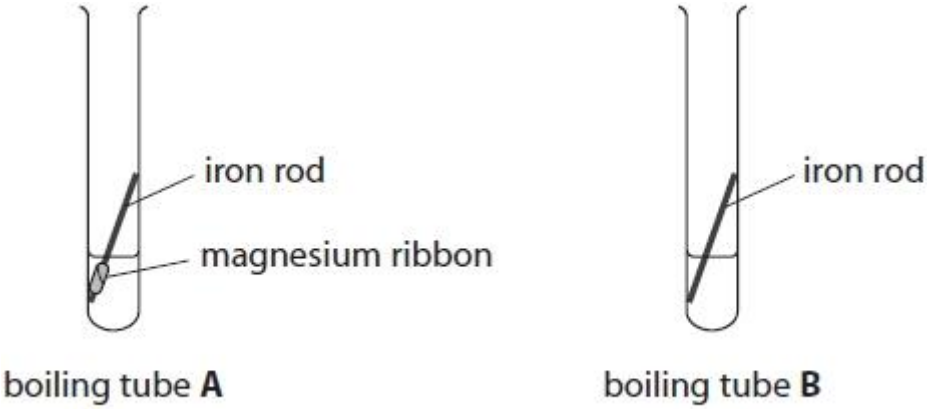

Figure 4

The method used is

- an iron rod, with magnesium ribbon wrapped around it, is placed in a boiling tube labelled **A**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube
- an identical rod but with no magnesium ribbon wrapped around it is placed in a second boiling tube labelled **B**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube.

Both boiling tubes are left for a few days.

(i) Explain why iron rod rather than stainless steel rod is used in this experiment.

(2)

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.....

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.....

(ii) State why it is not necessary to use a pipette to measure out 10 cm^3 water in this experiment.

(1)

.....

(iii) After a few days the two boiling tubes were examined.

The results are shown in Figure 5.

boiling tube A	the appearance of the iron rod is unchanged the magnesium has started to disappear
boiling tube B	a small amount of brown deposit has formed around the rod

Figure 5

Explain the results of this experiment.

(2)

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.....

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(Total for question = 5 marks)

Q4.

Lead can be obtained by heating its oxide with carbon.
The balanced equation for the reaction is

$$2PbO + C \rightarrow 2Pb + CO_2$$

Calculate the atom economy for the production of lead in this reaction.
(relative atomic masses: C = 12, O = 16, Pb = 207
relative formula masses: PbO = 223, CO_2 = 44)

Give your answer to two significant figures.

(4)

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.....

atom economy = ... %

(Total for question = 4 marks)

Q5.

Lead nitrate solution mixed with sodium sulfate solution forms lead sulfate as a precipitate.

$$Pb(NO_3)_2 + Na_2SO_4 \rightarrow PbSO_4 + 2NaNO_3$$

The theoretical yield of lead sulfate for this reaction was 2.85 g.
The actual yield of lead sulfate obtained was 2.53 g.

Calculate the percentage yield of lead sulfate in this experiment.

Give your answer to two significant figures.

(3)

percentage yield = ... %

(Total for question = 3 marks)

Q6.

Calcium carbonate decomposes on heating to form calcium oxide and carbon dioxide.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

8.000 g of $CaCO_3$ was heated strongly for about 10 minutes. 6.213 g of solid remained.
Calculate the mass of carbon dioxide gas given off.

(1)

.....

.....

.....

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mass of carbon dioxide = ... g

(Total for question = 1 mark)

Q7.

In an experiment, ammonia gas is made by heating a mixture of ammonium chloride and calcium hydroxide.

$$2NH_4Cl(s) + Ca(OH)_2(s) \rightarrow CaCl_2(s) + 2NH_3(g) + 2H_2O(l)$$

10.0 g of ammonium chloride is added to an excess of calcium hydroxide.

Calculate the maximum volume of ammonia gas that could be formed.

(relative atomic mass H = 1.00, N = 14.0, O = 16.0 and Ca = 40.0; one mole of any gas occupies 24 dm^3 at room temperature and pressure)

(2)

volume = ... dm^3

(Total for question = 2 marks)

Q8.

In one stage of the production of nitric acid, nitrogen oxide, NO, is reacted with oxygen to make nitrogen dioxide, NO_2.

$$2NO + O_2 \rightarrow 2NO_2$$

Calculate the minimum volume of air, measured at room temperature and pressure, required to react with 1000 g nitrogen oxide to form nitrogen dioxide.

Assume that the air contains 20% oxygen by volume.
(relative atomic masses: N = 14, O = 16

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1 mol of gas occupies 24 dm^3 at room temperature and pressure)

(4)

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.....

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.....

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.....

.....

volume of air = ... dm^3

(Total for question = 4 marks)

Q9.

Calcium carbonate decomposes on heating to form calcium oxide and carbon dioxide.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

A second sample of calcium carbonate is strongly heated in a crucible until there is no further loss in mass.
The mass of calcium oxide remaining in the crucible is 5.450 g.

(i) The theoretical yield of calcium oxide in this experiment is 5.600 g.

Calculate the percentage yield of calcium oxide.

(2)

.....

.....

.....

.....

.....

percentage yield = ...

(ii) The mass of solid left in the crucible is less than the theoretical mass of calcium oxide that should be obtained.

A possible reason for this is that

(1)

☒ **A** some solid was lost from the crucible

☒ **B** the solid remaining absorbed some water from the air

☒ **C** some carbon dioxide remained in the crucible

☒ **D** the decomposition was incomplete

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(Total for question = 3 marks)

Q10.

Calcium carbonate decomposes on heating to form calcium oxide and carbon dioxide.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

(i) Calculate the relative formula mass of calcium carbonate, $CaCO_3$.
(relative atomic masses: C = 12, O = 16, Ca = 40)

(2)

.....

.....

.....

relative formula mass = ...

(ii) Calculate the atom economy for the formation of calcium oxide in this reaction.

$$CaCO_3 \rightarrow CaO + CO_2$$

You must show your working.
(relative atomic masses: C = 12, O = 16, Ca = 40;
relative formula mass: calcium oxide = 56)

(2)

.....

.....

.....

atom economy = ... %

(Total for question = 4 marks)

Q11.

In an experiment to prepare some ammonium chloride crystals, it is calculated that the maximum mass of ammonium chloride produced from the mass of ammonia used should be 24.60 g.

In the experiment, the actual yield was 17.73 g.

Calculate the percentage yield, giving your answer to **three** significant figures.

(3)

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.....

percentage yield = ...

(Total for question = 3 marks)

Q12.

A student was asked to plan a titration experiment to find the exact volume of hydrochloric acid that would neutralise 25.0 cm^3 of sodium hydroxide solution.

The student used 25.0 cm^3 of 0.50 mol dm^{-3} sodium hydroxide solution, NaOH, in the titration.

22.85 cm^3 of hydrochloric acid was required to neutralise the sodium hydroxide solution.

The equation for the reaction is

$$NaOH + HCl \rightarrow NaCl + H_2O$$

Calculate the concentration, in mol dm^{-3}, of the hydrochloric acid, HCl.
Give your answer to 3 significant figures.

(4)

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.....

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.....

concentration = ... mol dm^{-3}

(Total for question = 4 marks)

Q13.

A student was asked to plan a titration experiment to find the exact volume of hydrochloric

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acid that would neutralise 25.0 cm^3 of sodium hydroxide solution.

The concentration of a solution of potassium hydroxide, KOH, is 0.625 mol dm^{-3}.

Calculate the concentration of this solution in g dm^{-3}.
(relative atomic masses: H = 1.0, O = 16, K = 39)

(2)

.....

.....

.....

.....

concentration = ... g dm^{-3}

(Total for question = 2 marks)

Q14.

During fermentation glucose, $C_6H_{12}O_6$, reacts to form ethanol, C_2H_5OH, and carbon dioxide.

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

(relative formula masses: $C_6H_{12}O_6$ = 180, C_2H_5OH = 46;
volume of 1 mol of gas at room temperature and pressure = 24 dm^3)

Calculate the maximum volume, in dm^3, of carbon dioxide that can be produced when 75 kg of glucose reacts completely.

(3)

.....

.....

.....

.....

.....

.....

volume = ... dm^3

(Total for question = 3 marks)

Q15.

The concentration of dilute sulfuric acid can be determined by titration with sodium hydroxide solution of known concentration.

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25.00 cm^3 of dilute sulfuric acid was measured out using a pipette and transferred to a conical flask.

A few drops of methyl orange indicator were added to the acid in the conical flask. Sodium hydroxide solution was added to the acid from a burette until the indicator changed colour.

The titration was repeated until two concordant results were obtained.

The accurate result was the average of the two concordant results.

In the titration, 25.00 cm^3 of dilute sulfuric acid reacted with 24.25 cm^3 of 0.200 mol dm^{-3} sodium hydroxide solution, NaOH.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of the dilute sulfuric acid, H_2SO_4, in mol dm^{-3}.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

concentration of sulfuric acid = ... mol dm^{-3}

(Total for question = 4 marks)

Q16.

The industrial production of sulfuric acid involves several steps.

One of these steps is the reaction of sulfur dioxide, SO_2, with oxygen to form sulfur trioxide, SO_3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

Calculate the mass, in kilograms, of 750 dm^3 of sulfur dioxide, measured at room temperature and pressure.

(relative formula mass: SO_2 = 64;

1 mol of any gas at room temperature and pressure occupies 24 dm^3)

(3)

.....

.....

.....

.....

.....

.....

mass of sulfur dioxide = ... kg

(Total for question = 3 marks)

Q17.

The concentration of dilute sulfuric acid can be determined by titration with sodium hydroxide solution of known concentration.

25.00 cm^3 of dilute sulfuric acid was measured out using a pipette and transferred to a conical flask.

A few drops of methyl orange indicator were added to the acid in the conical flask. Sodium hydroxide solution was added to the acid from a burette until the indicator changed colour.

The titration was repeated until two concordant results were obtained.

The accurate result was the average of the two concordant results.

The concentration of some dilute sulfuric acid, H_2SO_4, is 0.250 mol dm^{-3}.

Calculate the concentration of sulfuric acid in this solution in g dm^{-3}.
(relative formula mass: H_2SO_4 = 98)

(2)

.....

.....

.....

concentration of sulfuric acid = ... g dm^{-3}

(Total for question = 2 marks)

Q18.

The industrial production of sulfuric acid involves several steps.

One of these steps is the reaction of sulfur dioxide, SO_2, with oxygen to form sulfur trioxide, SO_3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

Calculate the volume of oxygen needed to react completely with 750 dm^3 of sulfur dioxide.

(all volumes of gases are measured under the same conditions of temperature and pressure)

(1)

.....

.....

.....

volume of oxygen = ... dm^3

(Total for question = 1 mark)

Q19.

The concentration of dilute sulfuric acid can be determined by titration with sodium hydroxide solution of known concentration.

25.00 cm^3 of dilute sulfuric acid was measured out using a pipette and transferred to a conical flask.

A few drops of methyl orange indicator were added to the acid in the conical flask. Sodium hydroxide solution was added to the acid from a burette until the indicator changed colour.

The titration was repeated until two concordant results were obtained.

The accurate result was the average of the two concordant results.

Describe the colour change seen at the end point of the titration.

(1)

from ..... to .....

(Total for question = 1 mark)

Q20.

Hydrogen burns in air at a temperature well above 100 °C to form water.

(i) The boiling points of hydrogen and water are shown in Figure 3.

	boiling point in °C
hydrogen	−253
water	100

Figure 3

Use this information to add the missing state symbols to the equation for the reaction taking place as the hydrogen burns.

(2)

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$$2H_2(\ldots\ldots) + O_2(g) \rightarrow 2H_2O(\ldots\ldots)$$

(ii) The atom economy for the reaction in (i) is 100%.

State how the equation shows that the atom economy is 100%.

(1)

.....

.....

(Total for question = 3 marks)

Q21.

The industrial production of sulfuric acid involves several steps.

One of these steps is the reaction of sulfur dioxide, SO_2, with oxygen to form sulfur trioxide, SO_3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

* The reaction to produce sulfur trioxide reaches an equilibrium.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.
The rate of attainment of equilibrium and the equilibrium yield of sulfur trioxide are affected by pressure and temperature.

A manufacturer considered two sets of conditions, A and B, for this reaction.
In each case sulfur dioxide is mixed with excess oxygen.
The manufacturer changed the temperature and the pressure and only used a catalyst in B.
The sets of conditions A and B are shown in Figure 7.

set of conditions	pressure in atm	temperature in °C	catalyst
A	2	680	no catalyst used
B	4	425	catalyst used

Figure 7

The manufacturer chooses set of conditions B rather than set of conditions A.

Explain, by considering the effect of changing the conditions on the rate of attainment of equilibrium and on the equilibrium yield of sulfur trioxide, why the manufacturer chooses the set of conditions B rather than the set of conditions A.

(Total for question = 6 marks)

Q22.

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Ammonium sulfate and ammonium nitrate are used as fertilisers as they both contain nitrogen, which will increase the yield of crops.

(i) Suggest **one** other reason for using solid ammonium sulfate and solid ammonium nitrate as nitrogenous fertilisers.

(1)

.....

.....

(ii) Ammonium nitrate can be made by the reaction of ammonia with nitric acid.

Write the balanced equation for this reaction.

(2)

.....

(iii) Describe **one** similarity and **one** difference between the industrial production of ammonium sulfate and the laboratory preparation of ammonium sulfate.

(2)

similarity .....

.....

difference .....

.....

(Total for question = 5 marks)

Q23.

Sodium hydroxide solution reacts with hydrochloric acid.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

(i) 25.0 cm^3 of 0.100 mol dm^{-3} sodium hydroxide, NaOH, solution is added to 35.0 cm^3 of 0.0750 mol dm^{-3} dilute hydrochloric acid, HCl.

Use the information to determine which reagent is in excess.

(3)

(ii) To find the exact amount of dilute hydrochloric acid that reacts with 25.0 cm^3 of the sodium hydroxide solution, a titration is carried out. Figure 14 shows the results for the titrations.

	1st titration	2nd titration	3rd titration	4th titration
final burette reading / cm^3	37.60	36.20	39.15	38.40
initial burette reading / cm^3	1.80	0.00	3.95	2.10
volume of acid used / cm^3	35.80	36.20	35.20	36.30

Figure 14

In this titration, the accurate volumes of acid used that are within 0.20 cm^3 of each other are considered concordant volumes.
Use the concordant results to calculate the mean volume of hydrochloric acid required.

(1)

mean volume = ... cm^3

(iii) During the titration, the indicator used changed colour at the end point.

Which of the following shows an indicator with the colour change that would be seen in this titration?

(1)

		indicator	colour in alkali	colour at end point
☐	**A**	phenolphthalein	colourless	pink
☐	**B**	phenolphthalein	pink	yellow
☐	**C**	methyl orange	red	yellow
☐	**D**	methyl orange	yellow	orange

(Total for question = 5 marks)

Q24.

* The reaction between nitrogen and hydrogen is exothermic.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

If nitrogen and hydrogen were reacted at 150 atm pressure and 300 °C, without a catalyst, some ammonia would be formed.
In the Haber process a pressure of 150 atm and a temperature of 450 °C are used, in the presence of an iron catalyst.
Explain why the conditions used in the Haber process are better than the first set of conditions for the manufacture of ammonia.

(6)

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(Total for question = 6 marks)

Q25.

Methane reacts with steam to form hydrogen and carbon dioxide.

The reaction takes place in two stages.

stage 1: $CH_4(g) + H_2O(g) \rightleftharpoons 3H_2(g) + CO(g)$

stage 2: $CO(g) + H_2O(g) \rightleftharpoons H_2(g) + CO_2(g)$

(i) Stage 1 takes in heat energy, it is endothermic.

Explain the effect of increasing the temperature on the yield of the products of stage 1.

(2)

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(ii) The overall equation for the process is

$$CH_4(g) + 2H_2O(g) \rightarrow 4H_2(g) + CO_2(g)$$

0.40 g of methane were fully reacted with steam to form carbon dioxide and hydrogen.
Calculate the maximum volume of hydrogen in dm^3, measured at room temperature and pressure, that could be made in this reaction.
(relative formula mass: CH_4 = 16, 1 mol of any gas at room temperature and pressure occupies 24 dm^3)

(3)

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maximum volume of hydrogen = ... dm^3

(Total for question = 5 marks)

Q26.

Sulfur trioxide is produced by reacting sulfur dioxide with oxygen.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

(i) This reaction takes place in industry at 1–2 atm pressure and can reach a dynamic equilibrium.

Explain the effect on the rate of attainment of equilibrium, if the process is carried out at a pressure higher than 1–2 atm.

(3)

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(ii) What volume of oxygen, in cm^3, would react completely with 500 cm^3 sulfur dioxide?

(1)

- ☒ **A** 500 ÷ 2
- ☒ **B** 500
- ☒ **C** 500 × 2
- ☒ **D** 500 × 32

(Total for question = 4 marks)

Q27.

In another stage in the production of nitric acid, ammonia is reacted with oxygen to form nitrogen oxide and water.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

Heat energy is given out when ammonia reacts with oxygen.

The conditions chosen for the reaction are

- excess air, rather than just the right amount
- a pressure of 10 atm, rather than atmospheric pressure
- a temperature of 900 °C, rather than room temperature.

Explain the effect of the conditions chosen on the equilibrium yield of nitrogen oxide and on the rate of attainment of equilibrium.

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(Total for question = 6 marks)

Q28.

Potassium hydroxide reacts with hydrochloric acid to form potassium chloride and water.

potassium hydroxide + hydrochloric acid → potassium chloride + water

A student carried out a titration to find the exact volume of dilute hydrochloric acid that reacted with 25.0 cm^3 of potassium hydroxide solution.

There were five steps in the titration.
The steps shown are not in the correct order.

step J pour the potassium hydroxide solution into a conical flask and add a few drops of indicator to this solution

step K fill a burette with the dilute hydrochloric acid and record the initial reading from the burette

step L use a measuring cylinder to obtain 25 cm^3 of potassium hydroxide solution

step M take a final reading from the burette and calculate the volume of the dilute hydrochloric acid reacted

step N run the dilute hydrochloric acid from the burette into the conical flask until the indicator changes colour

A student was then asked to produce a pure sample of solid potassium chloride.

After finding the volume of acid reacted in step M, the student added this volume of acid to a fresh 25.0 cm^3 sample of the potassium hydroxide solution.
This mixture was then evaporated.

(i) Explain why this new mixture was evaporated rather than the original mixture from the titration, to produce a
pure sample of solid potassium chloride.

(2)

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(ii) After evaporation, the mass of the potassium chloride was determined.

The theoretical yield of the experiment was 0.70 g.
The actual yield was 0.84 g.
This gave a percentage yield greater than 100%.
Calculate the percentage yield of this experiment.

(2)

.....

.....

.....

percentage yield = ...

(iii) Suggest a reason why the actual yield was greater than the theoretical yield.

(1)

.....

.....

.....

(iv) The equation for the reaction between potassium hydroxide solution and dilute hydrochloric acid is

$$KOH + HCl \rightarrow KCl + H_2O$$

Calculate the atom economy for the production of potassium chloride from potassium hydroxide and hydrochloric acid.
(relative formula masses: KOH = 56.0, HCl = 36.5, KCl = 74.5, H_2O = 18.0)
Give your answer to one decimal place.

(4)

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.....

.....

.....

.....

.....

atom economy = ... %

(Total for question = 9 marks)

Q29.

Nitrogen reacts with hydrogen to form ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(i) Calculate the minimum volume of nitrogen, in dm^3, required to react completely with 1000 dm^3 of hydrogen.

All volumes are measured at the same temperature and pressure.
Put a cross (☒) in the box next to your answer.

(1)

☐ **A** 333 dm^3

☐ **B** 1000 dm^3

☐ **C** 3000 dm^3

☐ **D** 4666 dm^3

(ii) The minimum volumes of nitrogen and hydrogen that must react completely to form 5000 dm^3 of ammonia are calculated.

These volumes are mixed and left, under appropriate conditions, until the reaction reaches equilibrium.
Explain which gas or gases will be present when equilibrium is reached.

(2)

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(iii) The Haber process is carried out under a pressure of about 200 atm.

Explain the effect on the **equilibrium yield** of ammonia, if the process is carried out at a pressure higher than 200 atm.

(2)

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(iv) Explain the effect on the **rate of attainment of equilibrium**, if the process is carried out at a pressure higher than 200 atm.

(3)

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Q30.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Ammonia is manufactured by the Haber process.

The equation for the reaction is

$$N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$$

The reaction is reversible and can reach equilibrium.

(i) An iron catalyst can be used in the reaction.

Which row of the table shows how adding the iron catalyst affects the rate of attainment of equilibrium and the equilibrium yield of ammonia?

(1)

		rate of attainment of equilibrium	equilibrium yield of ammonia
☐	**A**	increases	increases
☐	**B**	decreases	does not change
☐	**C**	decreases	increases
☐	**D**	increases	does not change

(ii) Which of the following statements is correct when the reaction reaches equilibrium?

(1)

☐ **A** the reverse reaction starts to take place
☐ **B** the amounts of nitrogen, hydrogen and ammonia are equal
☐ **C** the amounts of nitrogen, hydrogen and ammonia become constant
☐ **D** the reaction stops

(iii) The reaction is carried out at a pressure of 200 atmospheres.

Explain what effect a pressure higher than 200 atmospheres would have on the rate of attainment of equilibrium and on the equilibrium yield of ammonia.

(4)

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(Total for question = 6 marks)

Q31.

Ammonium nitrate is produced from ammonia and nitric acid on a large scale in industry.

Ammonium nitrate can also be made in the laboratory by titrating ammonia solution with dilute nitric acid.

$$NH_3 + HNO_3 \rightarrow NH_4NO_3$$

Ammonium nitrate crystals can then be obtained by evaporating off some of the water from the solution.

Give **two** reasons why this laboratory method is not suitable for use on a large scale in industry.

(2)

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(Total for question = 2 marks)

Q32.

The method used to make lead sulfate is:

- pour 100 cm^3 lead nitrate solution into a beaker
- add drops of sodium sulfate solution until a precipitate is seen
- allow the precipitate to settle to the bottom of the beaker

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- pour off the liquid
- use a spatula to transfer the solid lead sulfate onto a filter paper

Explain **two** ways of improving this experimental method to increase the amount and quality of lead sulfate obtained from the same volume of lead nitrate solution.

(4)

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(Total for question = 4 marks)

Q33.

(i) In an experiment to produce lead, 7.67 g of lead are obtained.

The theoretical yield of lead for the experiment is 11.80 g.
Calculate the percentage yield of lead in this experiment.

(2)

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.....

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.....

percentage yield = ...

(ii) In most reactions, the percentage yield of any product is less than 100%.

Give **two** reasons why the percentage yield is less than 100%.

(2)

reason 1

.....

.....

reason 2

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(Total for question = 4 marks)

Q34.

The compound ammonium chloride is used as a fertiliser.

Starting with a dilute solution of ammonia, describe how you could prepare a pure solution of ammonium chloride in the laboratory.

(3)

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(Total for question = 3 marks)

Q35.

A solution is made by dissolving calcium chloride in water.

11.1 g of calcium chloride are dissolved in water.

The volume of the solution is made up to 500 cm^3.

Calculate the concentration, in mol dm^{-3}, of calcium chloride, $CaCl_2$, in this solution.

(relative atomic masses: Cl = 35.5, Ca = 40.0)

(3)

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concentration = ...mol dm^{-3}

Q36.

When there are alternative methods of producing a product, the final pathway is chosen by considering atom economy, cost of energy, yield of product and rates of reactions.

State another factor that should also be considered.

(1)

.....

(Total for question = 1 mark)

Q37.

Many metals corrode.

Ammonia is used to make hydrazine.

In the industrial process to manufacture ammonia, nitrogen and hydrogen are combined in the presence of an iron catalyst.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(i) State the name of the industrial process to manufacture ammonia.

(1)

.....

(ii) Predict the effect that adding the catalyst has on the rate of attainment of equilibrium.

(1)

.....

.....

(iii) Predict the effect that adding the catalyst has on the equilibrium yield of ammonia.

(1)

.....

.....

(Total for question = 3 marks)

Q38.

Nitric acid can be titrated with a solution of ammonia.

(i) State the type of reaction occurring when nitric acid reacts with ammonia.

(1)

.....

(ii) What salt is formed in this reaction?

(1)

- ☒ **A** ammonia nitric
- ☒ **B** ammonia nitrate
- ☒ **C** ammonium nitric
- ☒ **D** ammonium nitrate

(Total for question = 2 marks)

Q39.

Ammonia is manufactured in the Haber process.

In this process, hydrogen reacts with nitrogen under a pressure of about 200 atmospheres and at 450 °C.

A dynamic equilibrium can be reached.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

Explain the effect on the **rate of attainment of equilibrium**, of carrying out the process at the same temperature but at a pressure higher than 200 atmospheres.

(3)

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(Total for question = 3 marks)

Q40.

The concentration of a solution of an alkali can be determined by titration with an acid.

25.0 cm^3 portions of the solution of the alkali are transferred into a conical flask and titrated with the acid solution, using a suitable indicator.

(i) Describe how you would measure out and transfer 25.0 cm^3 of the solution of the alkali.

(2)

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(ii) Complete the sentence by putting a cross (☒) in the box next to your answer.

The burette readings of acid added were

	titration 1	titration 2	titration 3
final volume / cm^3	27.20	30.10	25.35
initial volume / cm^3	2.05	5.20	0.10
volume of acid added / cm^3	25.15	24.90	25.25

The volume of acid added that should be used in the calculation is

(1)

☒ **A** 24.90 cm^3

☒ **B** 25.00 cm^3

☒ **C** 25.10 cm^3

☒ **D** 25.20 cm^3

Q41.

A student was asked to plan a titration experiment to find the exact volume of hydrochloric acid that would neutralise 25.0 cm^3 of sodium hydroxide solution.

The student's plan is

1. use a measuring cylinder to pour 25 cm^3 of sodium hydroxide solution into a conical flask
2. add a few drops of an indicator to the sodium hydroxide solution
3. use a burette to add hydrochloric acid to the sodium hydroxide solution until the

indicator changes colour

(i) State the name of the piece of apparatus that should be used, instead of the measuring cylinder in step 1, in order to improve the accuracy of the experiment.

(1)

.....

(ii) Suggest the name of a suitable indicator and state the colour change that would occur at the end point in this experiment.

(2)

name of indicator

.....

colour change

.....

.....

(iii) Suggest **two** details that could be added to the plan to make the experiment more accurate.

(2)

1 .....

.....

2 .....

.....

(Total for question = 5 marks)

Q42.

The industrial production of sulfuric acid involves several steps.

One of these steps is the reaction of sulfur dioxide, SO_2, with oxygen to form sulfur trioxide, SO_3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

What volume of sulfur trioxide, in dm^3, is produced by the complete reaction of 750 dm^3 of sulfur dioxide?

(all volumes of gases are measured under the same conditions of temperature and pressure)

(1)

- ☒ **A** 375.5
- ☒ **B** 750
- ☒ **C** 1125.5
- ☒ **D** 1500

(Total for question = 1 mark)

Q43.

Potassium hydroxide reacts with hydrochloric acid to form potassium chloride and water.

potassium hydroxide + hydrochloric acid → potassium chloride + water

A student carried out a titration to find the exact volume of dilute hydrochloric acid that reacted with 25.0 cm^3 of potassium hydroxide solution.

There were five steps in the titration.
The steps shown are not in the correct order.

step J pour the potassium hydroxide solution into a conical flask and add a few drops of indicator to this solution

step K fill a burette with the dilute hydrochloric acid and record the initial reading from the burette

step L use a measuring cylinder to obtain 25 cm^3 of potassium hydroxide solution

step M take a final reading from the burette and calculate the volume of the dilute hydrochloric acid reacted

step N run the dilute hydrochloric acid from the burette into the conical flask until the indicator changes colour

(i) Write the steps in the correct order.

Some of the steps have been completed for you.

(1)

first step				last step
K				M

(ii) Suggest an alternative piece of apparatus that could be used in step L to obtain exactly 25.0 cm^3 of potassium hydroxide solution.

(1)

.....

(Total for question = 2 marks)

Name: _____

Chemistry Paper 1 Low Tariff Topics

Date:

Time:

Total marks available:

Total marks achieved: _____

Questions

Q1.

Acid solutions contain hydrogen ions.

Aluminium reacts with dilute hydrochloric acid to form a solution containing aluminium ions, Al^{3+}.

Complete the balanced ionic equation for this reaction.

(2)

..... + ... H^+ → ..... Al^{3+} + ...

(Total for question = 2 marks)

Q2.

Many metals corrode.

An experiment is carried out to see if magnesium ribbon wrapped around a piece of iron rod has an effect on the rate at which the iron rod rusts.

The apparatus is shown in Figure 4.

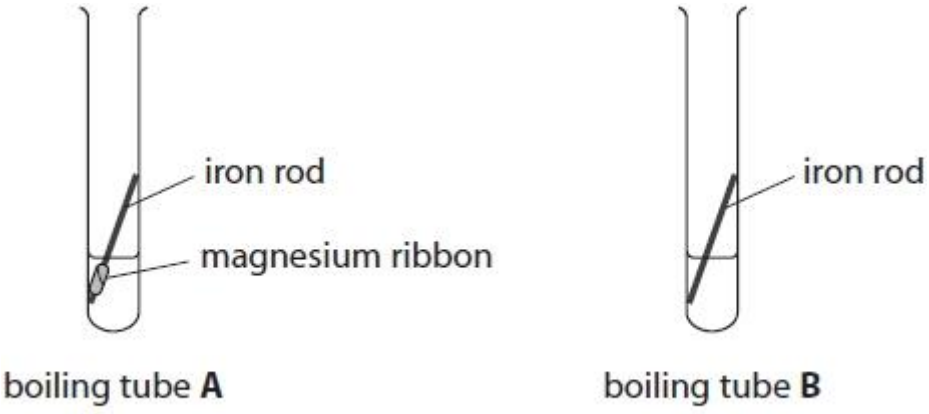

Figure 4

The method used is

- an iron rod, with magnesium ribbon wrapped around it, is placed in a boiling tube labelled **A**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube
- an identical rod but with no magnesium ribbon wrapped around it is placed in a second boiling tube labelled **B**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube.

Both boiling tubes are left for a few days.

(i) Explain why iron rod rather than stainless steel rod is used in this experiment.

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(2)

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(ii) State why it is not necessary to use a pipette to measure out 10 cm^3 water in this experiment.

(1)

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(iii) After a few days the two boiling tubes were examined.

The results are shown in Figure 5.

boiling tube A	the appearance of the iron rod is unchanged the magnesium has started to disappear
boiling tube B	a small amount of brown deposit has formed around the rod

Figure 5

Explain the results of this experiment.

(2)

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(Total for question = 5 marks)

Q3.

Calcium nitrate solution can be made by adding solid calcium carbonate to dilute nitric acid in a beaker.

The solid calcium carbonate is added until some remains at the bottom of the beaker.

(i) After this reaction the liquid in the beaker is

(1)

☒ **A** acidic

☒ **B** alkaline

☒ **C** neutral

☒ **D** pure water

(ii) Explain why the calcium carbonate is added until some solid remains at the bottom of the beaker.

(2)

.....

.....

.....

(iii) Write the balanced equation for the reaction between calcium carbonate and nitric acid to form calcium nitrate, $Ca(NO_3)_2$.

(3)

.....

(Total for question = 6 marks)

Q4.

In a titration, 25.0 cm^3 of a different sodium hydroxide solution is titrated with 0.200 mol dm^{-3} sulfuric acid, H_2SO_4.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

24.80 cm^3 of acid are required to neutralise 25.0 cm^3 of the sodium hydroxide solution.

Calculate the concentration of the sodium hydroxide solution, NaOH, in mol dm^{-3}.

(4)

concentration = ... mol dm^{-3}

(Total for question = 4 marks)

Q5.

Gold is often alloyed with other metals when it is used to make jewellery.

The proportion of gold in a piece of gold jewellery is measured in carats.

Pure gold is 24 carats.

A 9 carat gold ring has a mass of 12 g.

Calculate the mass of gold in this ring.

(2)

mass of gold ring = ... g

(Total for question = 2 marks)

Q6.

Hydrogen burns in air at a temperature well above 100 °C to form water.

(i) The boiling points of hydrogen and water are shown in Figure 3.

	boiling point in °C
hydrogen	−253
water	100

Figure 3

Use this information to add the missing state symbols to the equation for the reaction taking place as the hydrogen burns.

(2)

$2H_2($ ..... $) + O_2(g) \rightarrow 2H_2O($ ..... $)$

(ii) The atom economy for the reaction in (i) is 100%.

State how the equation shows that the atom economy is 100%.

(1)

.....

.....

(Total for question = 3 marks)

Q7.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

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

$$\text{copper carbonate} + \text{sulfuric acid} \rightarrow \text{copper sulfate} + \text{carbon dioxide} + \text{water}$$

(i) Complete the balanced equation for this reaction.

(2)

$$CuCO_3 + \text{.....} \rightarrow \text{.....} + CO_2 + H_2O$$

(ii) Calculate the relative formula mass of copper carbonate, $CuCO_3$.
(relative atomic masses: C = 12.0, O = 16.0, Cu = 63.5)

(2)

.....

.....

.....

relative formula mass of $CuCO_3$ = ...

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

(1)

- ☒ **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

(Total for question = 5 marks)

Q8.

Calcium oxide is an ionic solid.

Figure 5 shows the arrangement of electrons in a calcium atom and in an oxygen atom.

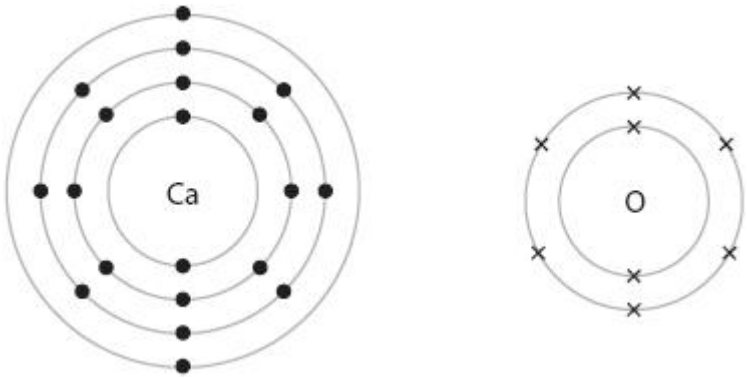
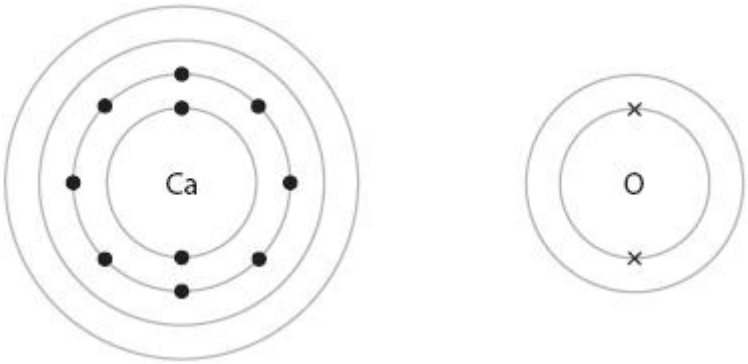


Figure 5

Complete Figure 6 to show the electronic configurations and charges of the calcium ion and the oxide ion.

Use dots to show the electrons originally in the calcium atom and crosses to show the electrons originally in the oxygen atom.

(3)



charge on ion ..... charge on ion .....

Figure 6

(Total for question = 3 marks)

Q9.

Many metals corrode.

When a metal corrodes

(1)

- ☒ **A** the metal reacts with nitrogen
- ☒ **B** the metal reacts with another metal
- ☒ **C** the metal element decomposes
- ☒ **D** the metal is oxidised

(Total for question = 1 mark)

Q10.

Diamond and graphite are both forms of carbon.
In both substances, the carbon atoms are held together by covalent bonds.

Describe what is meant by a **covalent bond**.

(2)

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(Total for question = 2 marks)

Q11.

Titanium and iron are examples of transition metals.

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)

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balanced equation for the reaction is

..... Fe + ...O_2 → .....

(Total for question = 4 marks)

Q12.

Alloys of gold are often used to make jewellery.
The purity of gold is measured in carats.
Different alloys of gold have different carats.

Figure 2 shows the relationship between the purity of gold in carats and the percentage of gold in the alloy.

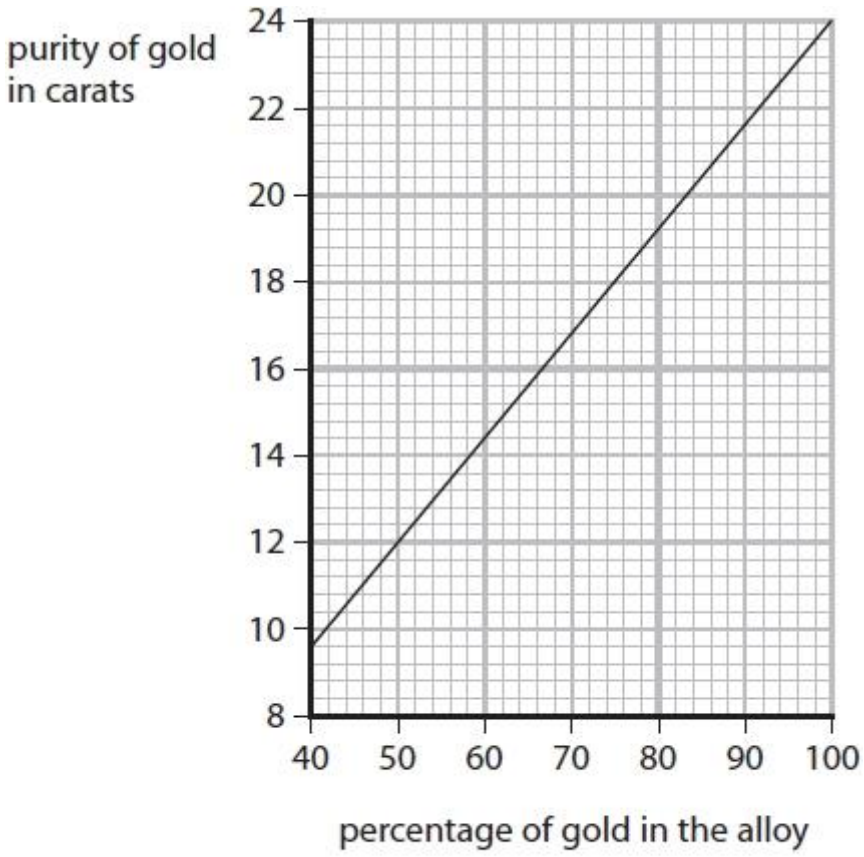

Figure 2

A necklace with a mass of 5.0 g was found to contain 2.9 g of gold.

Determine the purity of the gold necklace in carats.
Show your working.

(3)

.....

.....

.....

purity of the gold necklace = ... carats

(Total for question = 3 marks)

Q13.

Ammonium sulfate and ammonium nitrate are used as fertilisers as they both contain nitrogen, which will increase the yield of crops.

(i) Suggest **one** other reason for using solid ammonium sulfate and solid ammonium nitrate as nitrogenous fertilisers.

(1)

.....

.....

(ii) Ammonium nitrate can be made by the reaction of ammonia with nitric acid.

Write the balanced equation for this reaction.

(2)

.....

(iii) Describe **one** similarity and **one** difference between the industrial production of ammonium sulfate and the laboratory preparation of ammonium sulfate.

(2)

similarity .....

.....

difference .....

.....

(Total for question = 5 marks)

Q14.

Hydrogen sulphide, H_2S, is a simple molecular, covalent compound.

(i) A hydrogen atom has one electron in its outer shell.

A sulfur atom has six electrons in its outer shell.
Which of the following is the dot and cross diagram of a molecule of hydrogen sulfide?

(1)

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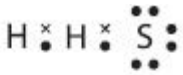
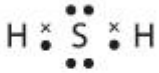
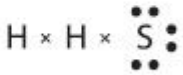
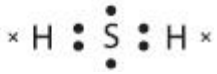
☐ **A** 

☐ **B** 

☐ **C** 

☐ **D** 

(ii) Which row in Figure 1 shows the properties of a simple molecular, covalent compound such as hydrogen sulfide?

(1)

		melting point	boiling point	conduction of electricity
☐	**A**	high	high	poor conductor
☐	**B**	high	high	good conductor only when liquid
☐	**C**	low	low	poor conductor
☐	**D**	high	high	good conductor

Figure 1

(Total for question = 2 marks)

Q15.

Covalent substances can be simple molecular covalent or giant covalent.

Oxygen, O_2, is also a simple molecular, covalent substance.

Draw a dot and cross diagram for the molecule of oxygen.

(2)

(Total for question = 2 marks)

Q16.

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)

(Total for question = 2 marks)

Q17.

Diamond and carbon dioxide are both covalent substances.

(i) Draw a dot and cross diagram to show the covalent bonding in a molecule of carbon dioxide, CO_2.

Show outer electrons only.

(2)

(ii) Diamond has a very high melting point.

Explain why the melting point of diamond is very high.

(2)

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(Total for question = 4 marks)

Q18.

A solution of sodium chloride contains the four ions shown in the box.

Na^+	Cl^-	OH^-	H^+

(a) The sodium chloride solution is electrolysed.

Give the formulae of the **two** ions that will be attracted to the positively charged electrode.

(1)

.....

(b) Complete the sentence by putting a cross (☒) in the box next to your answer.

When molten lead bromide is electrolysed the products are

(1)

☐ **A** lead and hydrogen

☐ **B** hydrogen and bromine

☐ **C** hydrogen and oxygen

☐ **D** lead and bromine

(c) During electrolysis, oxidation takes place at the anode and reduction takes place at the cathode.

Explain, in terms of electrons, what is meant by **oxidation** and **reduction**.

(2)

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.....

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(d) Explain why some metal objects are electroplated.

(2)

.....

.....

.....

.....

.....

Q19.

Ethanol is produced by the fermentation of glucose.

Yeast is needed for the fermentation reaction.

(i) State **two** other conditions for fermentation.

(2)

.....

.....

.....

(ii) Complete the sentence by putting a cross (☒) in the box next to your answer.

A dilute solution of ethanol can be converted to a concentrated solution of ethanol by

(1)

- ☐ **A** filtration
- ☐ **B** fractional distillation
- ☐ **C** dehydration
- ☐ **D** cracking

(iii) Write the balanced equation for the fermentation of glucose, $C_6H_{12}O_6$.

(2)

.....

Q20.

Duralumin is an alloy of aluminium and copper.

The radii of the aluminium and copper atoms are shown in Figure 11.

	radius of atom / m
aluminium	1.43×10^{-12}
copper	1.27×10^{-12}

Figure 11

Explain why copper added to aluminium to form the alloy makes the alloy stronger than pure aluminium.

(2)

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.....

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.....

(Total for question = 2 marks)

Q21.

Alloys of gold are often used to make jewellery.
The purity of gold is measured in carats.
Different alloys of gold have different carats.

Figure 1 shows the percentage of different metals in two samples of gold.

	percentage of metal		
	gold	silver	copper
18 carat gold	75.0	15.0	10.0
24 carat gold	100.0	0.0	0.0

Figure 1

Explain why 18 carat gold is stronger than 24 carat gold.

You may use diagrams to help your answer.

(2)

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.....

(Total for question = 2 marks)

Q22.

Iron is extracted from iron oxide, Fe_2O_3.

In the extraction process the iron oxide is heated with carbon to form iron and carbon dioxide.

Write the balanced equation for this reaction.

(3)

.....

Q23.

When sodium sulfate solution is electrolysed, using inert electrodes, hydrogen is formed at the cathode.

Write the half equation for the formation of hydrogen gas, H_2, from hydrogen ions, H^+.

(2)

.....

(Total for question = 2 marks)

Q24.

Calcium nitrate, $Ca(NO_3)_2$, is an ionic solid.

State the formulae of the ions in calcium nitrate.

(2)

.....

(Total for question = 2 marks)

Q25.

Alloy steels are made when iron is alloyed with other transition metals such as cobalt and chromium.

Iron fences can be galvanised by coating them with a layer of zinc. When the layer of zinc is scratched exposing the iron to the weather, the iron does not rust.

Explain why the exposed iron does not rust.

(2)

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(Total for question = 2 marks)

Q26.

The voltage of a cell is 1.5 V.

Give a reason why this voltage of the cell decreases when the cell is left connected in a circuit.

(1)

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.....

(Total for question = 1 mark)

Q27.

In Figure 1, the letters **A**, **E**, **G**, **J**, **X** and **Z** show the positions of six elements in the periodic table.

These letters are not the symbols of the atoms of these elements.

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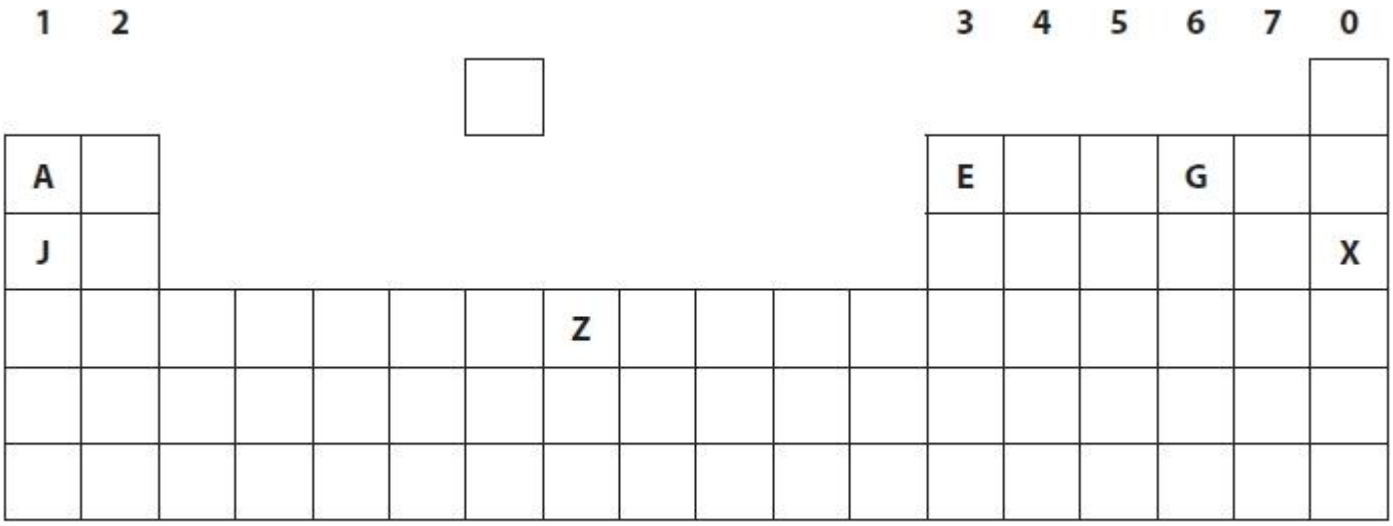

Figure 1

Using the letters **A**, **E**, **G**, **J**, **X** and **Z**

(i) give the letters of the **two** elements that are non-metals

(1)

.....

(ii) give the letters of **two** elements in period 2

(1)

.....

(iii) give the letter of an element that normally forms an ion with a charge of +1.

(1)

.....

(Total for question = 3 marks)

Q28.

Ships made of steel have blocks containing magnesium fixed to their hulls, as shown in Figure 3.

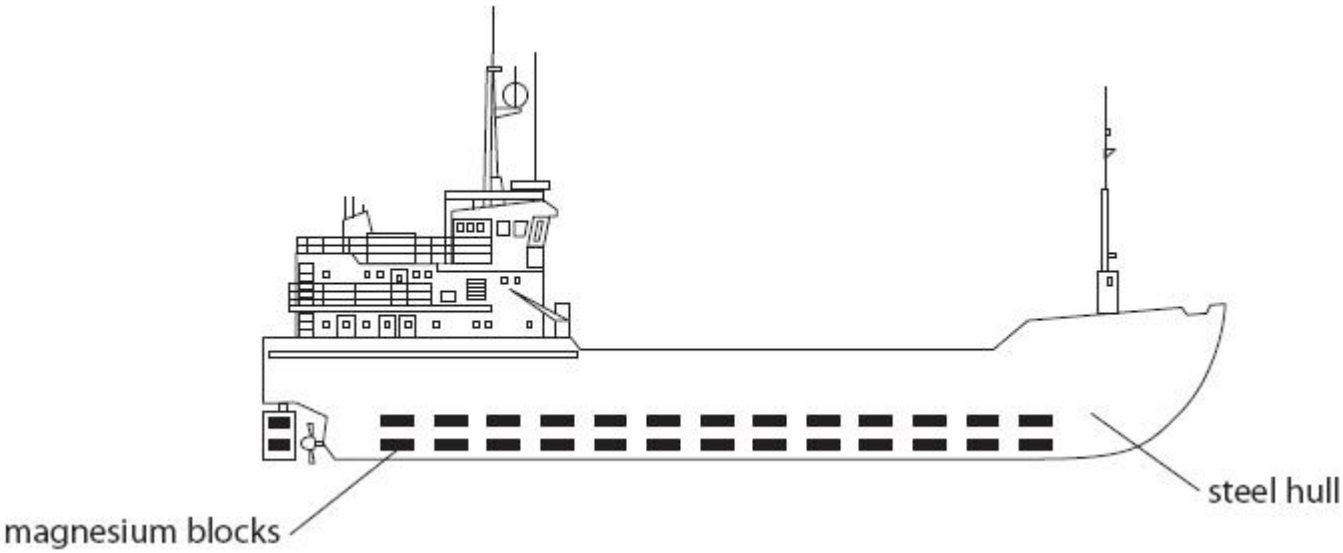

Figure 3

The magnesium prevents the steel hulls from rusting.

Explain how the magnesium prevents the steel from rusting.

(2)

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.....

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.....

(Total for question = 2 marks)

Q29.

Objects made from transition metals are sometimes coated with a thin layer of another transition metal to improve their appearance and to protect against corrosion.

Figure 10 shows equipment that can be used to electroplate an iron spoon with silver.

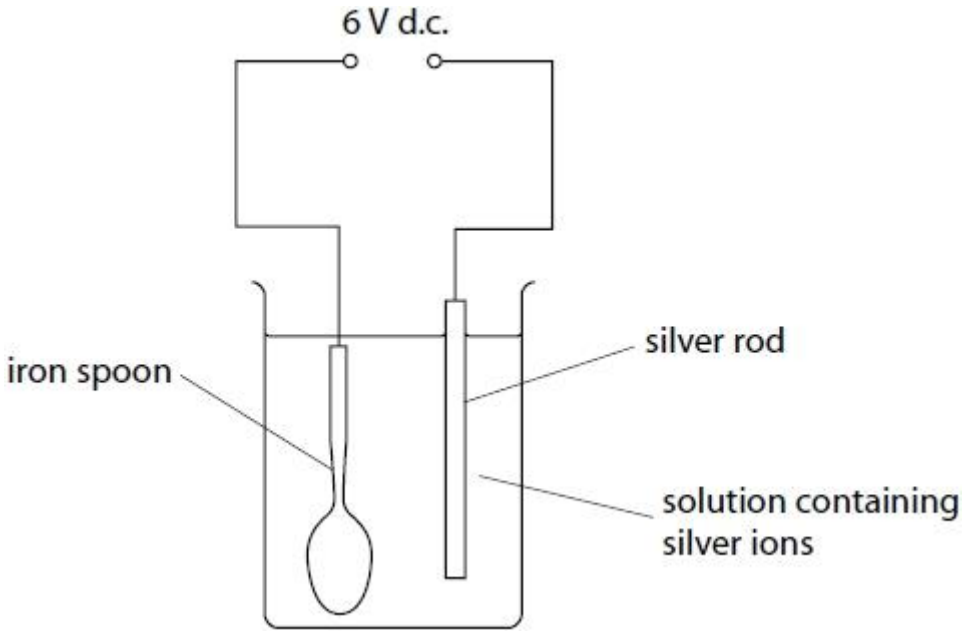

Figure 10

(i) Which row of the table correctly shows the charge on the silver rod electrode and the type of reaction occurring at this electrode?

(1)

	charge	type of reaction
☐ **A**	negative	oxidation
☐ **B**	negative	reduction
☐ **C**	positive	oxidation
☐ **D**	positive	reduction

(ii) Silver metal is deposited on the spoon.

Which half-equation represents this reaction?

(1)

☐ **A** $Ag + e \rightarrow Ag^+$

☐ **B** $Ag \rightarrow Ag^+ + e^-$

☐ **C** $Ag^+ + e \rightarrow Ag$

☐ **D** $Ag^+ \rightarrow Ag + e^-$

(Total for question = 2 marks)

Q30.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

When copper sulfate solution reacts with sodium hydroxide solution, a precipitate of copper hydroxide and a solution of sodium sulfate are formed.

The equation is

$$CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$$

The formula of the sodium ion is Na^+.

What is the formula of the sulfate ion?

(1)

☐ **A** SO_4^+

☐ **B** SO_4^-

☐ **C** SO_4^{2+}

☐ **D** SO_4^{2-}

(Total for question = 1 mark)

Q31.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

Magnesium has an atomic number of 12.

Which line in the table shows the correct numbers of protons, neutrons and electrons in a positively charged magnesium ion?

(1)

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	number of		
	protons	neutrons	electrons
☐ A	10	12	12
☐ B	10	12	10
☐ C	12	10	12
☐ D	12	12	10

(Total for question = 1 mark)

Q32.

When sodium hydroxide solution is mixed with a solution containing copper ions, Cu^{2+}, copper hydroxide, $Cu(OH)_2$, is formed.

(i) Describe what you would **see** when these solutions are mixed.

(2)

.....

.....

(ii) Write the ionic equation for this reaction.

.....

(3)

Q33.

When iron rusts it forms hydrated iron oxide, $Fe_2O_3.H_2O$.

$$4Fe + 3O_2 + 2H_2O \rightarrow 2Fe_2O_3.H_2O$$

(1)

In this reaction iron is

☐ **A** decomposed

☐ **B** neutralised

☐ **C** oxidised

☐ **D** reduced

(Total for question = 1 mark)

Q34.

Alloy steels are made when iron is alloyed with other transition metals such as cobalt and chromium.

Which row of the table shows the typical properties of a transition metal?

(1)

	used as a catalyst	density	colour of metal chloride
☐ A	yes	high	colourless
☐ B	no	low	colourless
☐ C	yes	high	coloured
☐ D	no	low	coloured

(Total for question = 1 mark)

Q35.

In a hydrogen-oxygen fuel cell, hydrogen and oxygen react at the electrodes.

Some metal objects are electroplated.

State **two** reasons for electroplating a metal object.

(2)

1 .....

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2 .....

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(Total for question = 2 marks)

Q36.

Covalent substances can be simple molecular covalent or giant covalent.

(i) Ammonia is a simple molecular, covalent substance.

Which is the most likely set of properties for ammonia?

(1)

	melting point in °C	boiling point in °C	ability to conduct electricity in liquid state
☐ A	1713	2950	does not conduct
☐ B	−78	−33	does not conduct
☐ C	−39	357	conducts
☐ D	801	1413	conducts

(ii) Ammonia, NH_3, is made by reacting nitrogen with hydrogen.

Write the balanced equation for this reaction.

(2)

.....

(Total for question = 3 marks)

Q37.

In a hydrogen-oxygen fuel cell, hydrogen and oxygen react at the electrodes.

The electrodes of a fuel cell are in contact with water and air.
The electrodes are made of platinum rather than iron.

(i) State why iron is not a suitable metal for the electrodes of the cell.

(1)

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.....

(ii) Platinum acts as a catalyst.

State, in terms of its position in the periodic table, why you would expect platinum to act as a catalyst.

(1)

.....

.....

.....

(Total for question = 2 marks)

Q38.

Salts of metals can be prepared by reacting the metal with an acid to produce the salt and hydrogen.

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

(2)

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.....

(ii) Nickel is a metal.

Explain how the structure of a nickel atom, Ni, changes when it forms a nickel ion, Ni^{2+}.

(2)

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.....

.....

.....

(Total for question = 4 marks)

Q39.

Many metals corrode.

Hydrazine, N_2H_4, reacts with oxygen.

$$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$$

A metal in water corrodes faster than an identical piece of metal in the same volume of water containing dissolved hydrazine.

Use the information to explain how hydrazine slows corrosion.

(2)

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.....

(Total for question = 2 marks)

Q40.

Acids are a hazard if a high concentration of hydrogen ions is present.

Hydrochloric acid is a strong acid, ethanoic acid is a weak acid.

Figure 9 shows the labels on bottles of dilute hydrochloric acid and concentrated ethanoic acid.

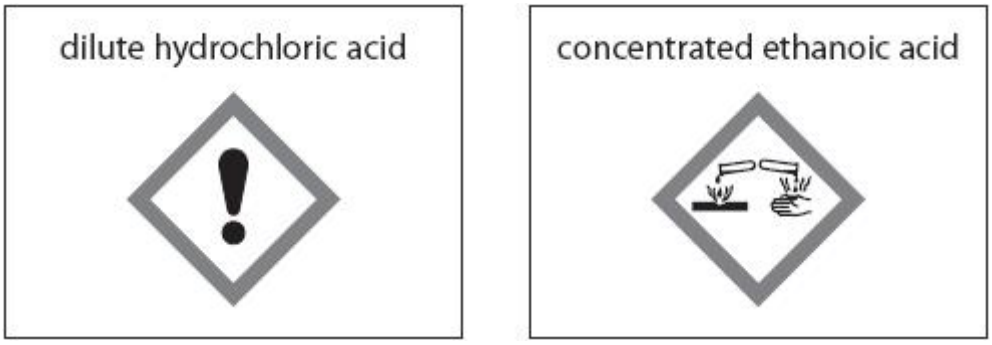

Figure 9

Explain why the hazard of the dilute hydrochloric acid is lower than the hazard of concentrated ethanoic acid, even though hydrochloric acid is a strong acid and ethanoic acid is a weak acid.

(4)

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(Total for question = 4 marks)

Q41.

In a hydrogen-oxygen fuel cell, hydrogen and oxygen react at the electrodes.

The overall reaction occurring in this fuel cell is a reaction of hydrogen with oxygen.

Write the balanced equation for this reaction.

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(2)

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.....

(Total for question = 2 marks)

Q42.

A Bunsen burner has a base and a chimney as shown in Figure 2.

Figure 2

The base can be made of steel.

Explain why steel is a suitable material for the base.

Do not consider cost.

(2)

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.....

.....

(Total for question = 2 marks)

Q43.

Some nickel ores contain nickel sulfide.

(i) In the first stage of extracting nickel from nickel sulfide, the nickel sulfide, NiS, is heated in air to form nickel oxide, NiO, and sulfur dioxide.

Write the balanced equation for this reaction.

(2)

.....

.....

(ii) In the final stage of the extraction process, a nickel compound is electrolysed to produce pure nickel.

An advantage of producing a metal by electrolysis is that

(1)

- ☒ **A** electrolysis uses a large amount of electricity
- ☒ **B** the metal produced by electrolysis is very pure
- ☒ **C** electrolysis is a very cheap method of extraction
- ☒ **D** electrolysis is the only method of extracting unreactive metals

(Total for question = 3 marks)

Q44.

The ions present in sodium sulfate are

sodium	Na^+
sulfate	SO_4^{2-}

Write the formula of sodium sulfate using this information.

(1)

.....

(Total for question = 1 mark)

Q45.

When copper sulfate solution reacts with sodium hydroxide solution, a precipitate of copper hydroxide and a solution of sodium sulfate are formed.

The equation is

$$CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$$

Copper ions, Cu^{2+}, react with hydroxide ions to form copper hydroxide.

Write the ionic equation for this reaction.

(2)

.....

(Total for question = 2 marks)

Q46.

Magnesium oxide reacts with dilute hydrochloric acid to produce magnesium chloride solution and water.

$$MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$$

Write the ionic equation for this reaction.

(3)

.....

(Total for question = 3 marks)

Name: _____

Paper 1 Core Practical 2022 Exam

Date:

Time:

Total marks available:

Total marks achieved: _____

Questions

Q1.

State the colour of Universal indicator in a solution of ethanoic acid.

(1)

.....

.

Q2.

State the colour of Universal indicator in a solution of ethanoic acid.

(1)

.....

.

Q3.

Hydrogen reacts with chlorine to form hydrogen chloride.

When hydrogen chloride gas, HCl, is dissolved in water an acidic solution is formed.

(i) Give the name of the acid.

(1)

.....

(ii) What colour is seen when methyl orange is added to this acidic solution?

(1)

- ☒ **A** blue
- ☒ **B** green
- ☒ **C** pink-red
- ☒ **D** orange

(Total for question = 2 marks)

Q4.

The concentration of dilute sulfuric acid can be determined by titration with sodium hydroxide solution of known concentration.

25.00 cm^3 of dilute sulfuric acid was measured out using a pipette and transferred to a conical flask.

A few drops of methyl orange indicator were added to the acid in the conical flask. Sodium hydroxide solution was added to the acid from a burette until the indicator changed colour.

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The titration was repeated until two concordant results were obtained.

The accurate result was the average of the two concordant results.

A brief report of the practical method has been given above.
Further detail can be added to this method to ensure that anyone following the method will obtain an accurate result.

Explain **two** details that could be added to this practical method to ensure an accurate result is obtained.

(4)

1 .....

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2 .....

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(Total for question = 4 marks)

Q5.

A titration is to be carried out to find the concentration of a solution of sodium hydroxide.

The sodium hydroxide solution is titrated with dilute sulfuric acid.

The available apparatus includes a burette, a pipette, a funnel, a conical flask and an indicator.

(a) State one safety precaution that must be taken when using sodium hydroxide solution and dilute sulfuric acid.

(1)

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.....

.....

(b) The sodium hydroxide solution is made by dissolving 4.3 g of sodium hydroxide in water and making the solution up to 250 cm^3 with water.

Calculate the concentration of the solution in g dm^{-3}.

(2)

concentration = ... g dm^{-3}

(c) Write the balanced equation for the reaction of dilute sulfuric acid, H_2SO_4, with sodium hydroxide.

(2)

.....

(d) The results of titrations to determine how much of an acid is required to neutralise a given volume of an alkaline solution are shown in Figure 14.

	titration 1	titration 2	titration 3	titration 4
final burette reading (cm^3)	27	27.40	29.20	29.30
initial burette reading (cm^3)	0	2.10	4.00	3.50
volume of acid used (cm^3)	27	25.30	25.20	25.80

Figure 14

Two of the titrations in Figure 14 should **not** be used to calculate the mean volume of acid required.
Identify each titration and give a reason why it should not be used in the calculation of the mean.

(2)

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.....

(Total for question = 7 marks)

Q6.

An experiment is planned to record the change in pH as a powdered base is added to 50 cm^3 dilute hydrochloric acid.

The method suggested is

step 1 add dilute hydrochloric acid up to the 50 cm^3 mark on a beaker;
step 2 add one spatula of the base and stir;
step 3 measure the pH of the mixture;
step 4 repeat steps 2 and 3 until the pH stops changing.

(i) State how you could change the method so that the amounts of dilute hydrochloric acid and of the base can be measured more accurately.

(2)

dilute hydrochloric acid

.....

.....

base

.....

.....

(ii) During the experiment the pH changes from 2 to 10.
If phenolphthalein indicator is added at the beginning of the experiment, a colour change occurs as the base is added.

State the colour change that occurs.

(1)

colour at start .....

colour at end .....

(iii) Explain, in terms of the particles present, why the pH increases during the experiment.

(2)

.....

.....

.....

.....

(Total for question = 5 marks)

Q7.

An experiment is planned to record the change in pH as a powdered base is added to 50 cm^3 dilute hydrochloric acid.

The method suggested is

step 1 add dilute hydrochloric acid up to the 50 cm^3 mark on a beaker
step 2 add one spatula of the base and stir
step 3 measure the pH of the mixture
step 4 repeat steps 2 and 3 until the pH stops changing.

(i) State how you could change the method so that the amounts of dilute hydrochloric acid and of the base can be measured more accurately.

(2)

dilute hydrochloric acid

.....

.....

base

.....

.....

(ii) During the experiment the pH changes from 2 to 10.

If phenolphthalein indicator is added at the beginning of the experiment, a colour change occurs as the base is added.
State the colour change that occurs.

(1)

colour at start .....
colour at end .....

(iii) Explain, in terms of the particles present, why the pH increases during the experiment.

(2)

.....

.....

.....

.....

(Total for question = 5 marks)

Q8.

Many metals corrode.

An experiment is carried out to see if magnesium ribbon wrapped around a piece of iron rod has an effect on the rate at which the iron rod rusts.

The apparatus is shown in Figure 4.

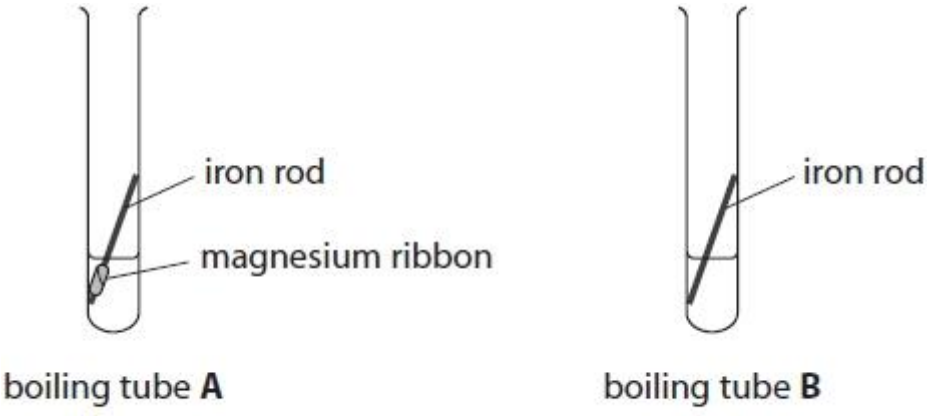

Figure 4

The method used is

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- an iron rod, with magnesium ribbon wrapped around it, is placed in a boiling tube labelled **A**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube
- an identical rod but with no magnesium ribbon wrapped around it is placed in a second boiling tube labelled **B**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube.

Both boiling tubes are left for a few days.

(i) Explain why iron rod rather than stainless steel rod is used in this experiment.

(2)

.....

.....

.....

.....

(ii) State why it is not necessary to use a pipette to measure out 10 cm^3 water in this experiment.

(1)

.....

(iii) After a few days the two boiling tubes were examined.

The results are shown in Figure 5.

boiling tube A	the appearance of the iron rod is unchanged the magnesium has started to disappear
boiling tube B	a small amount of brown deposit has formed around the rod

Figure 5

Explain the results of this experiment.

(2)

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.....

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.....

(Total for question = 5 marks)

Q9.

(a) Hydrogen chloride, HCl, can be formed by the reaction of hydrogen, H_2, with chlorine, Cl_2.

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Write the balanced equation for this reaction.

(2)

.....

(b) The electronic configuration of hydrogen is 1.
The electronic configuration of chlorine is 2.8.7.

Draw a dot and cross diagram to show the arrangement of electrons in a molecule of hydrogen chloride, HCl.
Show outer electrons only.

(2)

Q10.

A student has been asked to investigate how the pH changes when calcium oxide is added, a little at a time, to dilute hydrochloric acid.

Describe how the student should carry out this investigation.

(3)

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.....

(Total for question = 3 marks)

Q11.

Figure 3 shows some titration results obtained from an experiment in which an alkali is titrated with an acid.

	titration		
	rough	1	2
final burette reading in cm^3	25.75	49.35	23.70
initial burette reading in cm^3	0.00	25.75	0.00
volume of acid used in cm^3	25.75	23.60	23.70

Figure 3

Calculate the accurate volume of acid reacting with the alkali.

(2)

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.....

.....

accurate volume of acid reacting ..... cm^3

(Total for question = 2 marks)

Q12.

The concentration of dilute sulfuric acid can be determined by titration with sodium hydroxide solution of known concentration.

25.00 cm^3 of dilute sulfuric acid was measured out using a pipette and transferred to a conical flask.

A few drops of methyl orange indicator were added to the acid in the conical flask. Sodium hydroxide solution was added to the acid from a burette until the indicator changed colour.

The titration was repeated until two concordant results were obtained.

The accurate result was the average of the two concordant results.

Describe the colour change seen at the end point of the titration.

(1)

from ..... to .....

(Total for question = 1 mark)

Q13.

Ammonia solution and dilute sulfuric acid are used to prepare pure, dry ammonium sulfate crystals.

In an experiment a titration is carried out to determine the volumes of ammonia solution and dilute sulfuric acid that react together.
Then an ammonium sulfate solution is prepared from which the pure, dry crystals are obtained.

Describe in detail, using suitable apparatus, how this experiment should be carried out.

(Total for question = 6 marks)

Q14.

* Describe the experimental procedure to carry out a titration to find the exact volume of sulfuric acid needed to neutralise 25.0 cm^3 of sodium hydroxide solution and obtain pure, dry crystals of sodium sulfate.

(6)

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(Total for question = 6 marks)

Q15.

Electrolysis

(a) Some metal objects are electroplated to improve their appearance.

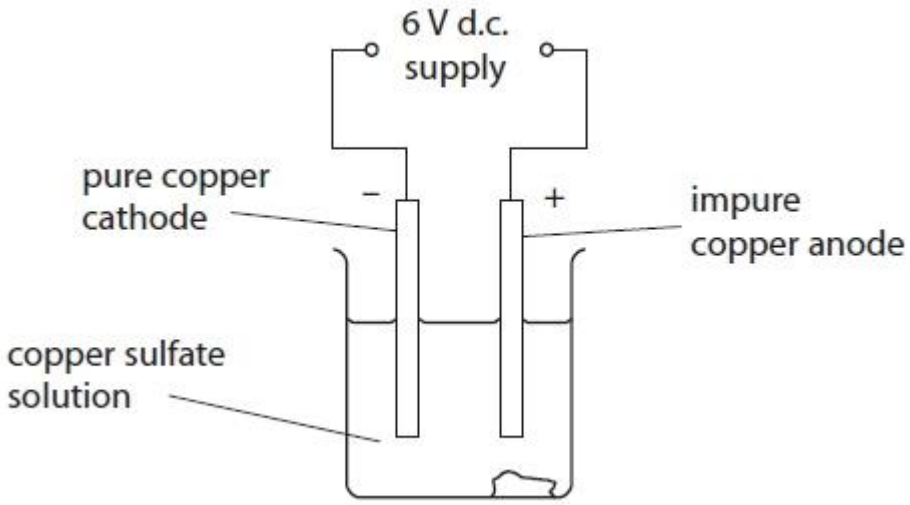
Give another reason why some metal objects are electroplated.

(1)

.....

.....

(b) Copper sulfate solution was electrolysed using copper electrodes.
The mass of each electrode was determined before it was placed in the solution.



The electrolysis was carried out for a period of time.
The electrodes were removed, washed, dried and their masses redetermined.
The table shows the masses of the electrodes before and after electrolysis.

	mass of electrode before electrolysis / g	mass of electrode after electrolysis / g	change in mass
mass of impure copper anode	40.0	35.0	5.0 g decrease
mass of pure copper cathode	10.0	14.8	4.8 g increase

Explain these results.

(3)

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(c) In an electrolysis experiment, oxide ions, O^{2-}, form oxygen gas, O_2.

Write the balanced half equation for the reaction.

(2)

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*(d) Sodium chloride is an ionic compound.
It contains sodium ions, Na^+, and chloride ions, Cl^-.

When molten sodium chloride is electrolysed, sodium metal and chlorine gas are formed. Describe how the sodium ions and chloride ions in solid sodium chloride are converted into sodium and chlorine by electrolysis.

(6)

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(Total for question = 12 marks)

Q16.

Electrolysis

(a) Some metal objects are electroplated to improve their appearance.

Give another reason why some metal objects are electroplated.

(1)

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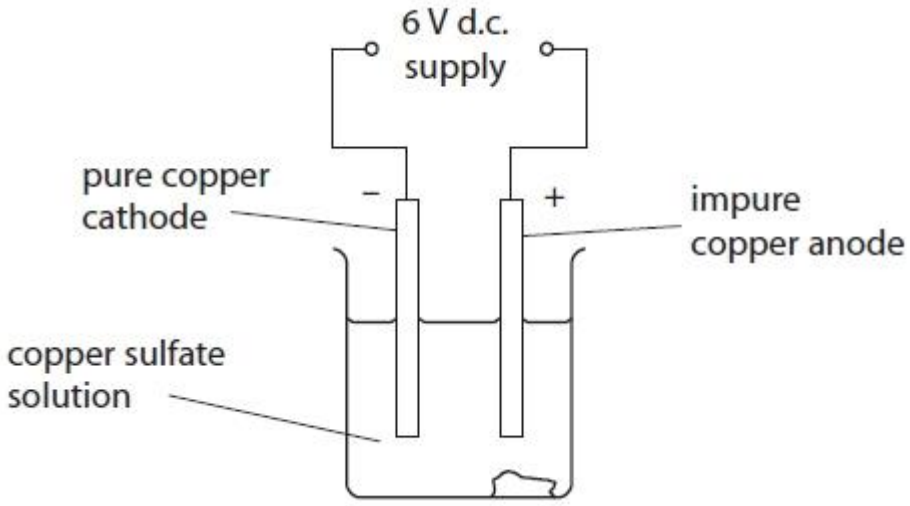
(b) Copper sulfate solution was electrolysed using copper electrodes.
The mass of each electrode was determined before it was placed in the solution.



The electrolysis was carried out for a period of time.
The electrodes were removed, washed, dried and their masses redetermined.
The table shows the masses of the electrodes before and after electrolysis.

	mass of electrode before electrolysis / g	mass of electrode after electrolysis / g	change in mass
mass of impure copper anode	40.0	35.0	5.0 g decrease
mass of pure copper cathode	10.0	14.8	4.8 g increase

Explain these results.

(3)

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(c) In an electrolysis experiment, oxide ions, O^{2-}, form oxygen gas, O_2.

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Write the balanced half equation for the reaction.

(2)

.....

*(d) Sodium chloride is an ionic compound.
It contains sodium ions, Na^+, and chloride ions, Cl^-.

When molten sodium chloride is electrolysed, sodium metal and chlorine gas are formed. Describe how the sodium ions and chloride ions in solid sodium chloride are converted into sodium and chlorine by electrolysis.

(6)

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(Total for question = 12 marks)

Q17.

(a) A bottle of wine is opened and left exposed to the air for a few days.
The ethanol in the wine reacts with oxygen from the air to form ethanoic acid.
Complete the sentence by putting a cross (■) in the box next to your answer.
In this reaction the ethanol is

(1)

- ☒ **A** hydrated
- ☒ **B** neutralised
- ☒ **C** oxidised

☒ **D** reduced

(b) Vinegar is a dilute solution of ethanoic acid.

Complete the sentence by putting a cross (■) in the box next to your answer.

Vinegar is used as a

(1)

☒ **A** fibre
☒ **B** fuel
☒ **C** perfume
☒ **D** preservative

(c) State the colour of Universal indicator in a solution of ethanoic acid.

(1)

.....

.

(d) The word equation for the reaction of dilute ethanoic acid with sodium hydroxide solution is

ethanoic acid + sodium hydroxide → sodium ethanoate + water

Complete the balanced equation for this reaction.

CH_3COOH +

..... → CH_3COONa + ...

.....

(e) When magnesium is added to dilute ethanoic acid, a colourless gas is formed.
This gas gives a squeaky pop when mixed with air and ignited.

Give the name of the gas given off in this reaction.

(1)

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(f) Ethanoic acid reacts with ethanol to form ethyl ethanoate.

(i) Write the word equation for this reaction.

(2)

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(ii) Ethyl ethanoate is an ester.

Explain **one** use of esters.

(2)

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(Total for Question = 10 marks)

Q18.

(a) A bottle of wine is opened and left exposed to the air for a few days.
The ethanol in the wine reacts with oxygen from the air to form ethanoic acid.

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Complete the sentence by putting a cross (■) in the box next to your answer.
In this reaction the ethanol is

(1)

- ☒ **A** hydrated
- ☒ **B** neutralised
- ☒ **C** oxidised
- ☒ **D** reduced

(b) Vinegar is a dilute solution of ethanoic acid.

Complete the sentence by putting a cross (■) in the box next to your answer.
Vinegar is used as a

(1)

- ☒ **A** fibre
- ☒ **B** fuel
- ☒ **C** perfume
- ☒ **D** preservative

(c) State the colour of Universal indicator in a solution of ethanoic acid.

(1)

.....

.

(d) The word equation for the reaction of dilute ethanoic acid with sodium hydroxide solution is

ethanoic acid + sodium hydroxide → sodium ethanoate + water

Complete the balanced equation for this reaction.

CH_3COOH + ... → CH_3COONa + ...

.....

(e) When magnesium is added to dilute ethanoic acid, a colourless gas is formed.
This gas gives a squeaky pop when mixed with air and ignited.
Give the name of the gas given off in this reaction.

(1)

.....

.

(f) Ethanoic acid reacts with ethanol to form ethyl ethanoate.

(i) Write the word equation for this reaction.

(2)

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(ii) Ethyl ethanoate is an ester.
Explain **one** use of esters.

(2)

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(Total for Question = 10 marks)

Q19.

Sodium hydroxide solution reacts with hydrochloric acid.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

(i) 25.0 cm^3 of 0.100 mol dm^{-3} sodium hydroxide, NaOH, solution is added to 35.0 cm^3 of 0.0750 mol dm^{-3} dilute hydrochloric acid, HCl.

Use the information to determine which reagent is in excess.

(3)

(ii) To find the exact amount of dilute hydrochloric acid that reacts with 25.0 cm^3 of the sodium hydroxide solution, a titration is carried out. Figure 14 shows the results for the titrations.

	1st titration	2nd titration	3rd titration	4th titration
final burette reading / cm^3	37.60	36.20	39.15	38.40
initial burette reading / cm^3	1.80	0.00	3.95	2.10
volume of acid used / cm^3	35.80	36.20	35.20	36.30

Figure 14

In this titration, the accurate volumes of acid used that are within 0.20 cm^3 of each other are considered concordant volumes.
Use the concordant results to calculate the mean volume of hydrochloric acid required.

(1)

mean volume = ... cm^3

(iii) During the titration, the indicator used changed colour at the end point.

Which of the following shows an indicator with the colour change that would be seen in this titration?

(1)

		indicator	colour in alkali	colour at end point
☐	**A**	phenolphthalein	colourless	pink
☐	**B**	phenolphthalein	pink	yellow
☐	**C**	methyl orange	red	yellow
☐	**D**	methyl orange	yellow	orange

(Total for question = 5 marks)

Q20.

Figure 2 shows the apparatus that can be used to electrolyse sodium chloride solution in the laboratory.

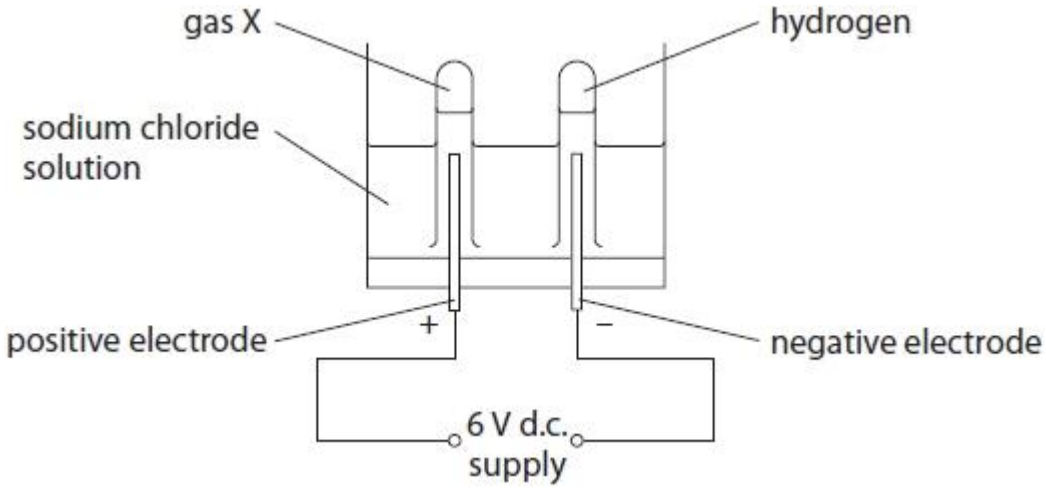

Figure 2

Some of the solution remaining after the electrolysis was tested with litmus paper.
The paper turned blue.

Explain why the litmus paper turned blue.

(2)

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(Total for question = 2 marks)

Q21.

In an experiment magnesium hydroxide powder is added in 0.1 g portions to 25 cm^3 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)

.....

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

(4)

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(Total for question = 5 marks)

Q22.

In an experiment magnesium hydroxide powder is added in 0.1 g portions to 25 cm^3 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)

.....

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

(4)

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.....

(Total for question = 5 marks)

Q23.

When hydrogen chloride gas, HCl, is dissolved in water an acidic solution is formed.

(i) Give the name of the acid.

(1)

.....

(ii) What colour is seen when methyl orange is added to this acidic solution?

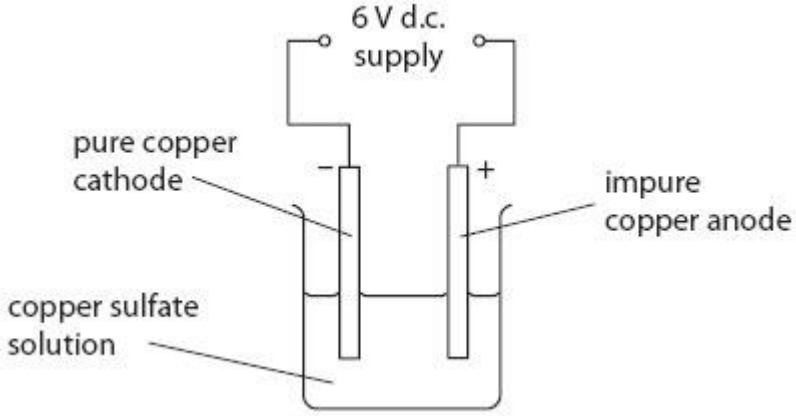
(1)

- ☒ **A** blue
- ☒ **B** green
- ☒ **C** pink-red
- ☒ **D** orange

(Total for question = 2 marks)

Q24.

* Impure copper can be purified using electrolysis.
The impure copper is used as the anode.
A pure copper cathode is used.
The electrodes are placed in copper sulfate solution.
A direct electric current is passed through the solution.



Describe and explain what is seen when this apparatus is used to purify a piece of impure copper.

(6)

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Q25.

A student has been asked to investigate how the pH changes when calcium oxide is added, a little at a time, to dilute hydrochloric acid.

Describe how the student should carry out this investigation.

(3)

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(Total for question = 3 marks)

Q26.

Making sodium chloride

To make pure sodium chloride from sodium hydroxide solution and dilute hydrochloric acid, a titration has to be used.

(a) Ethanol is produced by fermentation of carbohydrates.

The equation for the reaction is

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$$HCl(aq) + NaOH(aq) \rightarrow NaCl(.....) + H_2O(.....)$$

(a) Which state symbols follow NaCl and H_2O to complete the equation?
Put a cross (☒) in the box next to your answer.

(1)

		NaCl	H_2O
☐	**A**	s	l
☐	**B**	aq	aq
☐	**C**	s	aq
☐	**D**	aq	l

(b) The reaction above is a neutralisation reaction.

Write the ionic equation for the reaction.

(2)

.....

(c) When sodium hydroxide solution is titrated with dilute hydrochloric acid, an acid-base indicator is used.
The hydrochloric acid is added from a burette to the sodium hydroxide solution in a conical flask.
At the end point the indicator changes colour.

(i) Give the name of a suitable indicator to use in this titration.

(1)

.....

(ii) State the colour change for this indicator at the end point.

(1)

from ..... to .....

(d) A sodium hydroxide solution was made up by dissolving 20.0 g of sodium hydroxide in water and making the volume of the solution up to 1.00 dm^3. Calculate the concentration of sodium hydroxide, NaOH, in this solution in mol dm^{-3}.

(relative atomic masses: H = 1.00, O = 16.0, Na = 23.0)

(2)

.....

.....

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.....

concentration = ... mol dm^{-3}

(e) In another experiment, a titration was carried out.
25.0 cm^3 of 1.50 mol dm^{-3} sodium hydroxide solution, NaOH, was titrated with hydrochloric acid.
The volume of the hydrochloric acid required to neutralise the sodium hydroxide solution was 30.0 cm^3.

Calculate the concentration of the hydrochloric acid, HCl, in mol dm^{-3}.

$$HCl + NaOH \rightarrow NaCl + H_2O$$

(3)

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.....

concentration = ... mol dm^{-3}

(Total for question = 10 marks)

Q27.

Vinegar contains ethanoic acid.

(a) Which of these is a use of vinegar?

Put a cross (☒) in the box next to your answer.

(1)

- ☐ **A** fuel
- ☐ **B** perfume
- ☐ **C** preservative
- ☐ **D** soap

(b) An indicator can be used to show that ethanoic acid is acidic.

Give the name of an indicator that can be used and state its colour in the acid.

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(2)

indicator

.....

colour in acid

.....

(c) Use the gases from the box to complete the sentences.

Each gas may be used once, more than once or not at all.

carbon dioxide	hydrogen	nitrogen	oxygen

(3)

(i) If a bottle of wine is left open, ethanoic acid is formed when

ethanol in the wine is oxidised by ..... .

(ii) Ethanoic acid reacts with magnesium to give a gas. When the gas is mixed

with air and ignited with a lighted splint, it gives a squeaky pop.

This gas is ..... .

(iii) When solid sodium carbonate is added to dilute ethanoic acid,

effervescence occurs. The effervescence is bubbles of
..... .

(d) Ethanoic acid is reacted with ethanol to produce an ester, ethyl ethanoate, and water.

Write the word equation for this reaction.

(2)

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.....

Q28.

Vinegar contains ethanoic acid.

(a) Which of these is a use of vinegar?

Put a cross (☒) in the box next to your answer.

(1)

- ☐ **A** fuel
- ☐ **B** perfume
- ☐ **C** preservative
- ☐ **D** soap

(b) An indicator can be used to show that ethanoic acid is acidic.

Give the name of an indicator that can be used and state its colour in the acid.

(2)

indicator

.....

colour in acid

.....

(c) Use the gases from the box to complete the sentences.

Each gas may be used once, more than once or not at all.

carbon dioxide	hydrogen	nitrogen	oxygen

(3)

(i) If a bottle of wine is left open, ethanoic acid is formed when

ethanol in the wine is oxidised by ..... .

(ii) Ethanoic acid reacts with magnesium to give a gas. When the gas is mixed

with air and ignited with a lighted splint, it gives a squeaky pop.

This gas is ..... .

(iii) When solid sodium carbonate is added to dilute ethanoic acid,

effervescence occurs. The effervescence is bubbles of
..... .

(d) Ethanoic acid is reacted with ethanol to produce an ester, ethyl ethanoate, and water.

Write the word equation for this reaction.

(2)

.....

.....

Q29.

(a) (i) Which of the following is the formula for a molecule of butane?
Put a cross (■) in the box next to your answer.

(1)

- ☒ **A** C_3H_6
- ☒ **B** C_3H_8
- ☒ **C** C_4H_8
- ☒ **D** C_4H_{10}

(ii) Draw the structure of a molecule of propene, showing all covalent bonds.

(2)

(b) Complete the sentence by putting a cross (■) in the box next to your answer.
Ethanol, C_2H_5OH, can be converted into ethanoic acid, CH_3COOH.
In this reaction, ethanol is

(1)

- ☒ **A** dehydrated
- ☒ **B** neutralised
- ☒ **C** neutralised
- ☒ **D** reduced

(c) (i) Describe what you would **see** when solid sodium carbonate is added to dilute ethanoic acid.

(2)

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(ii) When ethanoic acid reacts with ethanol, one of the products is the ester, ethyl ethanoate.
Complete the balanced equation for this reaction.

(2)

$CH_3COOH + C_2H_5OH \rightarrow$ ..... + ...

(Total for Question = 8 marks)

Q30.

(a) (i) Which of the following is the formula for a molecule of butane?
Put a cross (■) in the box next to your answer.

(1)

- ☒ **A** C_3H_6
- ☒ **B** C_3H_8
- ☒ **C** C_4H_8
- ☒ **D** C_4H_{10}

(ii) Draw the structure of a molecule of propene, showing all covalent bonds.

(2)

(b) Complete the sentence by putting a cross (■) in the box next to your answer.
Ethanol, C_2H_5OH, can be converted into ethanoic acid, CH_3COOH.
In this reaction, ethanol is

(1)

- ☒ **A** dehydrated
- ☒ **B** neutralised
- ☒ **C** neutralised
- ☒ **D** reduced

(c) (i) Describe what you would **see** when solid sodium carbonate is added to dilute ethanoic acid.

(2)

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.....

(ii) When ethanoic acid reacts with ethanol, one of the products is the ester, ethyl ethanoate.
Complete the balanced equation for this reaction.

(2)

$CH_3COOH + C_2H_5OH \rightarrow$ ..... + ...

(Total for Question = 8 marks)

Q31.

Universal indicator solution is not a suitable indicator for an acid-alkali titration.

(i) Give the name of an indicator that is suitable for use in the titration of sodium hydroxide solution with hydrochloric acid.

(1)

.....

(ii) Universal indicator goes through a series of gradual colour changes as the pH changes in a solution.

Give a reason why universal indicator is not a suitable indicator to use in an acid-alkali titration.

(1)

.....

.....

(Total for question = 2 marks)

Q32.

* A student is told to prepare pure, dry crystals of ammonium sulfate.

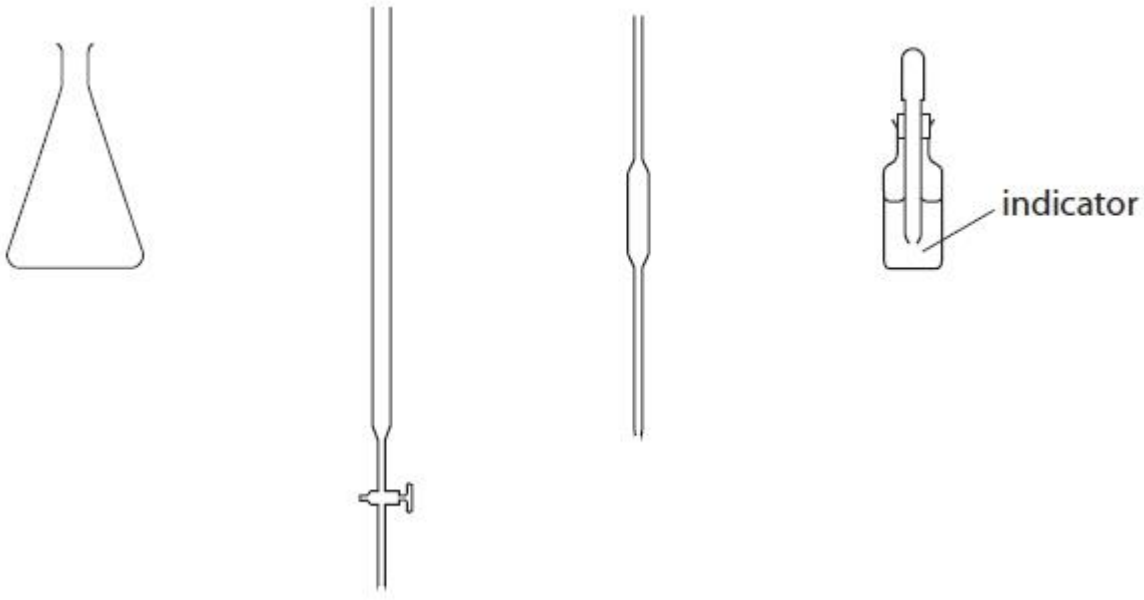
The student is told to carry out the experiment in four stages.

Stage 1: take 25.0 cm^3 of ammonia solution
Stage 2: find the volume of sulfuric acid that is needed to neutralise the ammonia solution
Stage 3: use this result to prepare an ammonium sulfate solution
Stage 4: prepare pure, dry crystals of ammonium sulfate from this solution

Describe how the student should carry out this experiment.

Some of the following apparatus may be used in the experiment.

(6)



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Q33.

(i) Describe what you would **see** when solid sodium carbonate is added to dilute ethanoic acid.

(2)

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(ii) When ethanoic acid reacts with ethanol, one of the products is the ester, ethyl ethanoate. Complete the balanced equation for this reaction.

(2)

$CH_3COOH + C_2H_5OH \rightarrow$ ..... + ...

Q34.

(i) Describe what you would **see** when solid sodium carbonate is added to dilute ethanoic acid.

(2)

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(ii) When ethanoic acid reacts with ethanol, one of the products is the ester, ethyl ethanoate. Complete the balanced equation for this reaction.

(2)

$CH_3COOH + C_2H_5OH \rightarrow$ ..... + ...

Q35.

X and **Y** are solutions of two different acids.
The concentration of acid in each solution, in mol dm^{-3}, is the same.
Solution **X** has a pH of 3.40 and solution **Y** has a pH of 4.40.

(i) State what could be used to measure these pH values of 3.40 and 4.40.

(1)

.....

.....

(ii) What is the concentration of hydrogen ions in solution **X** compared with that in solution **Y**?

(1)

- ☒ **A** ten times lower
- ☒ **B** lower by a factor of 3.30/4.40
- ☒ **C** higher by a factor of 4.40/3.30
- ☒ **D** ten times higher

(Total for question = 2 marks)

Q36.

Nitric acid can be titrated with a solution of ammonia.

(i) State the type of reaction occurring when nitric acid reacts with ammonia.

(1)

.....

(ii) What salt is formed in this reaction?

(1)

- ☒ **A** ammonia nitric
- ☒ **B** ammonia nitrate
- ☒ **C** ammonium nitric
- ☒ **D** ammonium nitrate

(Total for question = 2 marks)

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Q37.

X and **Y** are solutions of two different acids.
The concentration of acid in each solution, in mol dm^{-3}, is the same.
Solution **X** has a pH of 3.40 and solution **Y** has a pH of 4.40.

(i) State what could be used to measure these pH values of 3.40 and 4.40.

(1)

.....

.....

(ii) What is the concentration of hydrogen ions in solution **X** compared with that in solution **Y**?

(1)

- ☒ **A** ten times lower
- ☒ **B** lower by a factor of 3.30/4.40
- ☒ **C** higher by a factor of 4.40/3.30
- ☒ **D** ten times higher

(Total for question = 2 marks)

Q38.

The pH of a sodium chloride solution was measured.

(i) State what could be used to measure the pH of a solution.

(1)

.....

(ii) Sodium chloride solution is neutral.

Give the pH of this solution.

(1)

.....

(Total for question = 2 marks)

Q39.

The pH of a sodium chloride solution was measured.

(i) State what could be used to measure the pH of a solution.

(1)

.....

(ii) Sodium chloride solution is neutral.

Give the pH of this solution.

(1)

.....

(Total for question = 2 marks)

Q40.

A student was asked to plan a titration experiment to find the exact volume of hydrochloric acid that would neutralise 25.0 cm^3 of sodium hydroxide solution.

The student's plan is

1. use a measuring cylinder to pour 25 cm^3 of sodium hydroxide solution into a conical flask
2. add a few drops of an indicator to the sodium hydroxide solution
3. use a burette to add hydrochloric acid to the sodium hydroxide solution until the indicator changes colour

(i) State the name of the piece of apparatus that should be used, instead of the measuring cylinder in step 1, in order to improve the accuracy of the experiment.

(1)

.....

(ii) Suggest the name of a suitable indicator and state the colour change that would occur at the end point in this experiment.

(2)

name of indicator

.....

colour change

.....

.....

(iii) Suggest **two** details that could be added to the plan to make the experiment more accurate.

(2)

1 .....

.....

2 .....

.....

(Total for question = 5 marks)

Q41.

Titration can be used to determine the exact amount of hydrochloric acid that reacts with a given amount of sodium hydroxide solution.
$HCl + NaOH \rightarrow NaCl + H_2O$

* Sodium chloride solution can be made from dilute hydrochloric acid and sodium hydroxide solution.

Describe a titration experiment to find the exact volume of hydrochloric acid needed to neutralise 25.0 cm^3 of sodium hydroxide solution and how you would use this result to obtain pure, dry crystals of sodium chloride.

(6)

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Q42.

Titration can be used to determine the exact amount of hydrochloric acid that reacts with a given amount of sodium hydroxide solution.
$HCl + NaOH \rightarrow NaCl + H_2O$

Suggest why universal indicator must not be used in titration experiments.

(1)

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Q43.

A titration of sodium hydroxide solution with hydrochloric acid can be carried out as follows

1 a pipette is used to measure 25.00 cm^3 of sodium hydroxide solution into a conical flask
2 a few drops of indicator are added to the sodium hydroxide solution
3 the burette is filled with hydrochloric acid
4 the hydrochloric acid is added to the sodium hydroxide solution until the indicator changes colour.

(i) Describe how the pipette should be used to measure exactly 25.00 cm^3 of sodium hydroxide solution into the conical flask.

(2)

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(ii) The burette is first washed with water.

It is then rinsed with some of the acid before it is filled with the acid to begin the titration.
Explain why the burette is rinsed with the acid.

(2)

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(Total for question = 4 marks)

Q44.

The concentration of a solution of an alkali can be determined by titration with an acid.

25.0 cm^3 portions of the solution of the alkali are transferred into a conical flask and titrated with the acid solution, using a suitable indicator.

(i) Describe how you would measure out and transfer 25.0 cm^3 of the solution of the alkali.

(2)

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(ii) Complete the sentence by putting a cross (☒) in the box next to your answer.

The burette readings of acid added were

	titration 1	titration 2	titration 3
final volume / cm^3	27.20	30.10	25.35
initial volume / cm^3	2.05	5.20	0.10
volume of acid added / cm^3	25.15	24.90	25.25

The volume of acid added that should be used in the calculation is

(1)

☐ **A** 24.90 cm^3

☐ **B** 25.00 cm^3

☐ **C** 25.10 cm^3

☐ **D** 25.20 cm^3

Q45.

Titration can be used to determine the exact amount of hydrochloric acid that reacts with a given amount of sodium hydroxide solution.

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$HCl + NaOH \rightarrow NaCl + H_2O$

(a) What type of reaction takes place when hydrochloric acid reacts with sodium hydroxide solution?

(1)

Put a cross (☒) in the box next to your answer.

☒ **A** neutralisation
☒ **B** oxidation
☒ **C** precipitation
☒ **D** reduction

(b) Suggest why universal indicator must not be used in titration experiments.

(1)

.....
.

*(c) Sodium chloride solution can be made from dilute hydrochloric acid and sodium hydroxide solution.

Describe a titration experiment to find the exact volume of hydrochloric acid needed to neutralise 25.0 cm^3 of sodium hydroxide solution and how you would use this result to obtain pure, dry crystals of sodium chloride.

(6)

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(d) Sodium hydroxide solution is titrated with dilute hydrochloric acid.

The results of the experiment are

volume of sodium hydroxide solution = 25.0 cm^3
volume of 0.100 mol dm^{-3} hydrochloric acid used

rough titration	= 23.1 cm^3
1st titration	= 22.6 cm^3
2nd titration	= 22.8 cm^3

(i) State the volume of hydrochloric acid that must be used to calculate the concentration of sodium hydroxide solution.

(1)

volume of hydrochloric acid =..... cm^3

(ii) In a different experiment, 25.0 cm^3 of sodium hydroxide solution reacted with 23.2 cm^3 of 0.100 mol dm^{-3} hydrochloric acid, HCl.

Calculate the concentration of this sodium hydroxide solution, NaOH, in mol dm^{-3}.

(3)

$NaOH + HCl \rightarrow NaCl + H_2O$

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

concentration of sodium hydroxide solution = ...mol dm^{-3}

(Total for Question = 12 marks)

Q46.

Figure 5 shows the apparatus that can be used to electrolyse sodium chloride solution in the laboratory.

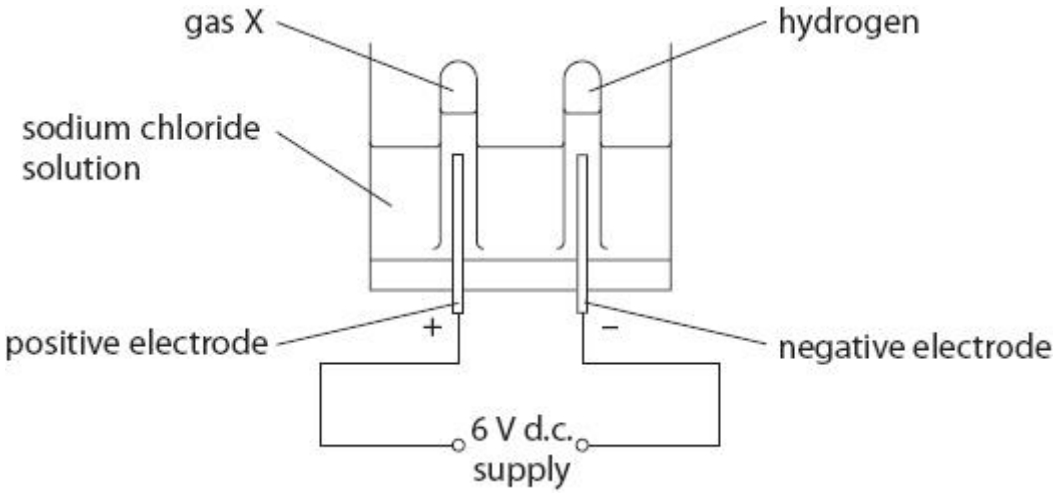

Figure 5

Some of the solution remaining after the electrolysis was tested with litmus paper.
The paper turned blue.

Explain why the litmus paper turned blue.

(2)

.....
.....

.....

.....

(Total for question = 2 marks)

Q47.

Potassium hydroxide reacts with hydrochloric acid to form potassium chloride and water.

potassium hydroxide + hydrochloric acid → potassium chloride + water

A student carried out a titration to find the exact volume of dilute hydrochloric acid that reacted with 25.0 cm^3 of potassium hydroxide solution.

There were five steps in the titration.
The steps shown are not in the correct order.

step J pour the potassium hydroxide solution into a conical flask and add a few drops of indicator to this solution

step K fill a burette with the dilute hydrochloric acid and record the initial reading from the burette

step L use a measuring cylinder to obtain 25 cm^3 of potassium hydroxide solution

step M take a final reading from the burette and calculate the volume of the dilute hydrochloric acid reacted

step N run the dilute hydrochloric acid from the burette into the conical flask until the indicator changes colour

(i) Write the steps in the correct order.

Some of the steps have been completed for you.

(1)

first step				last step
K				M

(ii) Suggest an alternative piece of apparatus that could be used in step L to obtain exactly 25.0 cm^3 of potassium hydroxide solution.

(1)

.....

(Total for question = 2 marks)

Q48.

Potassium hydroxide reacts with hydrochloric acid to form potassium chloride and water.

potassium hydroxide + hydrochloric acid → potassium chloride + water

A student carried out a titration to find the exact volume of dilute hydrochloric acid that reacted with 25.0 cm^3 of potassium hydroxide solution.

There were five steps in the titration.
The steps shown are not in the correct order.

step J pour the potassium hydroxide solution into a conical flask and add a few drops of indicator to this solution

step K fill a burette with the dilute hydrochloric acid and record the initial reading from the burette

step L use a measuring cylinder to obtain 25 cm^3 of potassium hydroxide solution

step M take a final reading from the burette and calculate the volume of the dilute hydrochloric acid reacted

step N run the dilute hydrochloric acid from the burette into the conical flask until the indicator changes colour

(i) Write the steps in the correct order.

Some of the steps have been completed for you.

(1)

first step				last step
K				M

(ii) Suggest an alternative piece of apparatus that could be used in step L to obtain exactly 25.0 cm^3 of potassium hydroxide solution.

(1)

.....

(Total for question = 2 marks)