Chemical changes Part 2

Q1.

Kelp is a seaweed.

Kelp can be used in foods and as a renewable energy source.

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(a) Scientific experiments, on their own, **cannot** fully answer one of the following questions. Which one?

Tick (✓) **one** box.

Questions	Tick (✔)
How much carbon dioxide is produced when 100 g of kelp is burned?	
Does kelp give out more heat energy than coal?	
Will kelp last longer than coal as an energy source?	
Which fuel, kelp or coal, produces the most ash when burned?	

(1)

(b) Scientists cannot answer the question 'should people use kelp instead of coal as an energy source?'

Give **two** reasons why.

_____

_____

_____

_____

(2)

(c) Sodium iodide can be produced from kelp.

(i) How many electrons are in the outer shell of an iodine atom?

(1)

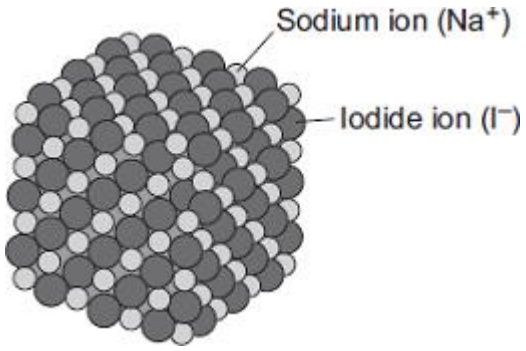
(ii) Sodium iodide contains sodium ions (Na^+) and iodide ions (I^-).

Describe, as fully as you can, what happens when sodium atoms react with iodine atoms to produce sodium iodide.

You may use a diagram in your answer

(3)

(iii) The diagram shows the structure of sodium iodide.



Solid sodium iodide does not conduct electricity.

Why does sodium iodide solution conduct electricity?

(1)

(iv) When sodium iodide solution is electrolysed, iodine is formed at the positive

electrode.

Complete and balance the half equation for the formation of iodine.

$$\_\_\_\_\_I^- \rightarrow I_2 + \_\_\_\_\_e^-$$

(1)

(v) What is formed at the negative electrode when sodium iodide solution is electrolysed?

Explain why.

_____

_____

_____

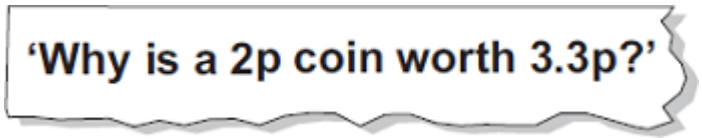
_____

(2)

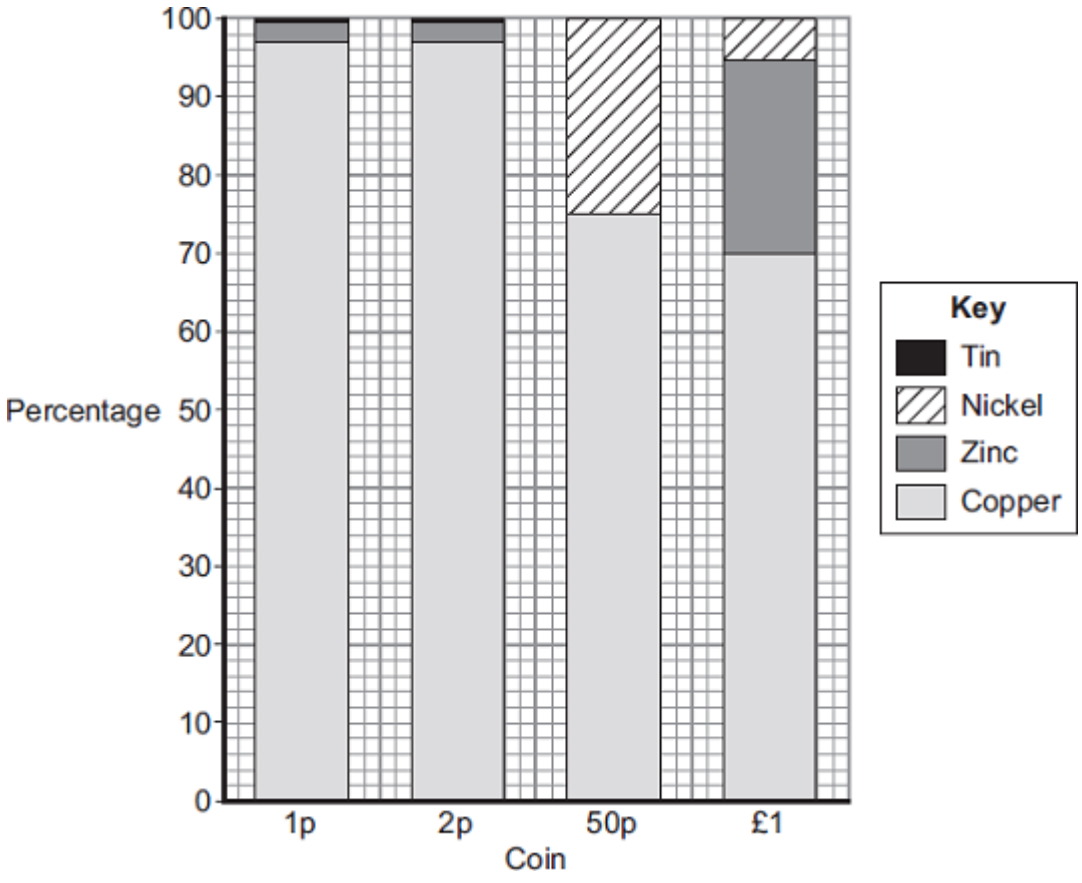
(Total 11 marks)

Q2.

This is the headline from a newspaper:



(a) The bar chart shows the percentage of metals in UK coins in 1991.



Use the bar chart to answer these questions.

(i) Which metal is in all of these coins?

_____

(1)

(ii) Which coin does **not** contain zinc?

_____

(1)

(iii) What is the percentage of nickel in a 50 p coin?

Percentage = _____ %

(1)

(iv) Draw a ring around the correct metal to complete the sentence.

Pure copper is too soft to be used for 1 p and 2 p coins.

Copper is mixed with zinc and | iron | nickel | tin | for 1 p and 2 p coins.

(1)

(b) The value of the metal in 2 p coins, made in 1991, is now 3.3 p.

Suggest why a 2 p coin made in 1991 is worth 3.3 p.

_____

_____

_____

(1)

(Total 5 marks)

Q3.

Ammonium salts, such as ammonium sulfate, are used to help farmers grow crops.

(a) Use the correct word from the box to complete the sentence.

fertilisers	**insecticides**	**pesticides**

Ammonium salts contain nitrogen and are used by farmers as

_____to replace the nitrogen lost from the soil.

(1)

(b) Ammonia is made by reacting nitrogen with hydrogen.

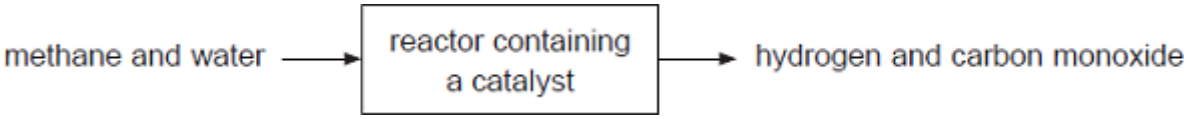
Which raw material provides nitrogen?

Draw a ring around your answer.

air **crude oil** **water**

(1)

(c) Methane and water react together to form hydrogen.



How does the catalyst help this reaction?

_____

(1)

(d) The reaction between nitrogen and hydrogen to make ammonia can be represented by this equation.

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

What is the meaning of this symbol $\rightleftharpoons$?

Draw a ring around your answer.

endothermic reaction **precipitation reaction** **reversible reaction**

(1)

(e) A solution of ammonia in water is alkaline.

(i) Which **one** of these values could be the pH of a solution of ammonia?

Draw a ring around your answer.

4 **7** **10**

(1)

(ii) Ammonium sulfate can be made by reacting ammonia solution with sulfuric acid.

Use the correct answer from the box to complete the sentence.

ammonium sulfate	**hydrogen**	**sulfuric**	**water**

During the reaction the hydrogen ions (H^+) from the acid react with hydroxide ions

(OH^-) from the alkali to make _____
.

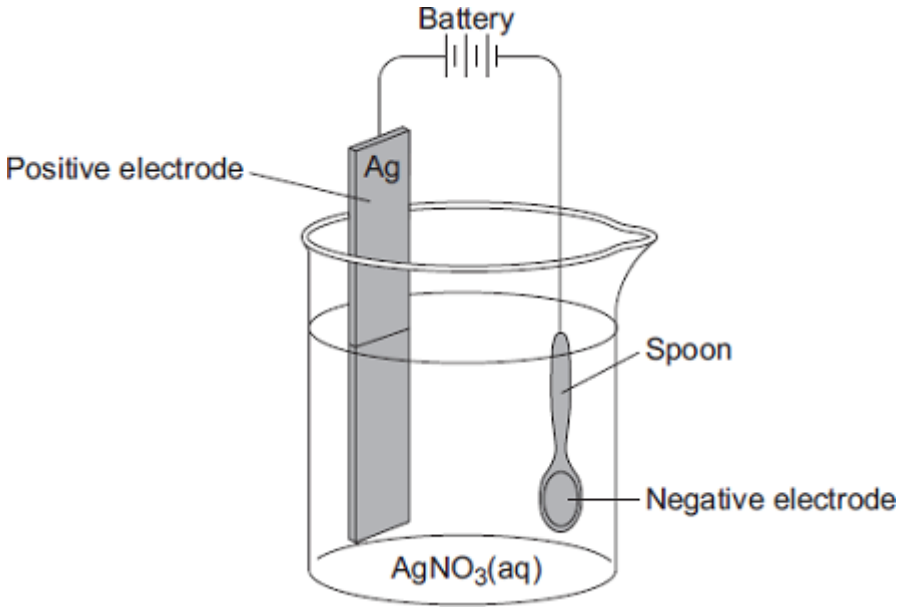
(1)

(Total 6 marks)

Q4.

Electroplating is used to coat a cheap metal with a thin layer of an expensive metal.

In the diagram a teaspoon made of nickel is being coated with silver.



Silver nitrate ($AgNO_3$) contains silver ions (Ag^+) and nitrate ions (NO_3^-).

(a) Solid silver nitrate, $AgNO_3(s)$, does **not** conduct electricity.

Choose the correct answer in the box to complete the sentence.

are too big	**cannot move**	**are too small**

Solid silver nitrate does **not** conduct electricity because the ions _____

_____

(1)

(b) Draw a ring around the correct answer to complete each sentence.

(i) Silver ions move to the negative electrode because they have

- no charge.
- a negative charge.
- a positive charge.

(1)

(ii) When silver ions reach the negative electrode they turn into silver

- atoms.
- compounds.
- molecules.

(1)

(Total 3 marks)

Q5.

Read the information below and then answer the questions that follow.

It was once thought that organic compounds could only be made in living organisms. The living organisms were assumed to have a special life force.

This life force allowed them to make organic compounds.

Urea is an organic compound produced in animals. It is found in urine. In 1828, Friedrich Wöhler made urea from chemicals which were not obtained from living things.

Other famous scientists still believed in the idea of a life force. Wöhler made another organic compound in 1845. Most scientists then stopped believing that a life force was needed to make organic compounds.

(a) How did Wöhler prove that a life force is **not** needed to make organic compounds?

_____

_____

(1)

(b) In 1828 most scientists continued to believe that a life force was needed to produce an organic compound.

Suggest why.

_____

_____

(1)

(c) In 1845 most scientists stopped believing that a life force was needed to make an organic compound.

Suggest why.

_____

_____

(1)

(d) Some scientists repeated Wöhler's experiment.
These scientists used lead nitrate as one of their starting materials.

Lead nitrate solution can be made by reacting lead with an acid.

(i) Give the name of this acid _____

(1)

(ii) State how solid lead nitrate can be obtained from lead nitrate solution.

_____

_____

(1)

(Total 5 marks)

Q6.

The table shows some information about acids and alkalis.

Name of acid	Type	Ions produced in	pH	Effect on

or alkali		solution			Universal Indicator
Hydrochloric acid	Strong acid	H^+	Cl^-	1	Goes red
Sodium hydroxide	Strong alkali	Na^+	OH^-	13	Goes purple

Use the information in the table to help you answer parts (a) and (b).

(a) Draw a ring around the correct answer to complete the sentences.

(i) Hydrochloric acid is acidic.

This is because it contains [Cl^- / H^+ / OH^-] ions.

(1)

(ii) Sodium hydroxide solution is alkaline.

This is because it contains [H^+ / Na^+ / OH^-] ions.

(1)

(b) Hydrochloric acid is a stronger acid than ethanoic acid.

When Universal Indicator is added to solutions of these acids at the same concentration the results are different.

Describe how the results would show that ethanoic acid is a weaker acid than hydrochloric acid.

_____

_____

_____

_____

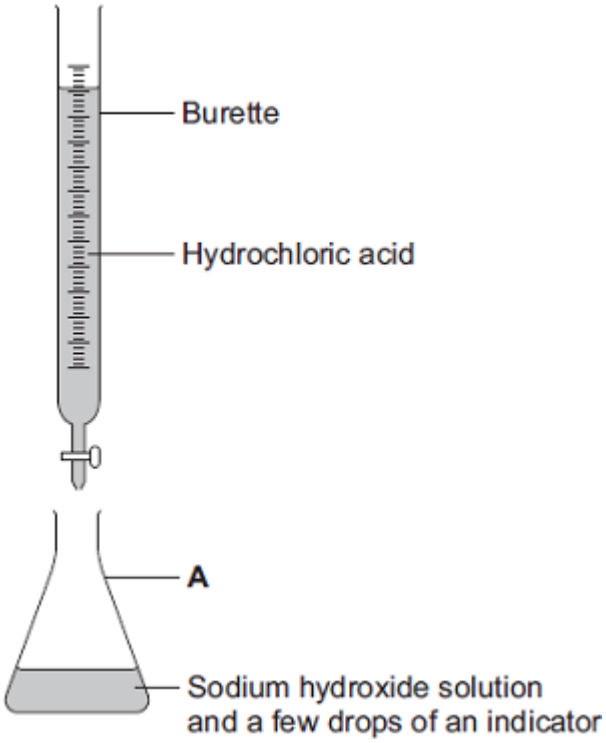
(2)

(c) Draw a ring around the correct answer to complete this sentence.

Strong acids and strong alkalis are [completely / not / partially] ionised in water.

(1)

(d) The diagram shows the apparatus used to find the volume of hydrochloric acid that reacts with 25.0 cm^3 of sodium hydroxide solution.



(i) Which **one** of the following is the correct name for **A**?

Draw a ring around your answer.

beaker **conical flask** **pipette**

(1)

(ii) Use the correct word from the box to complete the sentence.

distillation **filtration** **titration**

(1)

The method used to find the volume of acid that reacts with a known volume of alkali is called_____

(1)

(iii) Suggest **one** way to make the results more reliable.

_____

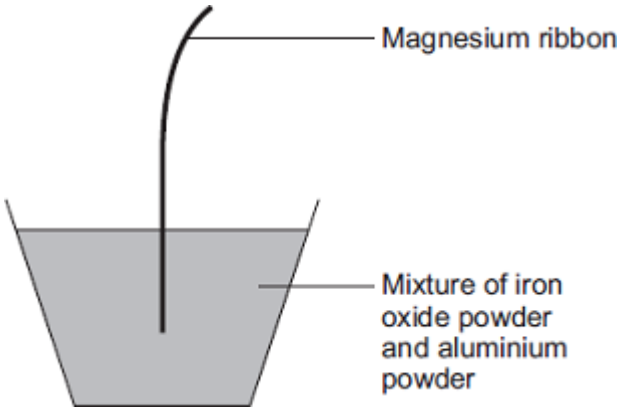
_____

(1)

(Total 8 marks)

Q7.

The diagram shows one way of producing iron.



Iron oxide reacts with aluminium to produce iron.

The symbol equation for the reaction is:

$Fe_2O_3 + 2\ Al \longrightarrow 2\ Fe + Al_2O_3$

(a) (i) Complete the word equation for this reaction.

iron oxide + aluminium ⟶ iron + _____

(1)

(ii) The magnesium ribbon is lit to start the reaction.

Why does the burning magnesium ribbon start the reaction?

_____

_____

(1)

(b) In industry, iron is produced in the blast furnace when iron oxide is heated with carbon.

The iron from the blast furnace is called cast iron.

Cast iron contains carbon.

The diagrams show the structure of pure iron and cast iron.

Pure iron Cast iron

Use the diagrams to help you answer the questions.

(i) Draw a ring around the correct answer to complete the sentence.

Pure iron is an element because pure iron

contains only one sort of atom.
is magnetic.

is a metal.

(1)

(ii) Suggest why cast iron is harder than pure iron.

_____

_____

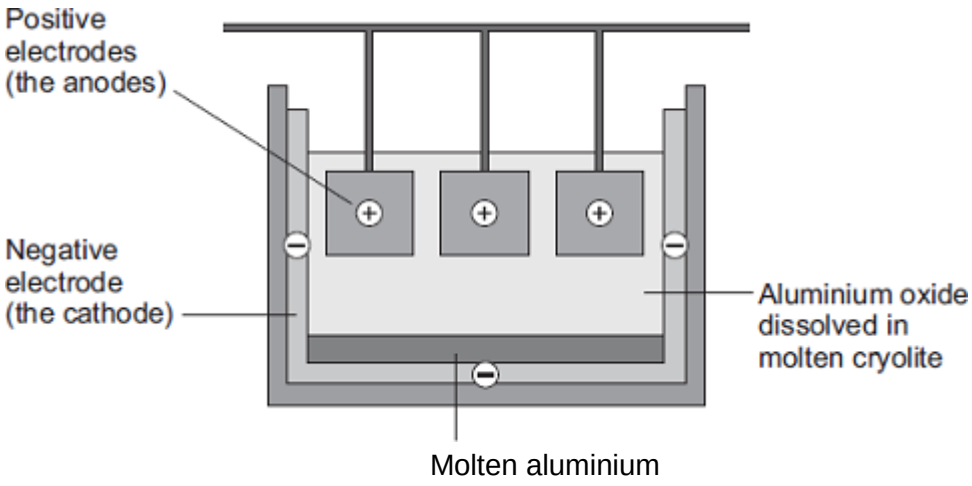
_____

_____

_____

(2)

(c) Aluminium is extracted by electrolysis using the ionic compound aluminium oxide.



(i) Aluminium **cannot** be extracted by heating aluminium oxide with carbon.

Suggest why.

_____

_____

(1)

(ii) Why is aluminium oxide dissolved in molten cryolite?

_____

_____

(1)

(iii) Aluminium metal is produced at the negative electrode (cathode).

Complete the half equation for the process.

Al^{3+} + _____ e^- $\longrightarrow$ Al

(1)

(iv) Use the half equation to state why Al^{3+} ions are reduced.

_____

_____

(1)

(v) Explain why the positive electrodes (anodes) burn away.

Use your knowledge of the products of electrolysis to help you.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

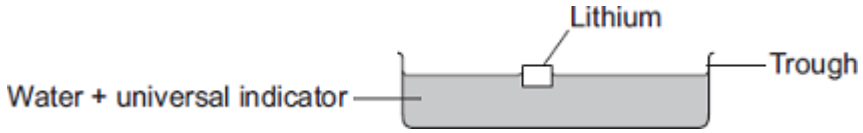
(4)

(Total 13 marks)

Q8.

A student was investigating the reaction of lithium and water.

She added a few drops of universal indicator to water in a trough and added a piece of lithium.



The word equation for the reaction is:

lithium + water ⟶ lithium hydroxide + hydrogen

(a) (i) The lithium floated on the water.

State **two** other observations that the student would **see** during the reaction.

1. _____

2. _____

(2)

(ii) Balance the symbol equation for the reaction of lithium and water.

2 Li(s) + _____ H_2O(l) ⟶ _____ LiOH(aq) + H_2(g)

(2)

(iii) Describe a simple test and the result that would show the gas was hydrogen.

_____

_____

(1)

(iv) All Group 1 metals have similar reactions with water.

State why, in terms of electronic structure.

_____

_____

(1)

(b) Lithium and other Group 1 metals have different properties from the transition metals.

Tick (✔) **two** properties that are properties of Group 1 metals.

They react with oxygen. ☐

They form coloured compounds. ☐

They are strong and hard. ☐

They have low melting points. ☐

(2)

(c) The electronic structure of a potassium atom is 2, 8, 8, 1

(i) Draw a diagram to show the electronic structure of a potassium ion.

Show the charge on the potassium ion.

(2)

(ii) Potassium is more reactive than sodium.

Explain why, in terms of electronic structure.

_____

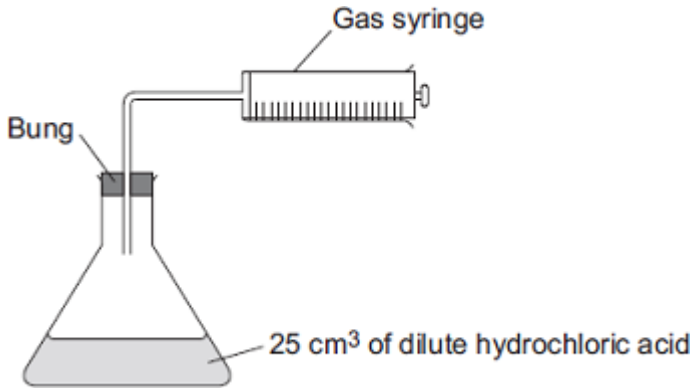
(3)

(Total 13 marks)

Q9.

A student investigated the reaction between magnesium metal and dilute hydrochloric acid.

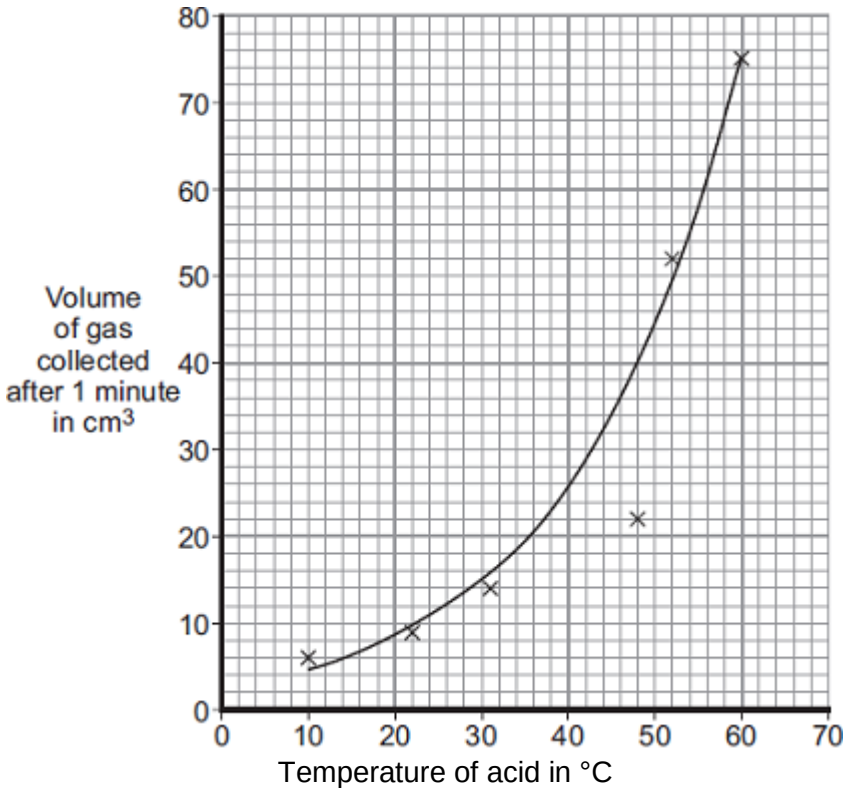
The student placed 25 cm^3 of dilute hydrochloric acid in a conical flask and set up the apparatus as shown in the diagram.



The student:

- took the bung out of the flask and added a single piece of magnesium ribbon 8 cm long
- put the bung back in the flask and started a stopwatch
- recorded the volume of gas collected after 1 minute
- repeated the experiment using different temperatures of acid.

The student plotted his results on a graph.



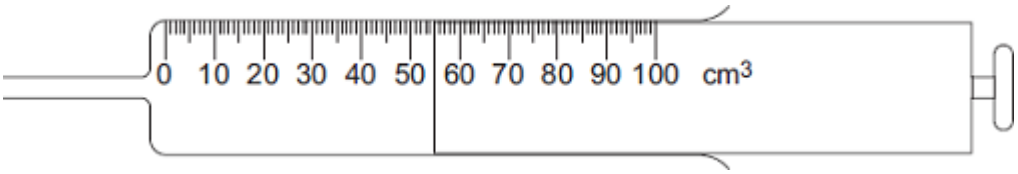
(a) Write the correct state symbols in the equation.

Choose from (s) for solid, (l) for liquid, (g) for gas and (aq) for aqueous.

Mg (….) + 2 HCl (….) $\longrightarrow$ $MgCl_2$ (….) + H_2 (….)

(2)

(b) The diagram shows a gas syringe after 1 minute.



(i) What volume of gas has been collected in the gas syringe after 1 minute?

Volume = _____ cm^3

(1)

(ii) Use the graph to determine the temperature of the acid used in this experiment.

Temperature = _____ °C

(1)

(iii) Calculate the average rate of reaction, in cm^3 of hydrogen made per second (cm^3/s), for this experiment.

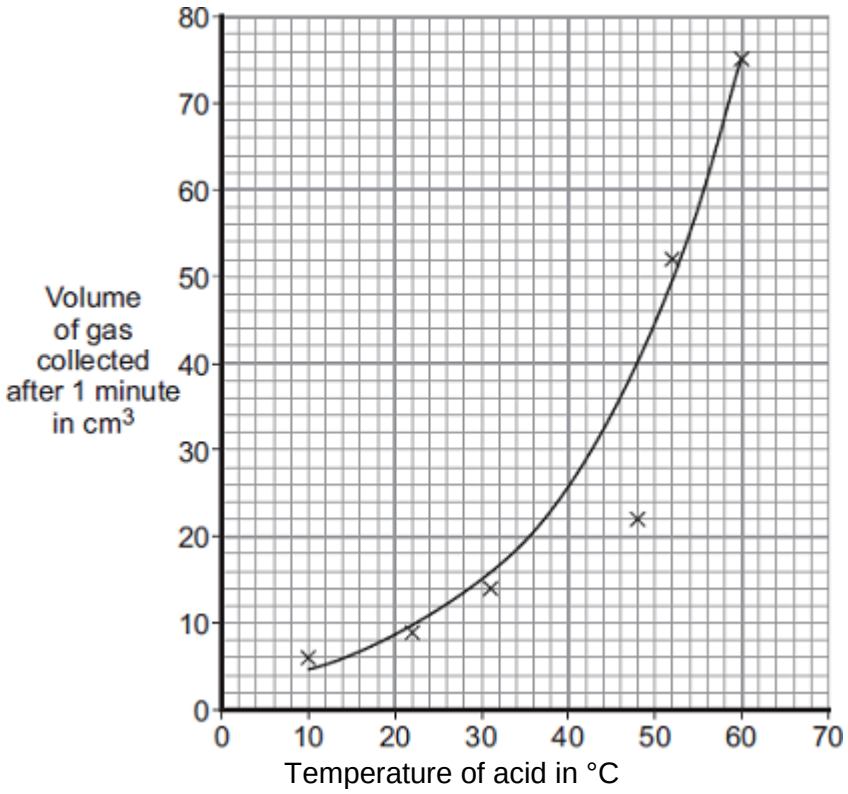
_____

_____

Rate of reaction = _____ cm^3/s

(2)

(c) The student's graph has been reprinted to help you answer this question.



One of the results on the graph is anomalous.

(i) Draw a circle on the graph around the anomalous point.

(1)

(ii) Suggest what may have happened to cause this anomalous result.

Explain your answer.

_____

_____

_____

_____

_____

_____

(2)

(d) Explain how the student could improve the accuracy of the volume of gas recorded at each temperature.

_____

_____

_____

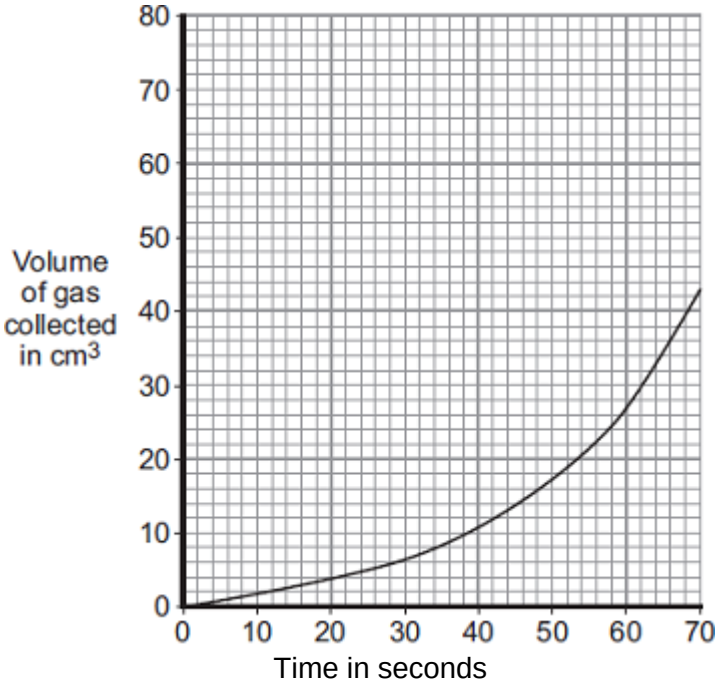
_____

_____

(3)

(e) The student then used the same apparatus to measure the volume of gas produced every 10 seconds at 40 °C.

The student's results are shown on the graph.



The rate at which the gas was produced got faster over the first 60 seconds.

The student's teacher gave two possible explanations of why the reaction got faster.

Explanation 1
There was a layer of magnesium oxide on the surface of the magnesium.
The layer of magnesium oxide prevented the magnesium reacting with the acid.
As the magnesium oxide reacted slowly with the acid, the magnesium was exposed to the acid and hydrogen gas was produced.

Explanation 2
The reaction is exothermic, and so the temperature of the acid increased during the reaction.

(i) Describe further experimental work the student could do to see if **Explanation 1** is correct.

(2)

(ii) Describe further experimental work the student could do to see if **Explanation 2** is correct.

_____

_____

_____

_____

_____

(2)

(Total 16 marks)

Q10.

(a) A student had a colourless solution.

The student thought the solution was dilute hydrochloric acid.

(i) The student added universal indicator to this solution.

What colour would the universal indicator change to if the solution is hydrochloric acid?

_____

(1)

(ii) Describe how the student could show that there are chloride ions in this solution.

_____

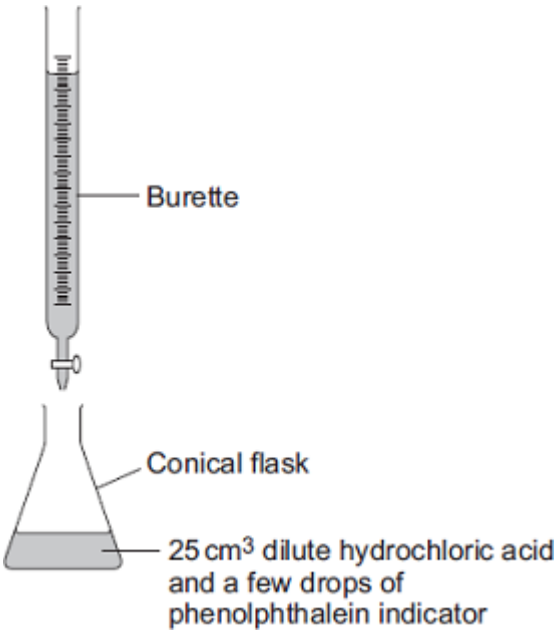
_____

_____

_____

(2)

(b) The results of a titration can be used to find the concentration of an acid.



Describe how to use the apparatus to do a titration using 25 cm^3 of dilute hydrochloric acid.

In your answer you should include:

- how you will determine the end point of the titration
- how you will make sure the result obtained is accurate.

(4)

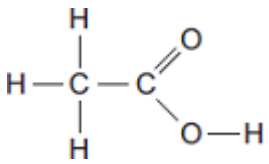
(c) Hydrochloric acid is a strong acid.

Ethanoic acid is a *weak acid*.

What is meant by the term *weak acid*?

(1)

(d) The displayed formula of ethanoic acid is:



(i) On the formula, draw a circle around the functional group in ethanoic acid.

(1)

(ii) Ethanoic acid and ethanol react together to make the ester ethyl ethanoate.

Draw the **displayed** formula of ethyl ethanoate.

(2)
(Total 11 marks)

Q11.

Magnesium burns in oxygen.

By Kingsway School [CC BY 2.0],
via Flickr

(a) Use the Chemistry Data Sheet to help you to answer this question.

The word equation for magnesium burning is:

magnesium + oxygen ⟶ magnesium oxide

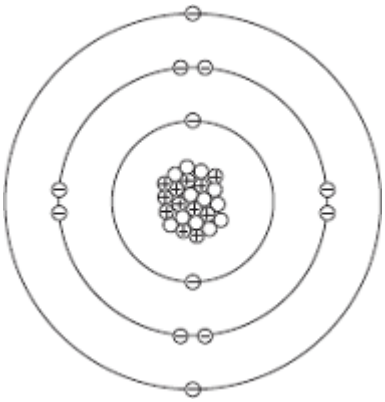
Draw **one** line from each substance to its correct description.

Substance	**Description**
magnesium	compound
magnesium oxide	metal
	mixture

oxygen	
	non-metal

(3)

(b) The diagram represents a magnesium atom.



Complete the table to show the name of each particle and the charge of each particle in the magnesium atom.

Name of particle	Charge
proton	+1
neutron	_____
_____ _____	−1

(2)

(c) Use the Chemistry Data Sheet to help you to answer these questions.

Draw a ring around the correct answer to complete each sentence.

(i)

In a magnesium atom, the protons and neutrons are in the

core.

nucleus.

shell.

(1)

(ii)

The number of protons in a magnesium atom is the

atomic number

mass number.

group number.

(1)

(iii) The sum of the protons and neutrons in a magnesium atom is the

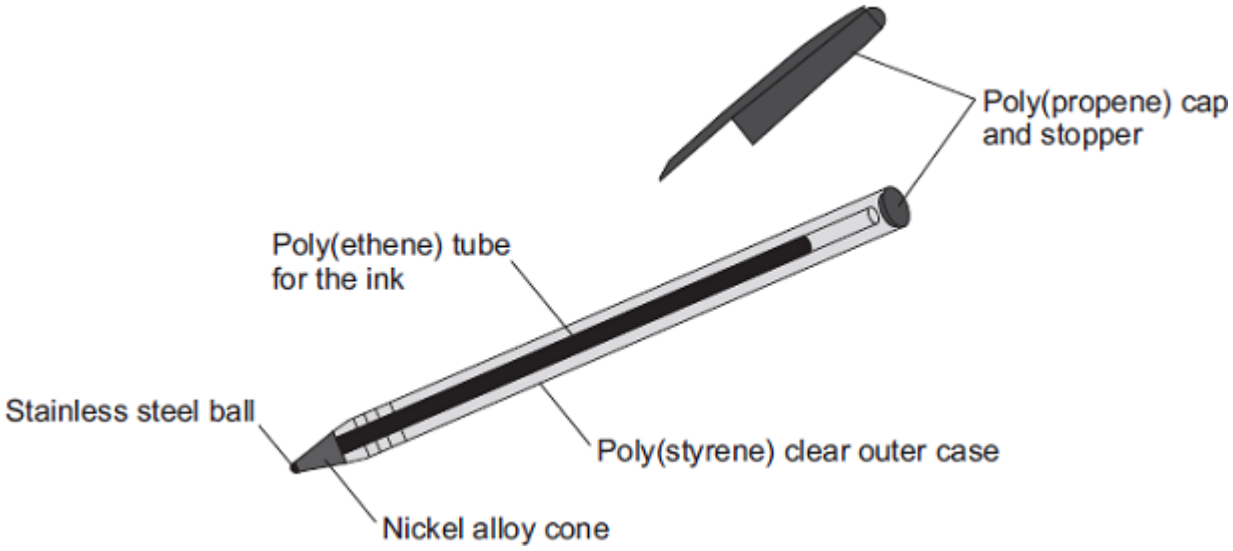
atomic number.
mass number.
group number.

(1)

(Total 8 marks)

Q12.

The diagram shows a ballpoint pen.



(a) Polymers are used to make the ballpoint pen.

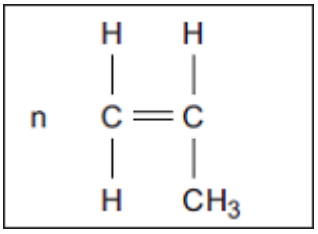
(i) Name the monomer used to make poly(ethene).

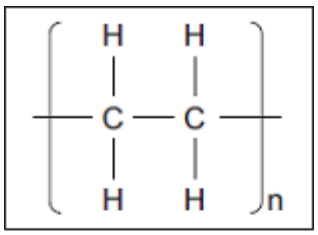
_____

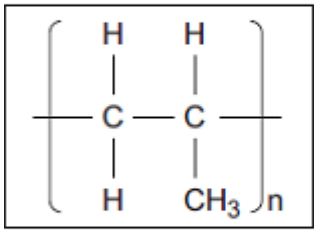
(1)

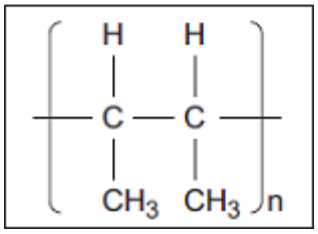
(ii) Draw **one** line from the monomer propene to its polymer poly(propene).

Monomer **Polymer**



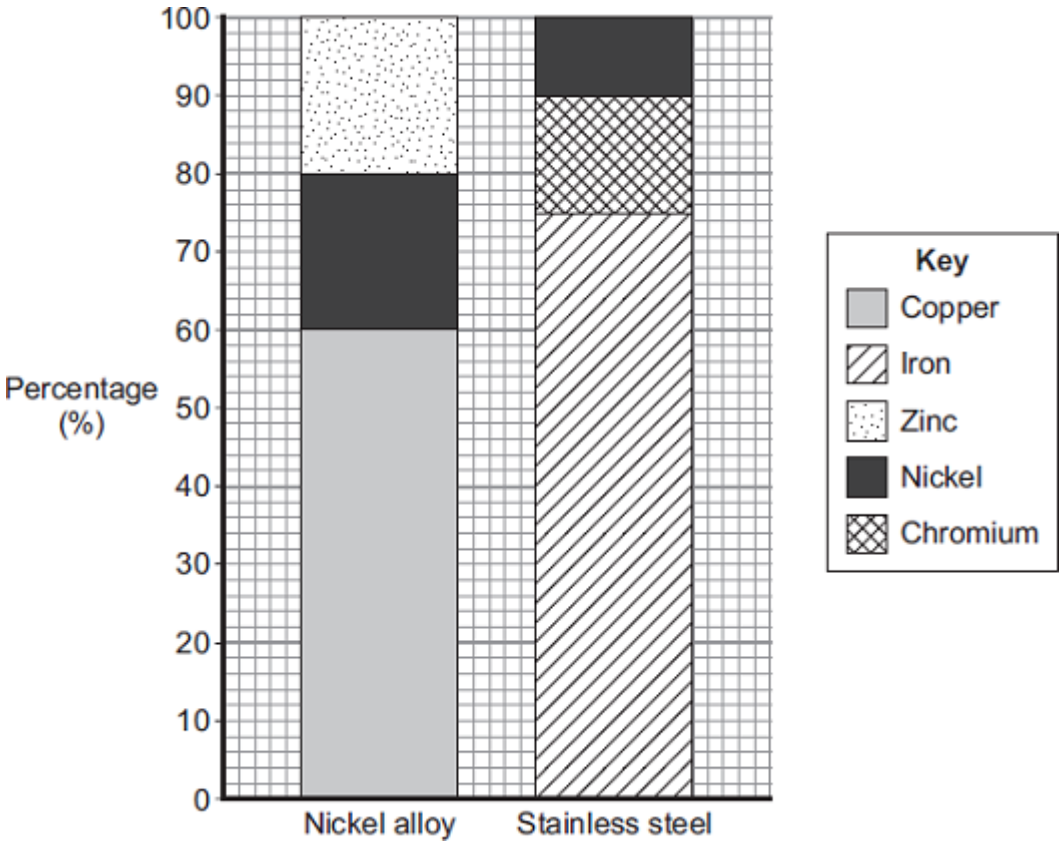






(1)

(b) Two alloys are used to make the ballpoint pen.



Use the bar chart to answer these questions.

(i) Which metal is in both of these alloys?

_____

(1)

(ii) What is the percentage of iron in the stainless steel?

_____ %

(1)

(iii) The alloy stainless steel is used instead of pure iron for the ball of the pen.

Give **two** reasons why.

_____

_____

_____

_____

(2)

(c) Tick (✓) **one** advantage and tick (✓) **one** disadvantage of **recycling** this type of ballpoint pen.

	Advantage Tick (✓)	**Disadvantage Tick (✓)**
Can be refilled and reused		
Conserves resources of crude oil and ores		
High cost of separating materials		
Polymers and alloys are not expensive		

(2)

(Total 8 marks)

Q13.

Metals are extracted from their ores.

Many copper ores contain only 2% of copper compounds.

(a) Copper is now extracted from ores containing a low percentage of copper compounds.

Suggest **two** reasons why.

_____

_____

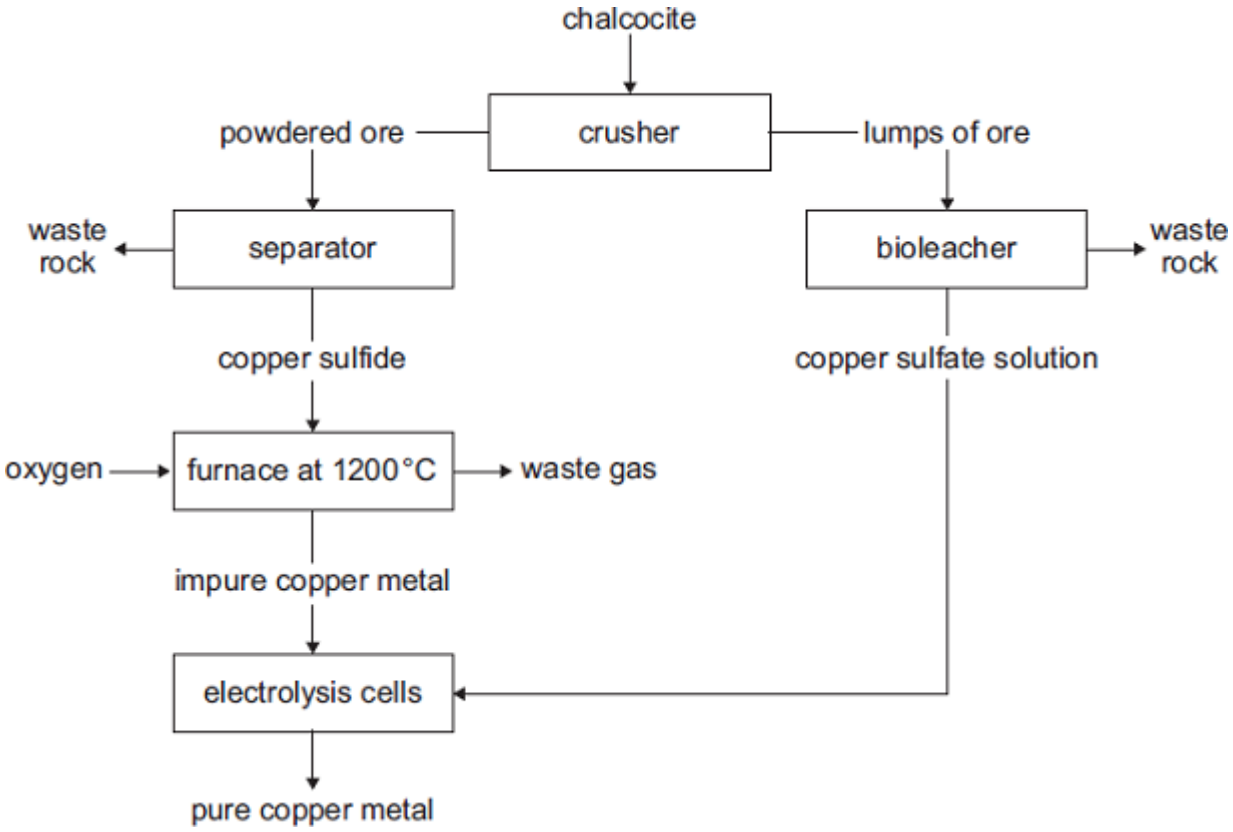
_____

_____

(2)

(b) Chalcocite, an ore of copper, contains copper sulfide.

The flow diagram shows how copper metal is extracted from chalcocite.



(i) Suggest **one** reason why it is difficult to dispose of the waste rock.

_____

_____

(1)

(ii) The reaction in the furnace could cause environmental pollution.
Explain how.

_____

_____

_____

_____

(2)

(iii) The extraction of pure copper is expensive.
Give **one** reason why.

_____

_____

(1)

(iv) Pure copper is produced by electrolysis of copper sulfate solution.

Which electrode do the copper ions move towards?
Give a reason for your answer.

_____

_____

_____

_____

(2)

(v) Large areas of land are contaminated with copper compounds.
Phytomining can be used to remove these copper compounds from the land.

What is used in phytomining to remove copper compounds from the land?

_____

_____

(1)

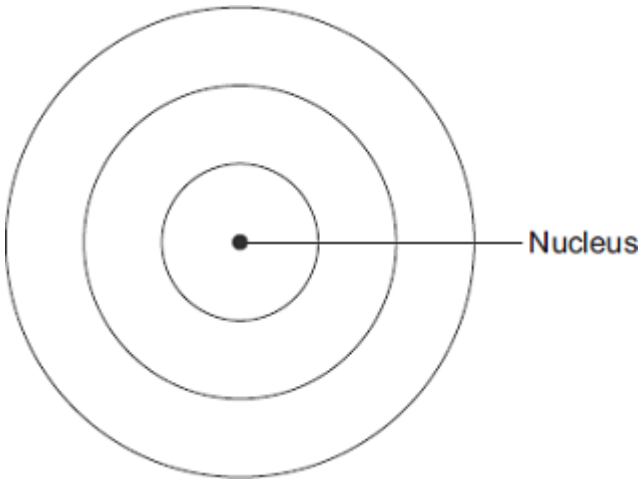
(Total 9 marks)

Q14.

Aluminium has many uses.

(a) An aluminium atom has 13 electrons.

(i) Draw the electronic structure of an aluminium atom.



(1)

(ii) Name the **two** sub-atomic particles in the nucleus of an aluminium atom.

_____ and _____

(1)

(iii) Why is there no overall electrical charge on an aluminium atom?

_____

_____

(1)

(b) Rail tracks are made from steel.

Molten iron is used to weld rail tracks.

The reaction of aluminium with iron oxide is used to produce molten iron.

(i) Balance the chemical equation for the reaction.

$$\text{.....Al} + Fe_2O_3 \longrightarrow \text{.....Fe} + Al_2O_3$$

(1)

(ii) Why does aluminium react with iron oxide?

_____

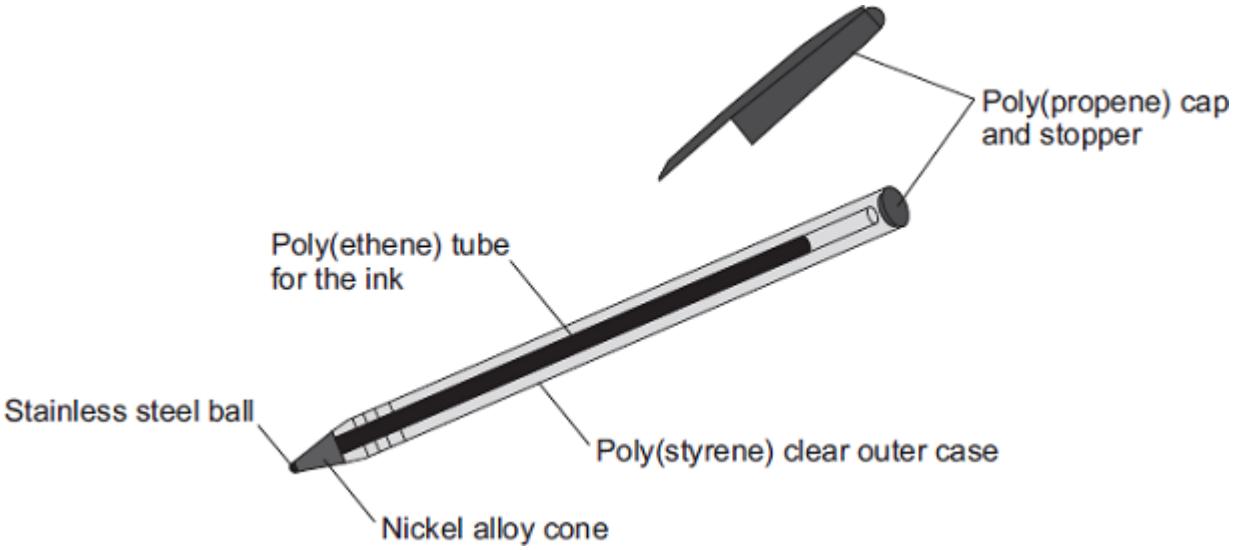
_____

(1)

(Total 5 marks)

Q15.

The diagram shows a ballpoint pen.



(a) Give **one** advantage and **one** disadvantage of recycling the materials from this type of ballpoint pen.

_____

_____

_____

_____

(2)

(b) Alloys are used to make the ballpoint pen.

Give **two** reasons why alloys are used in the ballpoint pen.

_____

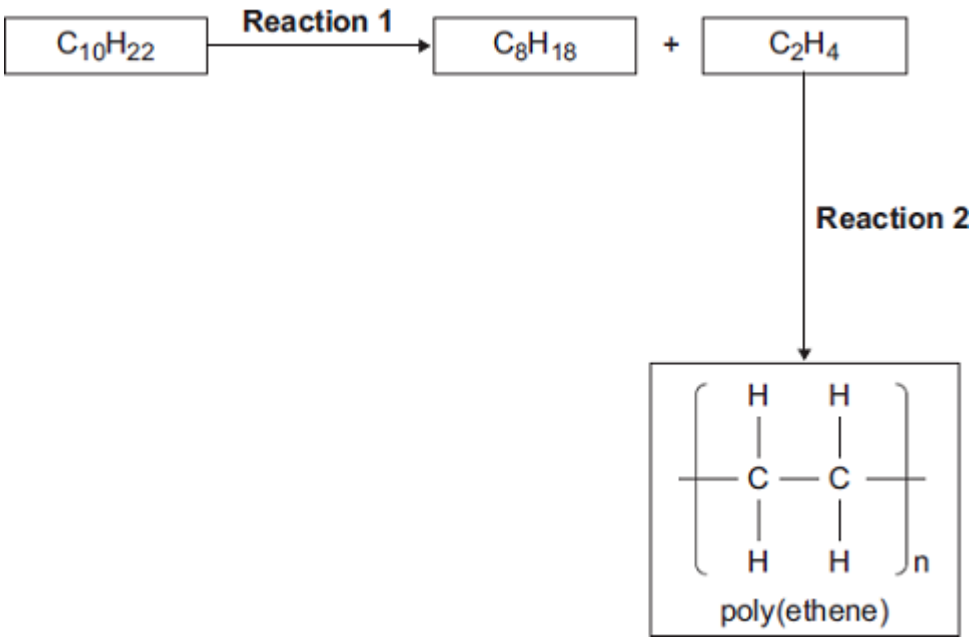
_____

_____

_____

(2)

(c) Decane ($C_{10}H_{22}$) can be used to produce poly(ethene).



(i) Describe the conditions needed for **Reaction 1**.

_____

_____

_____

_____

(2)

(ii) Describe, in terms of molecules, how poly(ethene) is produced in **Reaction 2**.

_____

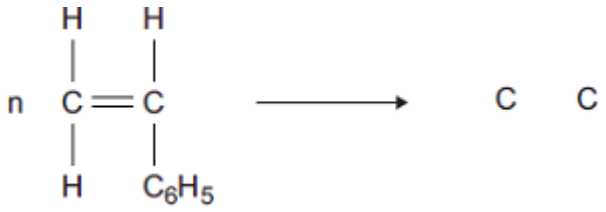
_____

_____

_____

(2)

(d) Complete the displayed structure of the product in the equation.



styrenepoly(styrene)

(2)

(Total 10 marks)

Q16.

Humphrey Davy was a professor of chemistry.

In 1807 Humphrey Davy did an electrolysis experiment to produce potassium.

(a) (i) Humphrey Davy was the first person to produce potassium.

Draw a ring around the correct answer to complete each sentence.

Humphrey Davy's experiment to produce this new element was quickly accepted by other scientists because he

had a lot of money.
had a lot of staff to help.
was well qualified.

(1)

(ii) Other scientists were able to repeat Davy's experiment.

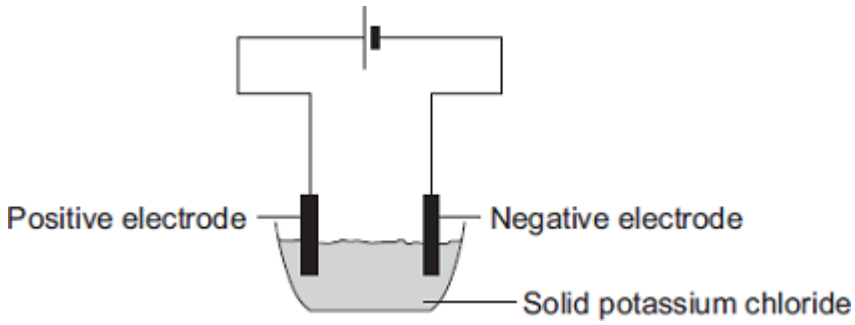
Draw a ring around the correct answer to complete each sentence.

Being able to repeat Davy's experiment is important because other scientists can

check the results of the experiment.
see if the experiment is safe.
take the credit for the discovery.

(1)

(b) A student tried to electrolyse potassium chloride.



Potassium chloride contains potassium ions (K^+) and chloride ions (Cl^-).

(i) The student found that solid potassium chloride does not conduct electricity.

Use the correct answer from the box to complete the sentence.

are too big	**cannot move**	**have no charge**

Solid potassium chloride does not conduct electricity because

the ions _____ .

(1)

(ii) What could the student do to the potassium chloride to make it conduct electricity?

_____

(1)

(iii) During electrolysis why do potassium ions move to the negative electrode?

_____

(1)

(iv) Draw a ring around the correct answer to complete the sentence.

When the potassium ions reach the negative electrode

they turn into potassium

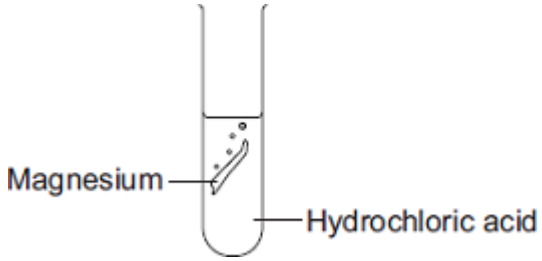
atoms.
electrodes.
molecules.

(1)

(Total 6 marks)

Q17.

A student investigated the reaction between magnesium and hydrochloric acid.



The equation for the reaction is:

Mg(s)	+	2 HCl(aq)	⟶	MgCl2(aq)	+	H2(g)
magnesium		hydrochloric acid		magnesium chloride		hydrogen

(a) Give **two** observations the student could make during the reaction.

1. _____

_____

2. _____

_____

(2)

(b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The student investigated how the rate of this reaction changed when the concentration of hydrochloric acid was changed.

Write a plan the student could use.

In your plan you should:

- describe how you would carry out the investigation and make it a fair test
- describe the measurements you would make.

(6)

(Total 8 marks)

Q18.

This question is about potassium.

(a) Humphrey Davy was a professor of chemistry.

In 1807 Davy did an electrolysis experiment to produce potassium.

(i) Davy first tried to electrolyse a solid potassium salt to produce potassium.

Explain why this electrolysis did **not** work.

(2)

(ii) Humphrey Davy was the first person to produce potassium.

Humphrey Davy's experiment to produce this new element was quickly accepted by other scientists.

Suggest why.

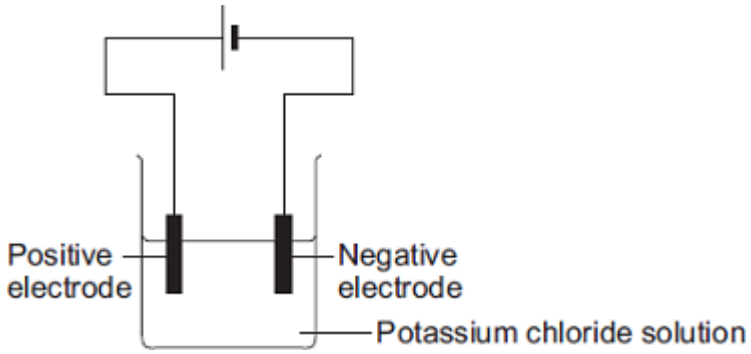
_____

_____

(1)

(b) A student dissolved some potassium chloride in water. The student tried to electrolyse the potassium chloride solution to produce potassium.

The apparatus the student used is shown in the diagram.



The student expected to see potassium metal at the negative electrode, but instead saw bubbles of a gas.

- Name the gas produced at the negative electrode.
- Explain why this gas was produced at the negative electrode **and** why potassium was not produced.

The reactivity series of metals on the Chemistry Data Sheet may help you to answer this question.

_____

_____

_____

_____

_____

_____

(3)

(c) The student tried to electrolyse molten potassium chloride to produce potassium.

(i) Potassium metal was produced at the negative electrode.

Describe how potassium atoms are formed from potassium ions.

_____

_____

_____

_____

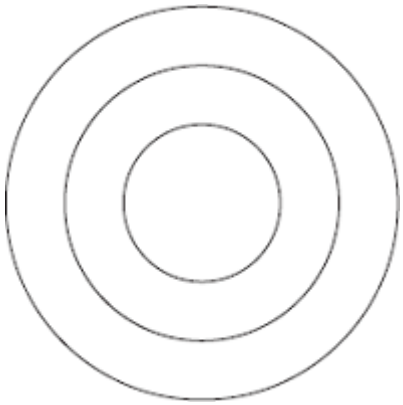
(2)

(ii) Complete and balance the equation for the reaction at the positive electrode.

$$\_\_\_\_\_Cl^- \longrightarrow Cl_2 + \_\_\_\_\_$$

(1)

(iii) Complete the diagram to show the electronic structure of a chloride ion (Cl^-).



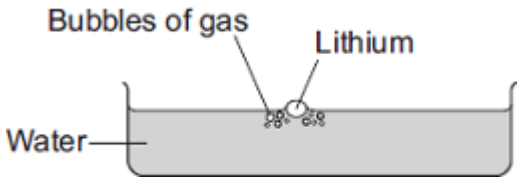
(1)

(Total 10 marks)

Q19.

Lithium is in Group 1 of the periodic table.

Lithium reacts with water to produce a gas and an alkaline solution.



(a) (i) Name the gas produced.

_____

(1)

(ii) Which ion causes the solution to be alkaline?

_____

(1)

(b) Potassium is also in Group 1 of the periodic table.
Potassium reacts with water in a similar way to lithium.

Write down **two** differences you would see between the reactions of potassium and lithium with water.

1. _____

_____

2. _____

_____

(2)

(Total 4 marks)

Q20.

Cans for food and drinks are made from steel or aluminium.
The main metal in steel is iron.

(a) Reacting iron oxide with carbon produces iron.

Draw a ring around the correct answer to complete the sentence.

The reaction to produce iron from iron oxide is	decomposition. oxidation. reduction.

(1)

(b) Aluminium cannot be produced by reacting aluminium oxide with carbon.

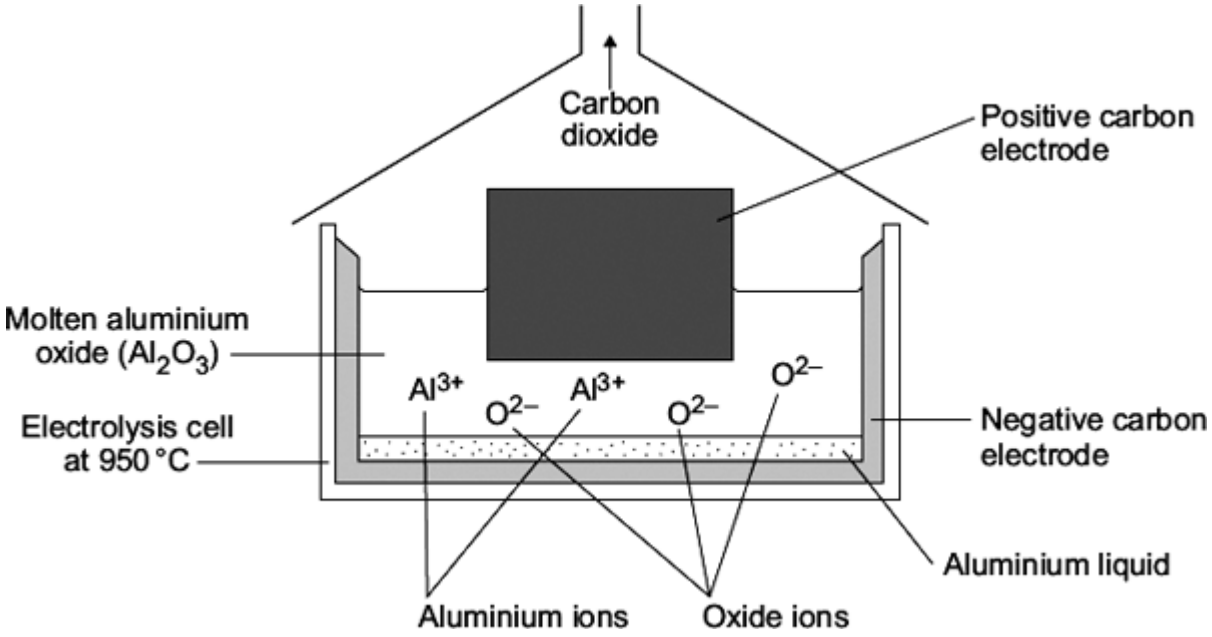
Why does aluminium oxide **not** react with carbon?

Tick (✓) the correct answer.

Answer	Tick (✓)
aluminium is less reactive than carbon	
carbon is less reactive than aluminium	
oxygen is more reactive than carbon	

(1)

(c) Aluminium can be produced by electrolysis.



Why do the aluminium ions collect at the negative electrode?

_____

_____

_____

_____

(2)

(d) Some statements about aluminium are given below.

Tick (✓) **two** statements that are correct reasons why aluminium is used to make cans.

Statement	Tick (✓)
aluminium conducts electricity	
aluminium is not a transition metal	
aluminium has a low density	
aluminium is resistant to corrosion	

(2)

(e) Recycling aluminium cans uses less fossil fuels than producing aluminium from its ore.

Tick (✓) **one** advantage and tick (✓) **one** disadvantage of recycling aluminium to make aluminium cans.

Statement	Advantage Tick (✓)	Disadvantage Tick (✓)
aluminium is the most common metal in the Earth's crust		

less carbon dioxide is produced		
more aluminium ore needs to be mined		
used aluminium cans have to be collected and transported		

(2)

(Total 8 marks)

Q21.

Cans for food and drinks are made from steel or aluminium.
The main metal in steel is iron.

By Sun Ladder (Own work) [CC-BY-SA-3.0 or GFDL], via Wikimedia Commons

(a) Iron is extracted by heating a mixture of iron oxide and carbon in a blast furnace.

(i) Name this type of reaction.

_____

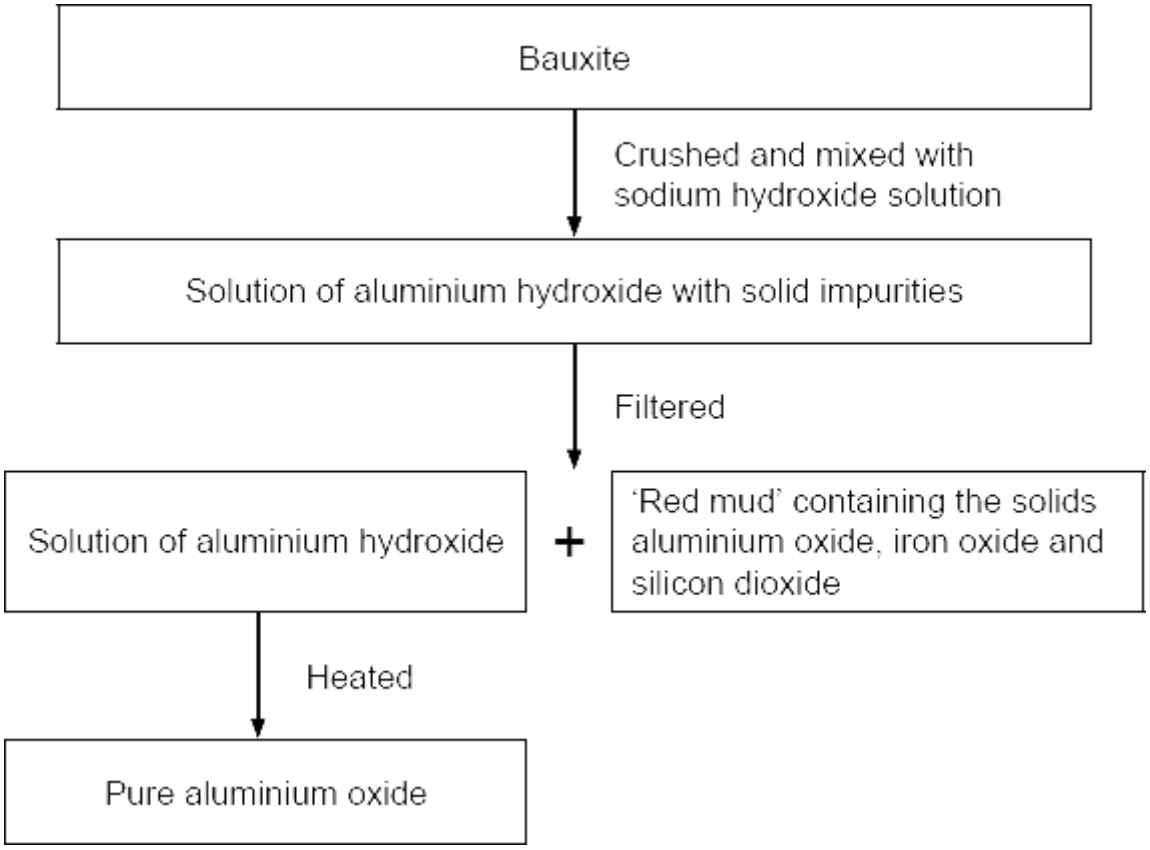
(1)

(ii) Balance the symbol equation for this reaction.

$2Fe_2O_3$ + _____ C → _____ Fe + _____ CO_2

(1)

(b) Aluminium ore, bauxite, contains aluminium oxide, iron oxide and silicon dioxide. Aluminium is extracted by electrolysis of aluminium oxide.



The 'red mud' which is dumped in very large ponds contains:

Name of solid	Percentage (%)
Aluminium oxide	10
Iron oxide	65
Silicon dioxide	25

(i) 100 tonnes of bauxite produced 50 tonnes of pure aluminium oxide and 50 tonnes of 'red mud'.

What percentage of aluminium oxide did the bauxite contain?

_____

Answer = _____ %

(1)

(ii) Apart from the solids shown in the table, name **one** other substance that would be in the 'red mud'.

_____

(1)

(iii) The purification of the aluminium oxide is usually done near to the bauxite quarries.

Suggest **one** reason why.

_____

(1)

(c) Aluminium is used to make many things including cans.

During one year in the USA:

- 100 billion aluminium cans were sold
- 55 billion aluminium cans were recycled.

Give **one** environmental impact of recycling aluminium cans and **one** ethical or social impact of recycling aluminium cans.

Environmental _____

_____

Ethical or social _____

_____

(2)

(Total 7 marks)

Q22.

Limestone is used as a building material. Acid rain erodes limestone.

(a) Limestone contains calcium carbonate.
The symbol equation for the reaction of calcium carbonate with hydrochloric acid is shown.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Describe a test to show that carbon dioxide is produced in this reaction.

Give the result of the test.

_____

_____

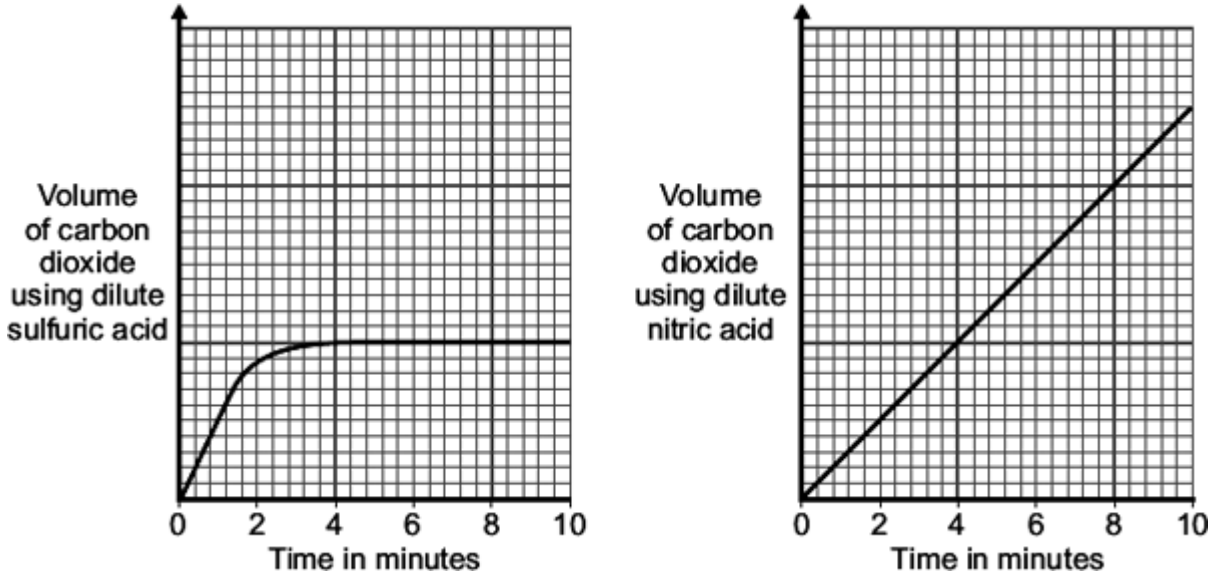
_____

_____

(2)

(b) Gases from vehicle exhausts produce sulfuric acid and nitric acid.

A student investigated the reaction of these two acids with calcium carbonate (limestone).
The type of acid was changed but all other variables were kept the same.
The student measured the volume of carbon dioxide produced each minute for a total of 10 minutes. He did this first for the reaction between dilute sulfuric acid and a cube of calcium carbonate (limestone).
The student repeated the experiment using dilute nitric acid in place of the dilute sulfuric acid.
The results are shown below.



(i) State **two** variables that must be kept the same for this investigation.

_____

_____

_____

_____

(2)

(i) Reacting calcium carbonate with sulfuric acid gave different results to nitric acid.

The symbol equations for the reaction of calcium carbonate with sulfuric acid and with nitric acid are shown below.

$CaCO_3(s) + H_2SO_4(aq) \rightarrow CaSO_4(s) + H_2O(l) + CO_2(g)$

$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$

Describe how the results for sulfuric acid are different **and** use the symbol equations to explain this difference.

_____

_____

_____

_____

_____

_____

_____

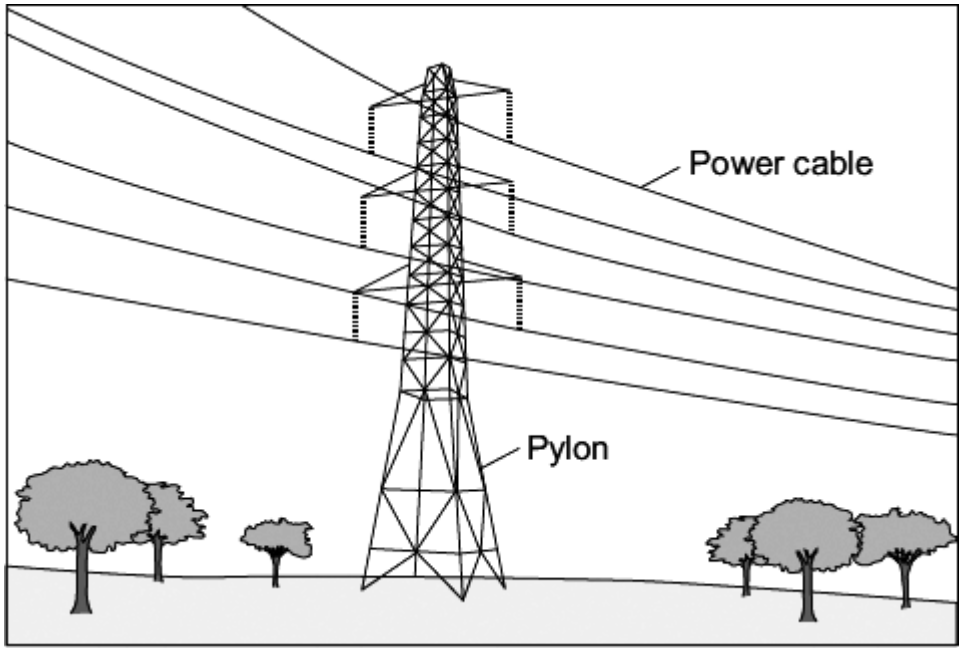
_____

(3)

(Total 7 marks)

Q23.

Metals are used in the manufacture of pylons and overhead power cables.



(a) Suggest **one** reason why iron (steel) is used to make pylons.

_____

_____

(1)

(b) The table shows some of the properties of two metals.

Metal	Density in g per cm^3	Melting point in °C	Percentage(%) relative electrical conductivity	Percentage(%) abundance in Earth's crust
copper	8.92	1083	100	0.007
aluminium	2.70	660	60	8.1

Use the information in the table to suggest why aluminium and **not** copper is used to conduct electricity in overhead power cables.

_____

_____

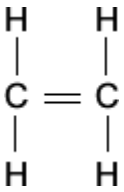
_____

_____

(2)

(c) A polymer can be used to cover and insulate power cables.

The polymer is made from the alkene:



Draw a ring around the correct answer to complete each of the sentences.

(i) The chemical formula of this alkene is

CH
CH_4
C_2H_4

(1)

(ii) The two lines between the carbon atoms are called a

double bond.
nucleus.
single bond.

(1)

(iii) The name of the polymer formed when many of these alkene molecules join together is

poly(ethene).
poly(ethenol).
poly(propene).

(1)

(Total 6 marks)

Q24.

(a) Ammonia solution is used in cleaning products to remove grease from kitchen surfaces.

Ammonia solution is alkaline.

(i) Draw a ring around the number most likely to be the pH of ammonia solution.

1 **3** **7** **10**

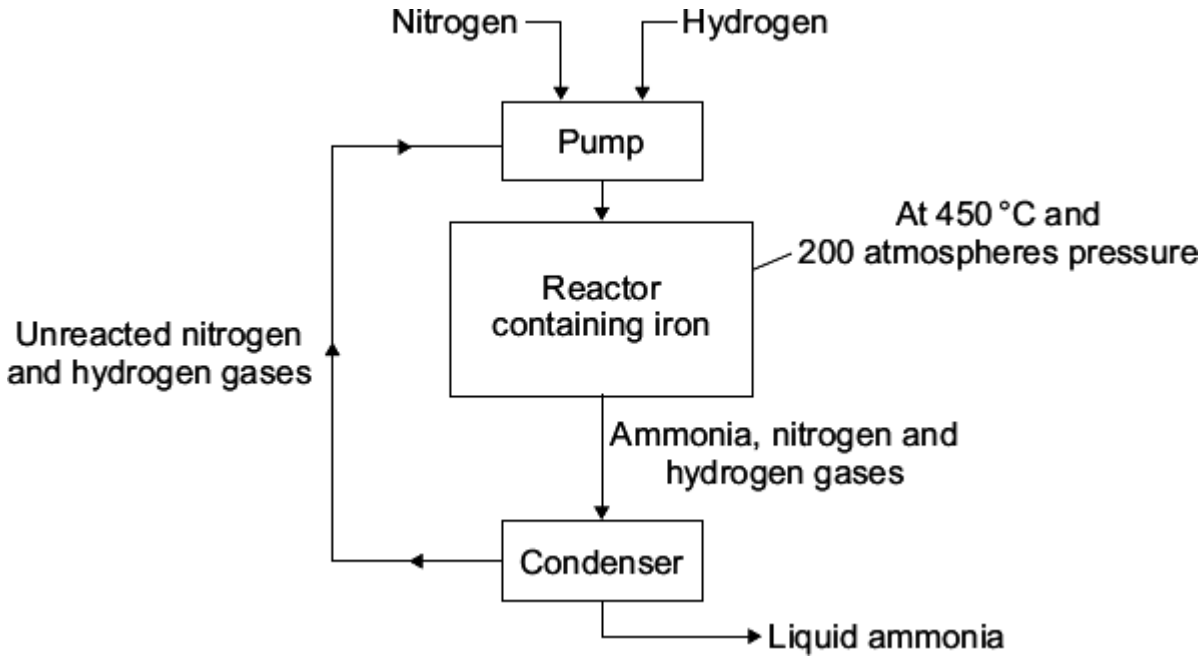
(1)

(ii) Draw a ring around the ion in ammonia solution which makes it alkaline.

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

(1)

(b) Ammonia is made using the Haber process.



(i) Where does the nitrogen used in the Haber process come from?

Draw a ring around your answer.

air **natural gas** **water**

(1)

(ii) A high temperature of 450 °C is used in the reactor.

Tick (✓) **two** reasons in the table which explain why high temperatures make reactions faster.

Reasons	Tick (✓)
Particles move faster	
Particles are closer together	
Particles collide more often	
Particles have less energy	

(2)

(iii) The iron in the reactor speeds up the reaction but is not used up.

What is the name given to substances that speed up the chemical reaction but which are not used up during the reaction?

_____

(1)

(c) Complete the sentence.

The condenser separates the ammonia from the unreacted nitrogen and hydrogen

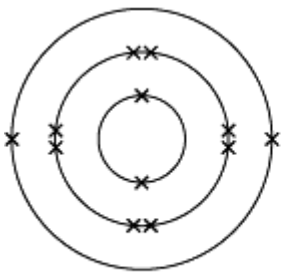
by turning the ammonia into a _____

(1)

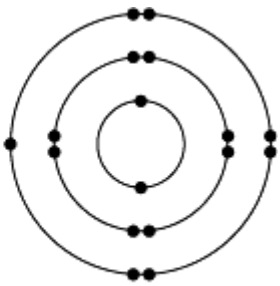
(Total 7 marks)

Q25.

The diagrams represent the electronic structure of a magnesium atom and a chlorine atom.



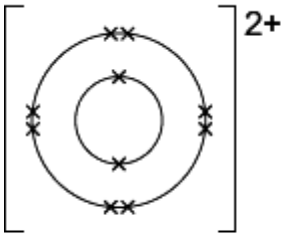
Magnesium atom



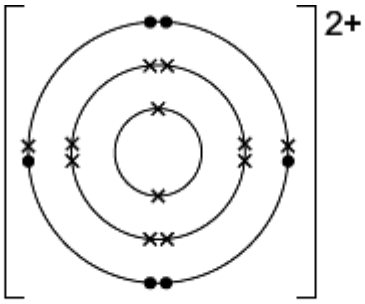
Chlorine atom

Magnesium reacts with chlorine to make the ionic compound called magnesium chloride. This contains magnesium ions, Mg^{2+}, and chloride ions, Cl^-

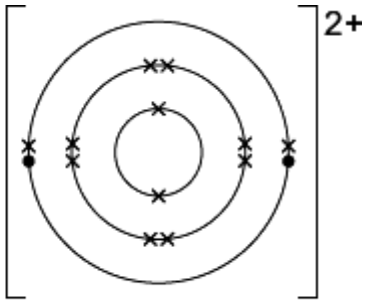
(a) (i) Which structure, **A**, **B** or **C**, represents a magnesium ion?



Structure **A**



Structure **B**

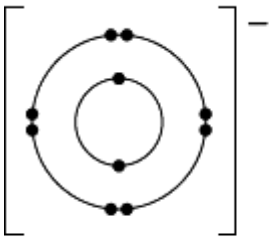


Structure **C**

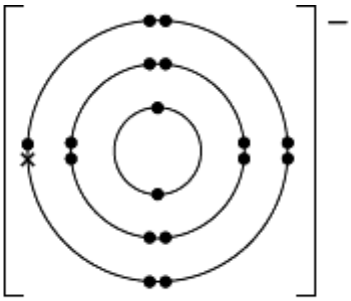
The magnesium ion is Structure ☐

(1)

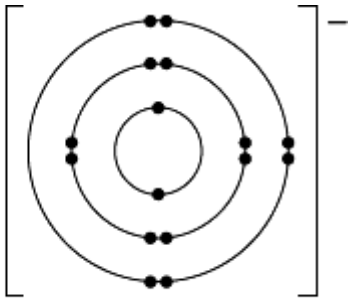
(ii) Which structure, **D**, **E** or **F**, represents a chloride ion?



Structure **D**



Structure **E**



Structure **F**

The chloride ion is Structure ☐

(1)

(b) Magnesium metal can be extracted from sea water.
Sea water contains magnesium chloride, $MgCl_2$

(i) Calcium hydroxide, $Ca(OH)_2$, is added to the sea water.
Magnesium hydroxide, $Mg(OH)_2$, is produced as a solid.

This is the equation for the reaction:

$$MgCl_2(aq) + Ca(OH)_2(aq) \rightarrow Mg(OH)_2(s) + CaCl_2(aq)$$

Draw a ring around the correct answer to complete each sentence.

Magnesium hydroxide forms as a solid because it is

soluble
insoluble
dissolved

in water.

This type of reaction is called

precipitation.
neutralisation.
thermal decomposition.

(2)

(ii) How is the solid magnesium hydroxide separated from the solution?

_____

(1)

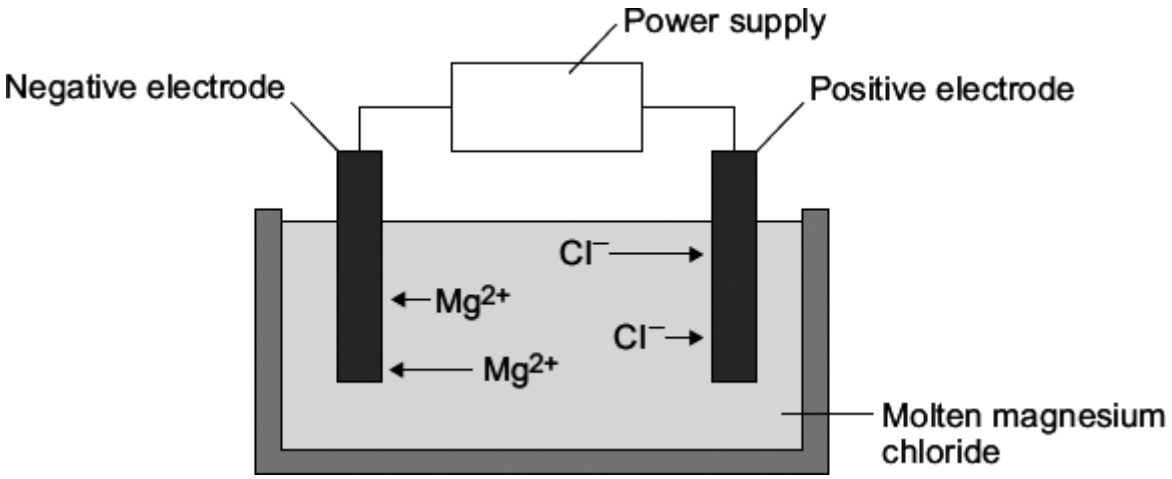
(iii) An acid is then added to the solid magnesium hydroxide to make magnesium chloride.

Draw a ring around the name of this acid.

nitric acid **hydrochloric acid** **sulfuric acid**

(1)

(c) Electrolysis is used to extract magnesium metal from magnesium chloride.



(i) What must be done to solid magnesium chloride to allow it to conduct electricity?

_____

(1)

(ii) Why do the magnesium ions move to the negative electrode?

_____

_____

(1)

(iii) Name the product formed at the positive electrode.

_____

(1)

(Total 9 marks)

Q26.

Read the information.

> Alumina is a white solid. In 1800, scientists thought that alumina contained an undiscovered metal. We now call this metal aluminium. At that time, scientists could not extract the aluminium from alumina.
>
> In 1825, Christian Oersted, a Danish scientist, did experiments with alumina.
>
> **Step 1** He reacted a mixture of hot alumina and carbon with chlorine to form aluminium chloride. The reaction is very endothermic.
>
> **Step 2** The aluminium chloride was reacted with potassium. He was left with potassium chloride and tiny particles of aluminium metal.
>
> Other scientists were **not** able to obtain the same results using his experiment and his work was not accepted at that time.
>
> In 1827, Friedrich Wöhler, a German chemist, made some changes to Oersted's experiment. He obtained a lump of aluminium. He tested the aluminium and recorded its properties.

(a) Suggest why scientists in 1800 could not extract aluminium from alumina.

_____

_____

(1)

(b) Oersted's experiment in 1825 was **not** thought to be reliable.

Explain why

_____

_____

(1)

(c) Why must the reaction in **Step 1** be heated to make it work?

_____

_____

(1)

(d) Complete the word equation for the reaction in **Step 2**.

aluminium chloride + potassium → _____ + _____

(1)

(e) Suggest how Wöhler was able to prove that he had made a new metal.

_____

_____

_____

_____

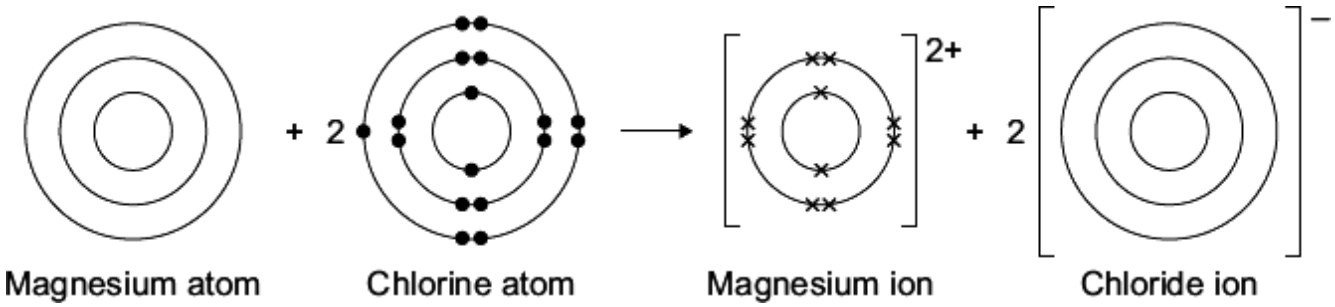
(2)

(Total 6 marks)

Q27.

Magnesium reacts with chlorine to make the ionic compound called magnesium chloride.

(a) Complete the diagram by adding the electronic structures of the magnesium atom and the chloride ion.



(2)

(b) Magnesium metal can be extracted from sea water.
Sea water contains magnesium chloride, $MgCl_2$

(i) Calcium hydroxide, $Ca(OH)_2$, is added to the sea water.
Magnesium hydroxide, $Mg(OH)_2$, is produced.

$$MgCl_2(aq) + Ca(OH)_2(aq) \rightarrow Mg(OH)_2(s) + CaCl_2(aq)$$

Name a method that could be used to separate magnesium hydroxide from the solution.

_____

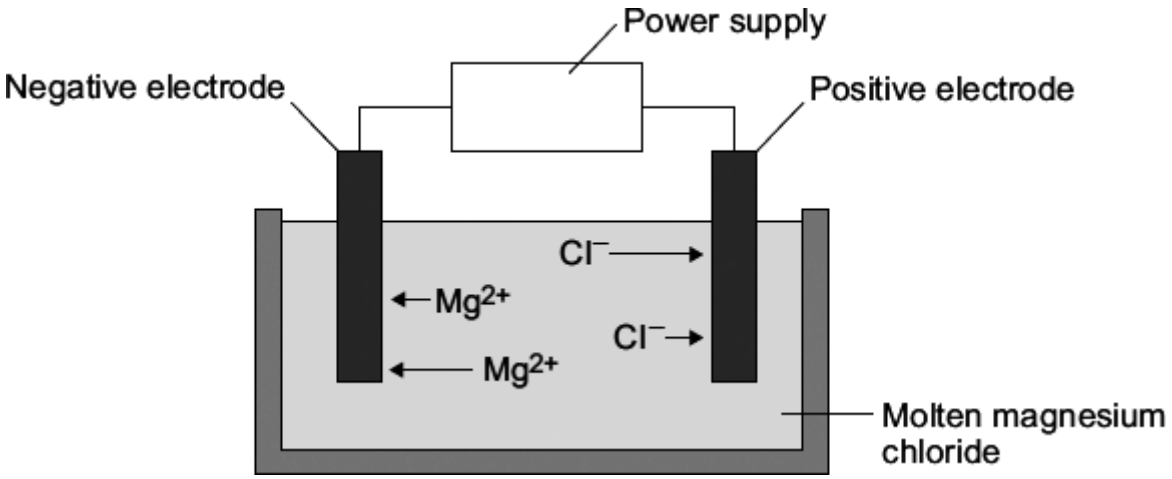
(1)

(ii) An acid is then added to the magnesium hydroxide to make magnesium chloride.

Name this acid. _____

(1)

(c) Electrolysis is used to extract magnesium metal from magnesium chloride.



(i) Why must the magnesium chloride be molten?

_____

_____

(1)

(ii) The equation shows the reaction that takes place at the positive electrode.

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

Why is this reaction an oxidation reaction?

_____

(1)

(iii) Complete the equation for the reaction at the negative electrode.

$$Mg^{2+} \rightarrow Mg$$

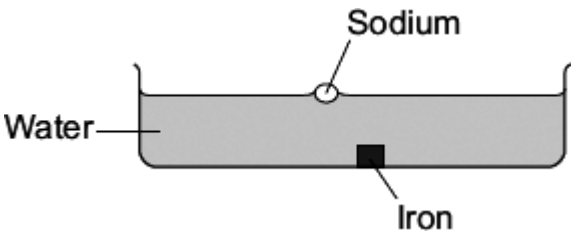
(1)

(Total 7 marks)

Q28.

How a metal is used depends on its properties.

A teacher demonstrated some of the properties of sodium (an alkali metal) and iron (a transition element) by placing a small cube of each metal into water.



A student observed that:

Sodium	Iron
floated on the surface of the water	sank to the bottom of the water
melted to form a molten ball of sodium	did not melt
reacted to produce a gas	did not react
no sodium was left after 5 minutes	the cube of iron remained after 5 minutes

(a) Tick (✓) **two** properties of sodium compared with iron that are shown by the student's observations.

Sodium compared with iron	Tick(✓)
sodium has a higher boiling point	
sodium has a lower density	
sodium is harder	
sodium is more reactive	
sodium is softer	

(2)

(b) Draw a ring around the correct answer to complete the word equation.

sodium + water → sodium hydroxide + [carbon dioxide / hydrogen / oxygen]

(1)

(c) Draw a ring around the correct answer to complete the sentence.

Sodium hydroxide is an alkali because it produces [$H^+(aq)$ / $OH^-(aq)$ / $Na^+(aq)$] ions

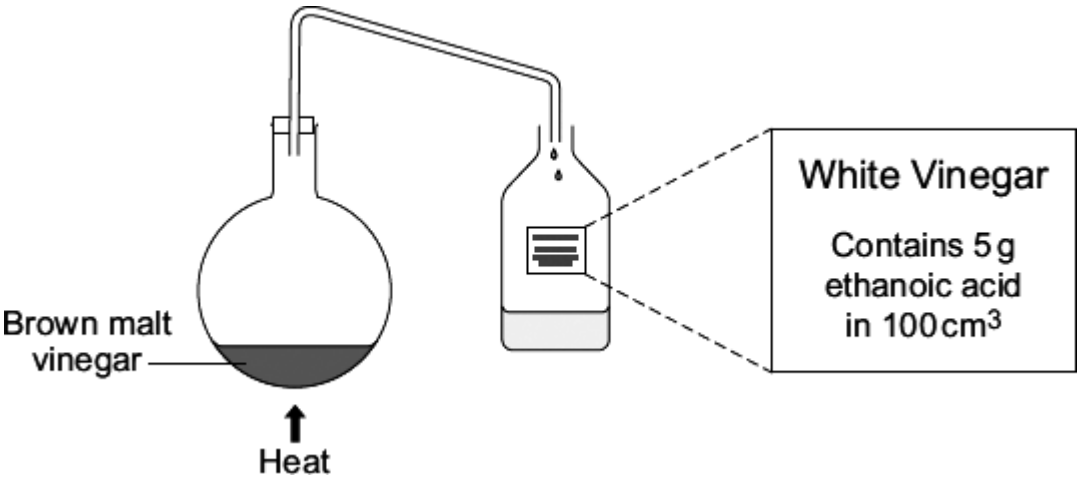
in aqueous solution.

(1)

(Total 4 marks)

Q29.

White vinegar can be made by distillation of brown malt vinegar.



(a) White vinegar contains only water (boiling point 100 °C) and ethanoic acid (boiling point 118 °C).

Suggest why the brown colour remains in the flask during the distillation.

_____

_____

(1)

(b) Ethanoic acid is a weak acid.

(i) Draw a ring around the correct answer to complete the sentence.

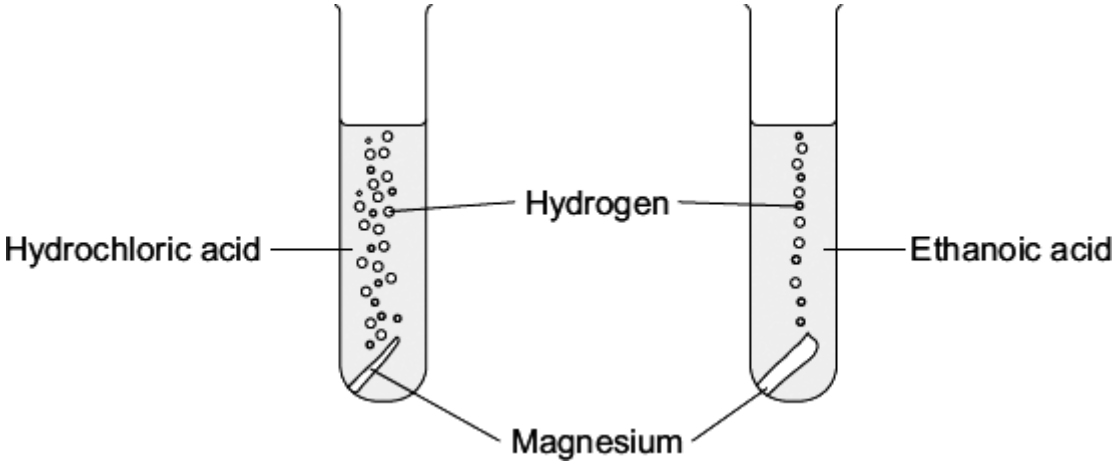
Weak acids are	completely not partially	ionised in water.

(1)

(ii) Hydrochloric acid and ethanoic acid were reacted with magnesium metal to produce hydrogen gas.

At the start:

- both acids were the same concentration
- both pieces of magnesium were the same size.



Give **two** observations which show that ethanoic acid is a weaker acid than hydrochloric acid.

1. _____

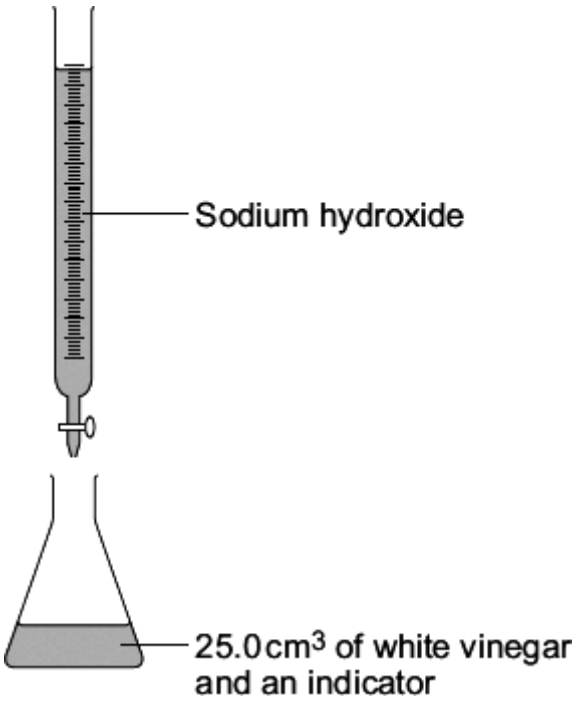
_____

2. _____

_____

(2)

(c) A student did a titration to find out if the white vinegar contains 5 g of ethanoic acid in 100 cm^3.



(i) Choose the correct words from the box to complete the sentences.
Use each word once or not at all.

burette	**conical flask**	**pipette**	**thermometer**

To do this titration 25.0 cm^3 of the white vinegar is measured

using a _____ .

The 25.0 cm^3 of white vinegar is then run into a

_____ .

An indicator is added to the white vinegar.

Sodium hydroxide solution is added to the white vinegar

from a _____ .

(3)

(ii) How does the student know when to stop adding the sodium hydroxide solution?

_____

_____

_____

_____

(2)

(d) The titration is repeated three more times. The results are shown in the table.

Titration	**1**	**2**	**3**	**4**
Volume of sodium hydroxide in cm^3	23.5	20.1	19.9	20.0

(i) The student decided that the mean of these results was 20.0 cm^3.

Explain why.
Use the figures from the table in your explanation.

_____

_____

_____

_____

(2)

(ii) From the results, the student calculated that the concentration of the ethanoic acid was 48 g per cubic decimetre.

Did the white vinegar contain 5 g of ethanoic acid in 100 cm^3 ?
Explain your answer.

_____

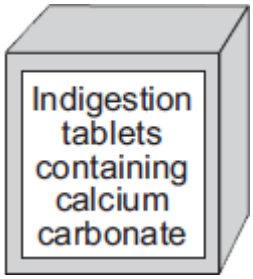
_____

(1)

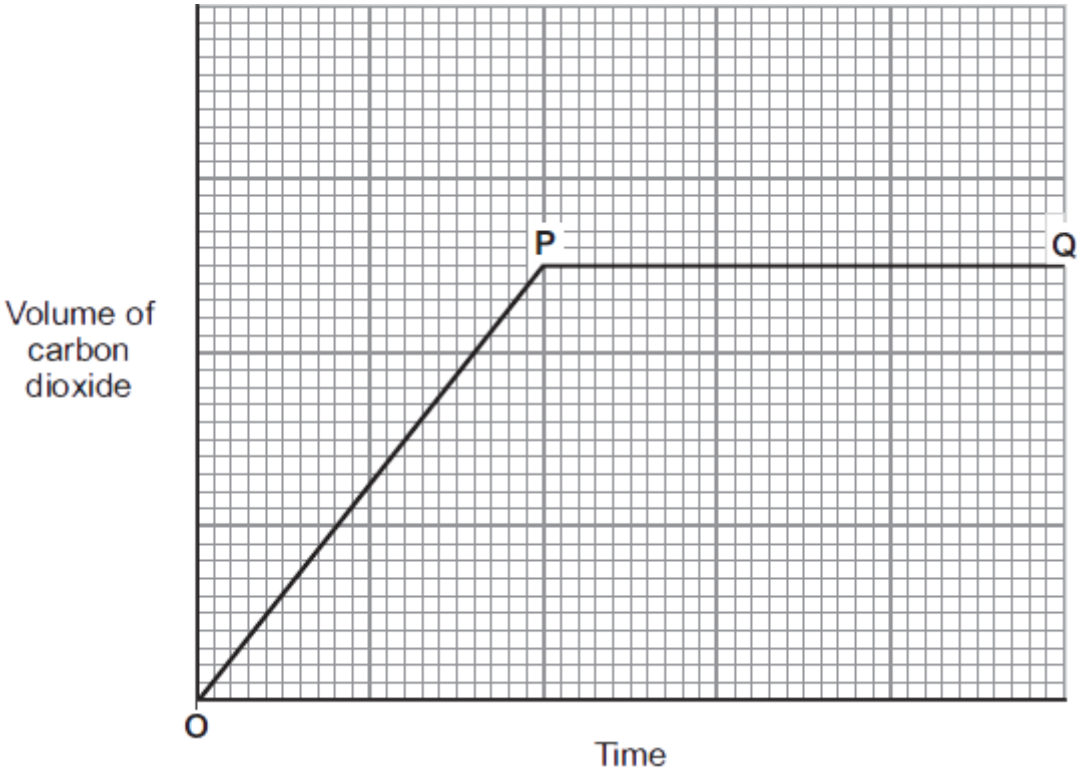
(Total 12 marks)

Q30.

Human stomachs contain hydrochloric acid.
Stomach ache can be caused by too much acid in the stomach.
Indigestion tablets can be used to reduce the amount of acid in the stomach.



(a) The graph shows how the volume of carbon dioxide produced changes with time, after some calcium carbonate is added to hydrochloric acid.



(i) Complete the sentence to explain what happens between **O**and **P**.

Between **O** and **P** the calcium carbonate and hydrochloric acid _____

(1)

(ii) Complete the sentence to explain what happens at **P**.

At **P** the calcium carbonate and hydrochloric acid _____

because _____

(2)

(iii) Describe the test for carbon dioxide gas.

Test _____

Result of the test _____

(2)

(b) Calcium carbonate is found in limestone.

Limestone is removed from the ground by quarrying.

Photograph supplied by Stockbyte/Thinkstock

Tick (✓) **one**advantage and tick (✓) **one**disadvantage of quarrying limestone.

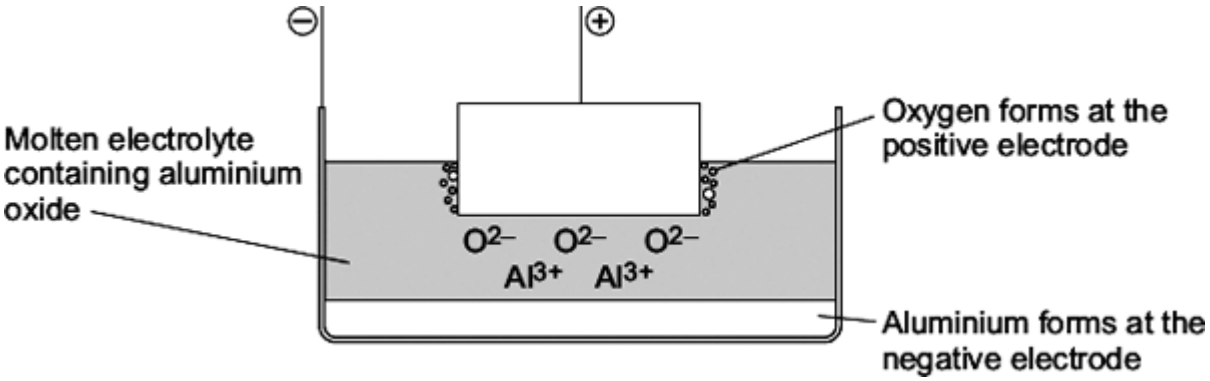
Statement	Advantage Tick (✓)	Disadvantage Tick (✓)
Quarrying limestone destroys the shells and skeletons of marine organisms that formed the limestone.		
Quarrying limestone releases dust, and lorries release carbon dioxide from burning diesel fuel.		
Quarrying limestone provides building materials, employment and new road links.		
Quarrying limestone removes ores from the ground.		

(2)

(Total 7 marks)

Q31.

The diagram represents an electrolysis cell for extracting aluminium.
The current will only flow when the electrolyte is molten.



(a) The electrolyte is aluminium oxide mixed with another substance.

(i) What is the name of the other substance in the electrolyte?

Draw a ring around the correct answer.

cryolite **rock salt** **limestone**

(1)

(ii) Draw a ring around the correct answer to complete the sentence.

This other substance is added to

condense the aluminium oxide.
lower the melting point of the aluminium oxide.
raise the boiling point of the aluminium oxide.

(1)

(b) (i) Oxide ions (O^{2-}) move to the positive electrode.

Explain why.

_____

_____

_____

_____

(2)

(ii) Oxygen is formed at the positive electrode. The oxygen then forms carbon dioxide.

The equation for the reaction is shown below.

$$C + O_2 \rightarrow CO_2$$

Complete the sentence.

The name of the element which reacts with oxygen is _____

(1)

(iii) The positive electrode gets smaller.

Suggest why.

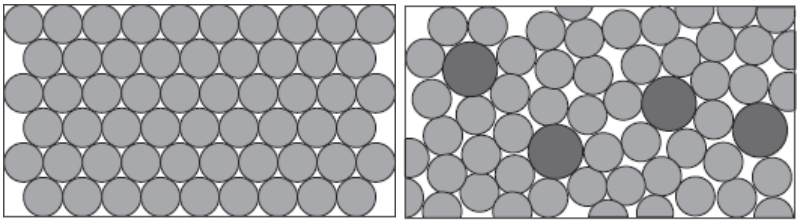
_____

_____

(1)

(c) Aluminium is used in an alloy with magnesium to make drinks cans.

The diagrams show the arrangement of atoms in pure aluminium and in the alloy.



Pure aluminium Alloy

The alloy is harder than pure aluminium.

Explain why. Use the diagrams to help you.

_____

_____

_____

_____

(2)

(Total 8 marks)

Q32.

(a) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The salt called potassium chloride is made when potassium hydroxide solution reacts with hydrochloric acid.

potassium hydroxide solution + hydrochloric acid → potassium chloride solution + water

Describe a method for making **crystals** of potassium chloride from potassium hydroxide solution and hydrochloric acid.

In this method you should:

- describe how you will add the correct amount of the hydrochloric acid to neutralise the potassium hydroxide solution
- describe how you will get crystals of potassium chloride.

_____

(6)

(b) Ammonium nitrate is another salt.
Ammonium nitrate is made when ammonia solution is neutralised with an acid.

Name the acid to complete the word equation.

ammonia + _____ acid → ammonium nitrate

(1)

(c) Read the information.

Ammonium nitrate – good or bad?

Some farmers put a lot of ammonium nitrate on their farmland.

Many people are worried about this use of ammonium nitrate.

Rain water can wash the ammonium nitrate off the farmland and into rivers and lakes. The ammonium nitrate may get into drinking water supplies and could be harmful to health.

(i) Why do some farmers put ammonium nitrate on their farmland?

(1)

(ii) Which **one** of the questions in the table cannot be answered by science

alone?

Tick (✓) **one** question.

Question	Tick (✓)
How much ammonium nitrate is in drinking water?	
Should farmers stop using ammonium nitrate on their farmland?	
Is ammonium nitrate soluble in rain water?	

Give **two** reasons why this question **cannot** be answered by science alone.

_____

_____

_____

_____

(3)

(Total 11 marks)

Q33.

Aluminium is extracted from aluminium oxide.

(a) The formula of aluminium oxide is Al_2O_3

The relative formula mass (M_r) of aluminium oxide is 102.

Calculate the percentage of aluminium in aluminium oxide.

Relative atomic masses (A_r): O = 16; Al = 27.

_____

_____

_____

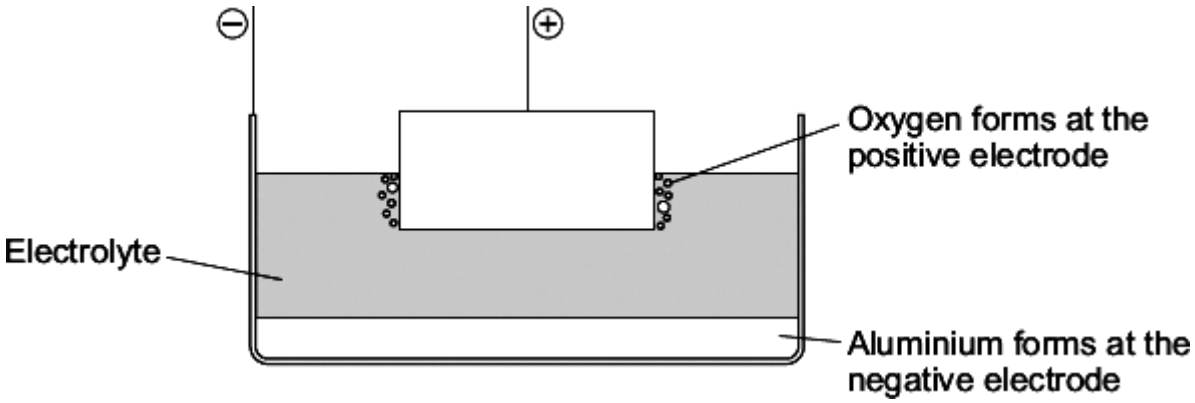
_____

Percentage of aluminium = _____ %

(2)

(b) Aluminium is extracted from aluminium oxide using electrolysis.

The diagram shows a cell used for the extraction of aluminium.



(i) The electrolyte contains cryolite.

Explain why.

_____

_____

_____

_____

(2)

(ii) Oxygen is formed at the positive electrode. Complete and balance the equation for this reaction.

$$\_\_\_\ O^{2-} \rightarrow O_2 + \_\_\_\_\_$$

(2)

(iii) The positive electrode in the cell is used up during the process.

Explain why.

_____

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Q34.

Iron is extracted from its ore.

(a) Iron ore is quarried.

Photograph supplied by Stockbyte/Thinkstock

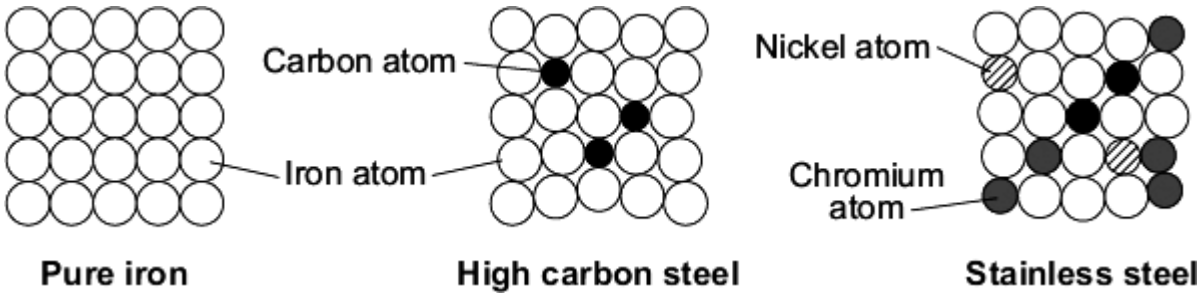
Quarrying iron ore has impacts that cause environmental problems.

Tick (✓) **two** impacts of quarrying that cause environmental problems.

Impact of quarrying	Tick (✓)
puts off tourists	
causes dust pollution	
increases jobs	
increases traffic	

(2)

(b) The diagrams represent the atoms in iron and the atoms in two alloys of iron.



Use the diagrams to help you to answer these questions.

(i) Complete the sentence.

Pure iron does **not** have many uses because _____

_____

(1)

(ii) Stainless steel is more expensive than pure iron.

Suggest why.

_____

_____

(1)

(c) Draw a ring around the correct answer to complete each sentence.

(i) Pure iron is

a compound.
an element.
a mixture.

(1)

(ii) High carbon steel is used for a drill bit because it is

brittle.
easily bent.
hard.

(1)

(iii) Stainless steel is used to make cutlery because it

contains three different atoms.
melts at a very high temperature.
is resistant to corrosion.

(1)

(Total 7 marks)

Q35.

Steels are used to make cars, bridges and knives.
The main element in steel is iron.

(a) Iron is extracted from an *ore* that contains about 60% iron oxide, Fe_2O_3

(i) What is the meaning of *ore*?

_____

_____

(1)

(ii) In a blast furnace, iron oxide reacts with carbon monoxide to produce iron.
The word equation for this reaction is:

iron oxide + carbon monoxide → iron + carbon dioxide

Complete and balance the chemical equation for this reaction.

Fe_2O_3 + ____ CO → _____ + _____

(2)

(iii) Name the type of reaction that produces a metal from its metal oxide.

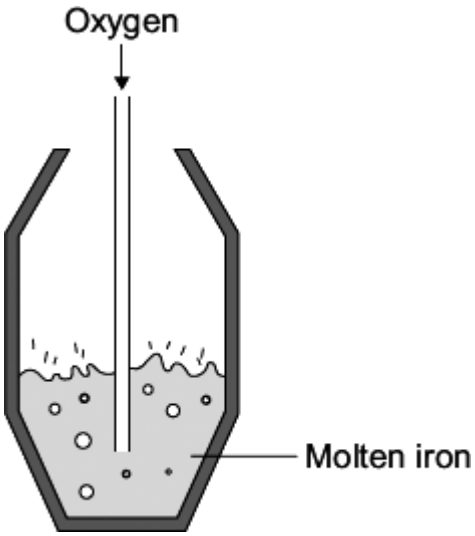
_____

(1)

(b) Steels are produced from molten iron in two stages:

Stage 1 blowing oxygen into molten iron from the blast furnace.

Stage 2 adding other metals to make different steels.



(i) In **Stage 1**, suggest how the oxygen removes most of the carbon from the molten iron.

_____

_____

_____

_____

(2)

(ii) **Stage 2** produces different steels.

Suggest why different steels are needed.

_____

_____

(1)

(c) Old 5p and 10p coins in the UK were made from cupro-nickel.
Cupro-nickel is 75% copper and 25% nickel.

New 5p and 10p coins in the UK are now made from nickel-plated steel and not from cupro-nickel.

Explain why.

_____

_____

_____

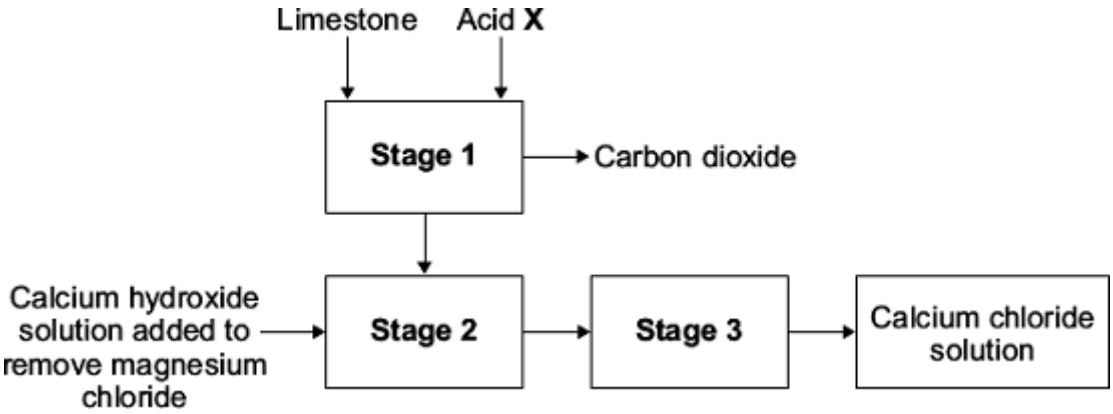
_____

(2)

(Total 9 marks)

Q36.

(a) Calcium chloride is made from limestone. Limestone contains mainly calcium carbonate and a small amount of magnesium carbonate.



(i) In **stage 1** calcium carbonate reacts with acid **X** to form calcium chloride.

Draw a ring around the name of acid **X**.

hydrochloric **nitric** **sulfuric**

(1)

(ii) **Stage 1** produces a concentrated solution of calcium chloride.
The solution also contains magnesium chloride.

Calcium hydroxide solution is added in **stage 2** to remove the magnesium chloride.

The equation for this reaction is:

$$MgCl_2(aq) + Ca(OH)_2(aq) \rightarrow Mg(OH)_2(s) + CaCl_2(aq)$$

Draw a ring around the correct answer to complete each sentence.

In **stage 2** a precipitate is made because

magnesium hydroxide is | dissolved / insoluble / soluble | in water.

In **stage 3** the solid magnesium hydroxide can be separated from the calcium

chloride solution using

chromatography.
electrolysis.
filtration.

(2)

(iii) What method can be used to change the calcium chloride solution into solid calcium chloride?
Draw a ring around your answer.

crystallisation **electrolysis** **reduction**

(1)

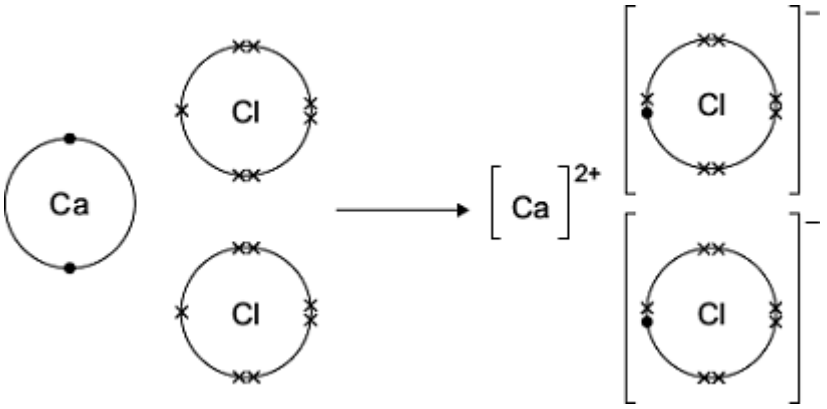
(b) Calcium chloride can also be made by reacting calcium with chlorine:

calcium + chlorine → calcium chloride

The diagram shows what happens to atoms of calcium and chlorine in this reaction.

The dots (●) and crosses (x) are used to represent electrons.

Only the outer electrons are shown.



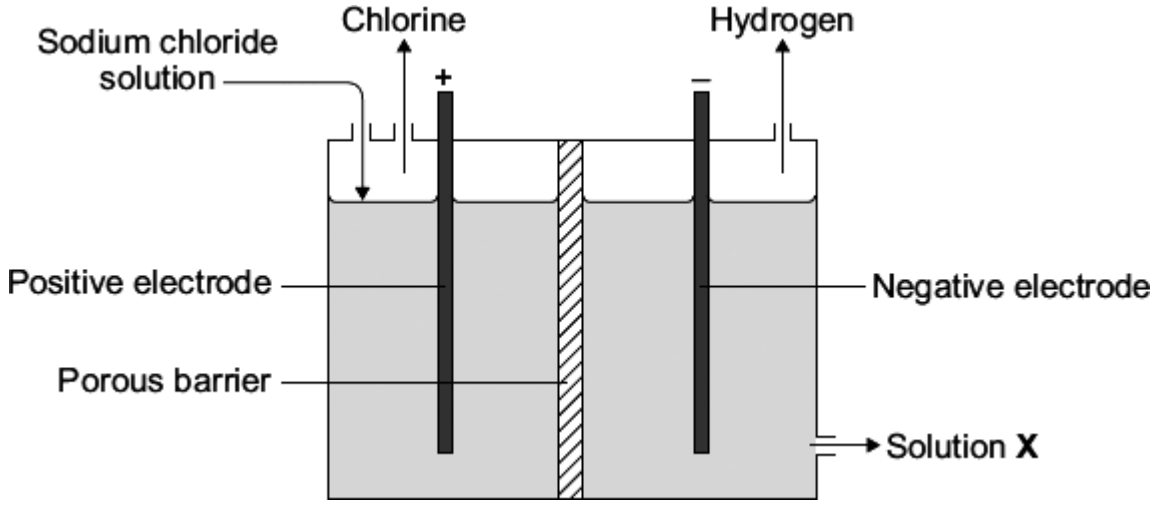
Use the diagram to help you to answer this question.

Describe, as fully as you can, what happens when calcium reacts with chlorine to make calcium chloride.

(4)
(Total 8 marks)

Q37.

The electrolysis of sodium chloride solution is an industrial process.



(a) Why do chloride ions move to the positive electrode?

_____

(1)

(b) Sodium chloride solution contains two types of positive ions, sodium ions (Na^+) and hydrogen ions (H^+).

Tick (✓) the reason why hydrogen is produced at the negative electrode and **not** sodium.

Reason	Tick (✓)
Hydrogen is a gas.	
Hydrogen is less reactive than sodium.	
Hydrogen is a non-metal.	
Hydrogen ions travel faster than sodium ions.	

(1)

(c) Solution **X** is alkaline.

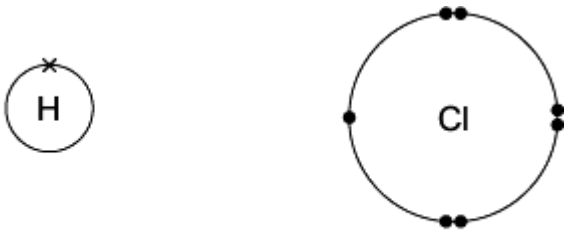
Which ion makes solution **X** alkaline?

_____

(1)

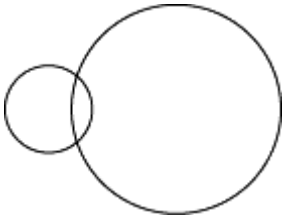
(d) Electrolysis of sodium chloride solution produces hydrogen and chlorine.
The hydrogen and chlorine can be used to make hydrogen chloride.

(i) The diagrams show how the outer electrons are arranged in atoms of hydrogen and chlorine.



Hydrogen atom Chlorine atom

Complete the diagram to show how the electrons are arranged in a molecule of hydrogen chloride (HCl).



(1)

(ii) Name the type of bond between the hydrogen and the chlorine atoms in a molecule of hydrogen chloride.

_____

(1)

(iii) Some hydrogen chloride was bubbled into water. This made a solution with a pH of 1.

Which ion gave the solution a pH of 1?

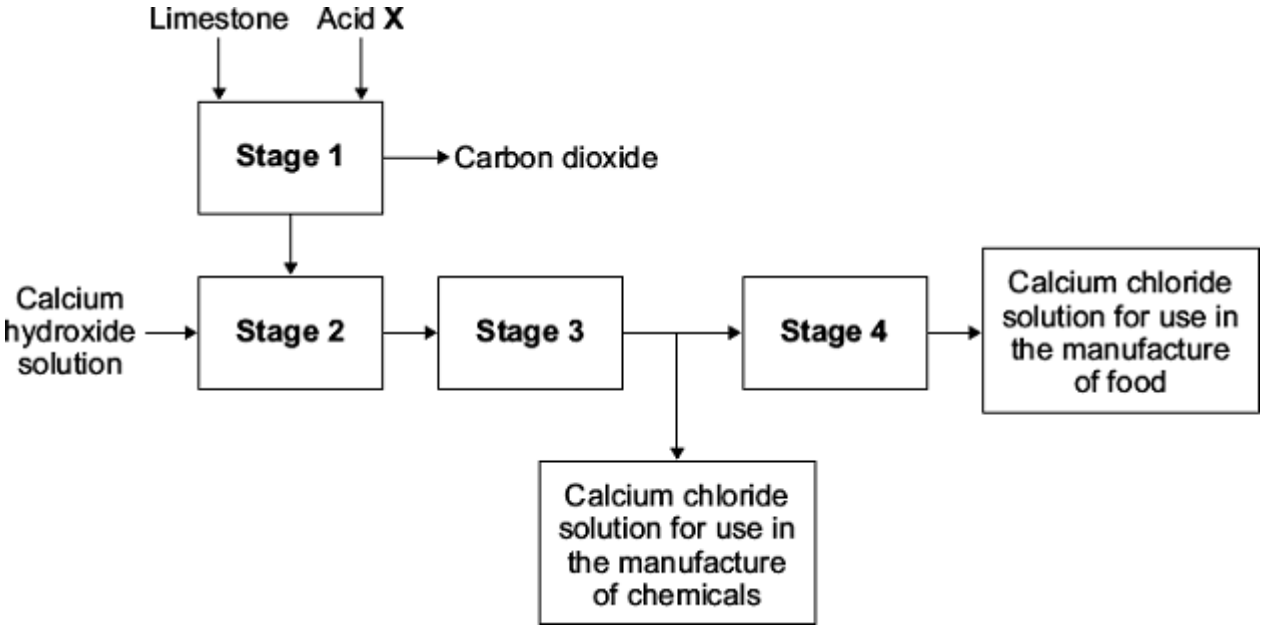
_____

(1)

(Total 6 marks)

Q38.

(a) Calcium chloride is made from limestone. The limestone used contains mainly calcium carbonate and a small amount of magnesium carbonate.



(i) In **stage 1** calcium carbonate reacts with acid **X** to form calcium chloride.

Name acid **X**.

_____

(1)

(ii) **Stage 1** produces a concentrated solution of calcium chloride.
The solution also contains magnesium chloride.

Calcium hydroxide solution is added to remove the magnesium chloride:

$$MgCl_2(aq) + Ca(OH)_2(aq) \rightarrow Mg(OH)_2(s) + CaCl_2(aq)$$

This is an example of a *precipitation* reaction.

What is the meaning of the term *precipitation* reaction?

_____

_____

(1)

(iii) The magnesium hydroxide can be separated from the calcium chloride solution.

State how.

_____

_____

(1)

(iv) Suggest why **stage 4** is needed.

_____

_____

(1)

(v) Name a method that can be used to change calcium chloride solution into solid calcium chloride.

_____

(1)

(b) Calcium chloride can also be made by reacting calcium with chlorine.

Calcium chloride is an ionic compound. It contains calcium ions (Ca^{2+}).

(i) Complete the equation for the formation of calcium ions.

$$Ca \rightarrow Ca^{2+} + \_\_\_\_\_$$

(1)

(ii) Why can the formation of calcium ions from calcium atoms be described as oxidation?

_____

_____

(1)

(Total 7 marks)

Q39.

Vinegar can be added to food.

Vinegar is a solution of ethanoic acid in water.

(a) Ethanoic acid is a *weak* acid.

Draw a ring around the correct answer to complete each sentence.

(i) When dissolved in water, an acid forms a solution containing

carbonate ions.
hydrogen ions.
hydroxide ions.

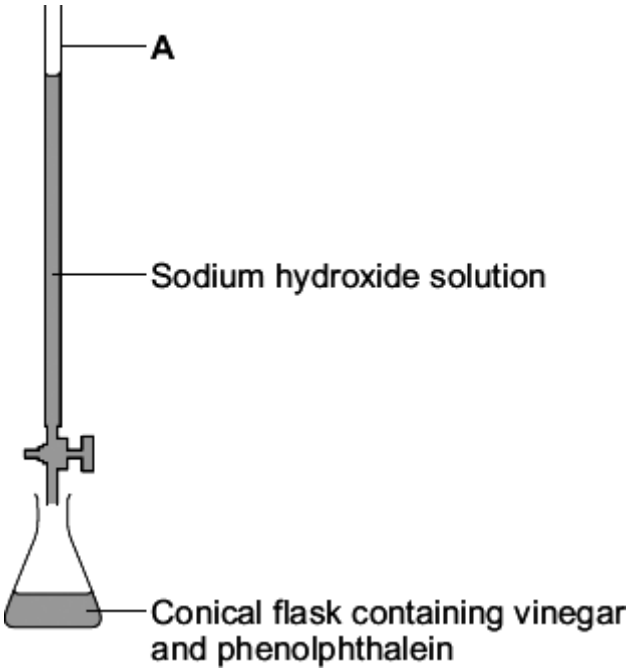
(1)

(ii) Ethanoic acid is a *weak* acid because in water it is

completely ionised.
not ionised.
partially ionised.

(1)

(b) The diagram shows the apparatus used to investigate the amount of ethanoic acid in vinegar.



(i) Draw a ring around the name of the piece of apparatus labelled **A** on the diagram.

burette **measuring cylinder** **pipette**

(1)

(ii) Phenolphthalein is added to the vinegar in the conical flask so that the end point of the titration can be seen.

What type of substance is phenolphthalein?

Draw a ring around the correct answer.

alkali **catalyst** **indicator**

(1)

(iii) How would you know that the end point of the titration has been reached?

_____

_____

(1)

(c) The results of the titration are shown in the table.

	Rough titration	Accurate titrations		
		1	2	3
Final reading in cm^3	22	21.30	22.50	24.40
Initial reading in cm^3	0	1.00	2.00	4.00
Volume used in cm^3	22	20.30	20.50	20.40

Calculate the best value of the mean volume from these titrations.

_____

_____

_____

Mean volume used = _____ cm^3

(2)

(d) 25.0 cm^3 of this vinegar contained 1.25 g of ethanoic acid.

Calculate the mass of ethanoic acid in 1 litre (1000 cm^3) of this vinegar.

_____

_____

_____

Mass = _____ g

(2)

(Total 9 marks)

Q40.

Vinegar can be added to food. Vinegar is an aqueous solution of ethanoic acid.

Ethanoic acid is a *weak* acid.

(a) Which ion is present in aqueous solutions of all acids?

_____

(1)

(b) What is the difference between the pH of a *weak* acid compared to the pH of a strong acid of the same concentration?

Give a reason for your answer.

_____

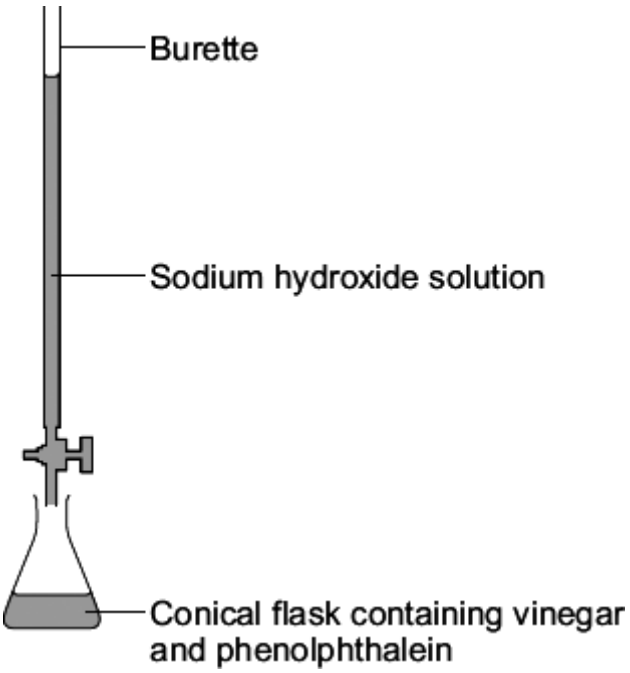
_____

_____

_____

(2)

(c) The diagram shows the apparatus used to find the concentration of ethanoic acid in vinegar.



(i) Why should phenolphthalein indicator be used for this titration instead of methyl orange?

_____

_____

(1)

(ii) 25.00 cm^3 of vinegar was neutralised by 30.50 cm^3 of a solution of sodium hydroxide with a concentration of 0.50 moles per cubic decimetre.

The equation for this reaction is:

$$CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$$

Calculate the concentration of ethanoic acid in this vinegar.

_____

_____

_____

_____

Concentration of ethanoic acid in this vinegar = _____ moles per cubic decimetre

(2)

(d) The concentration of ethanoic acid in a different bottle of vinegar was 0.80 moles per cubic decimetre.

Calculate the mass in grams of ethanoic acid (CH_3COOH) in 250 cm^3 of this vinegar. The relative formula mass (M_r) of ethanoic acid = 60.

_____

_____

_____

_____

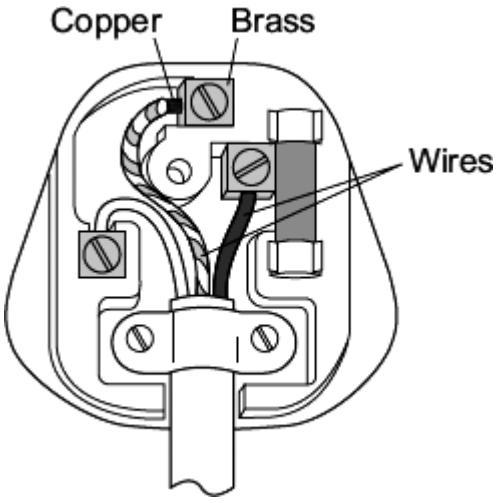
Mass of ethanoic acid = _____ g

(2)

(Total 8 marks)

Q41.

The diagram shows an electric plug.



(a) (i) Draw a ring around the correct answer to complete the sentence.

Copper is used for the wires because it	conducts electricity.
	conducts heat.
	is shiny.

(1)

(ii) Brass is an *alloy* of copper and zinc.

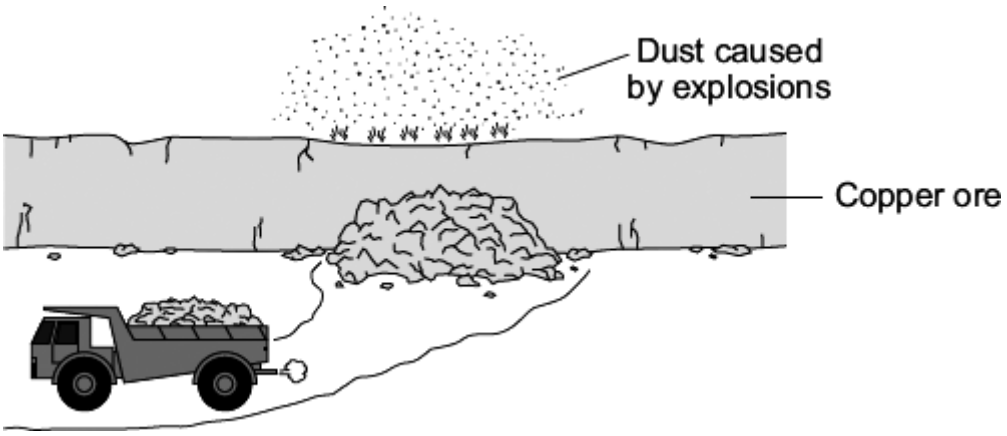
What is an *alloy*?

_____

_____

(1)

(b) Open-cast mines are used to obtain copper ore.



Suggest **two** reasons why people would **not** like to live near an open-cast mine.

1. _____

_____

2. _____

_____

(2)

(Total 4 marks)

Q42.

The flow diagram shows the main stages used to extract a metal from its ore.

mining the ore → purifying the ore → extracting the metal

The table shows some information about three metals.

Metal	Metal ore	Purified ore	% of metal in the ore	% of metal in the Earth's crust
aluminium	bauxite	aluminium oxide, Al_2O_3	28.0	8.0
copper	chalcocite	copper sulfide, Cu_2S	0.5	0.001
iron	haematite	iron oxide, Fe_2O_3	29.0	5.0

(a) Use the information in the table and your knowledge and understanding to help you to answer the questions.

(i) Suggest why purifying the copper ore produces large quantities of waste.

_____

_____

_____

(1)

(ii) Suggest why the annual world production of iron is forty times greater than that of aluminium.

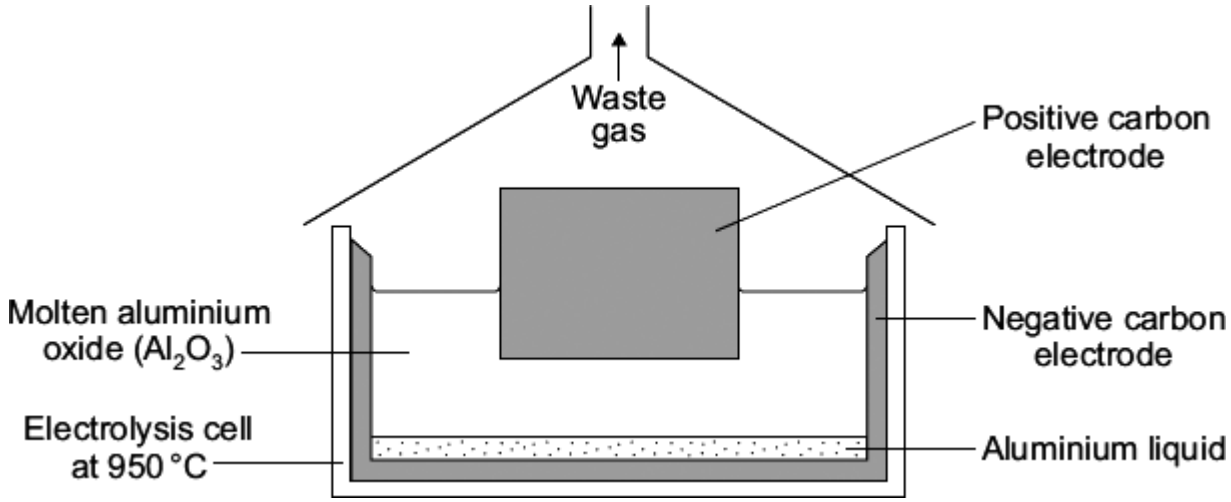
_____

_____

_____

(1)

(b) Aluminium is used for drinks cans.
Aluminium is extracted from its purified ore by electrolysis.



(i) Suggest why the aluminium produced in the electrolysis cell is a liquid.

_____

_____

(1)

(ii) In this electrolysis, aluminium and oxygen gas are produced from the aluminium oxide.

Use the information in the diagram to suggest why most of the waste gas is carbon dioxide and not oxygen.

_____

_____

_____

_____

(2)

(iii) Aluminium is the most abundant metal in the Earth's crust.

Suggest **two** reasons why we should recycle aluminium drinks cans.

1. _____

_____

2. _____

_____

(2)

(Total 7 marks)

Q43.

Titanium is used for replacement hip joints because it has a low density, is strong and does not corrode.
Titanium is extracted from titanium dioxide (TiO_2) in three stages.

(a) **Stage 1**
Titanium dioxide is converted into titanium chloride ($TiCl_4$) because the metal cannot be extracted from its oxide by *reduction* with carbon.

(i) What does *reduction* mean?

_____

_____

(1)

(ii) Balance the chemical equation for the conversion of titanium dioxide to titanium chloride.

$$TiO_2 \quad + \quad Cl_2 \quad + \quad C \quad \rightarrow \quad TiCl_4 \quad + \quad CO_2$$

(1)

(iii) Chemical equations are always balanced. Explain why.

_____

_____

_____

(1)

(b) **Stage 2**
Titanium is extracted from the titanium chloride by reacting it with sodium at 1000 °C in a reactor.
The only other substance in the reactor is argon gas.

$$TiCl_4 \quad + \quad 4Na \quad \rightarrow \quad Ti \quad + \quad 4NaCl$$

(i) What does this tell you about the reactivity of sodium compared with titanium?

_____

_____

(1)

(ii) Suggest why the reactor contains argon and **not** air.

_____

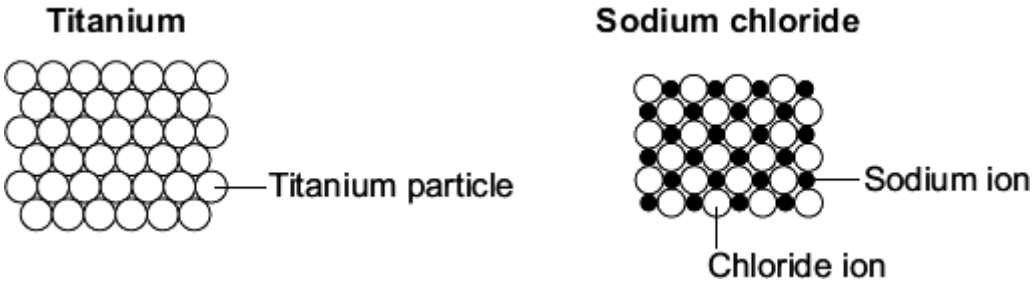
_____

(1)

(c) **Stage 3**

After **Stage 2** the titanium is separated from the products by washing out the sodium chloride with water.

The diagrams show sections through the lattice of titanium metal and the lattice of sodium chloride.



How do the diagrams show that:

(i) titanium is an element

_____

_____

(1)

(ii) sodium chloride is a compound?

_____

_____

_____

_____

(2)

(Total 8 marks)

Q44.

(a) A magnesium atom contains 12 protons (●),12 neutrons (o) and 12 electrons (x).

Which diagram, **A**, **B** or **C**, represents this magnesium atom?

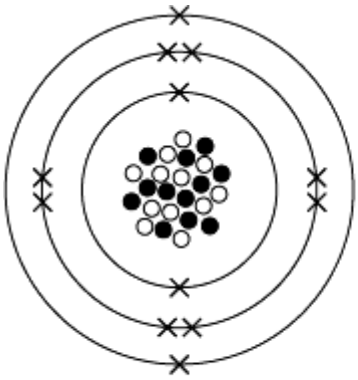


Diagram A

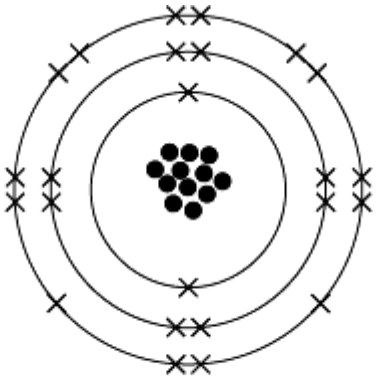


Diagram B

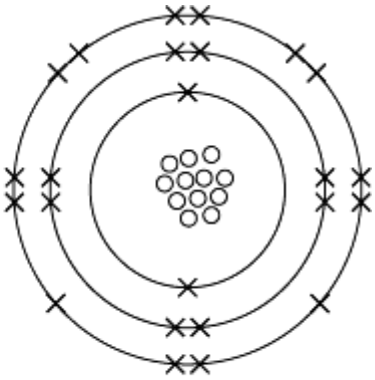
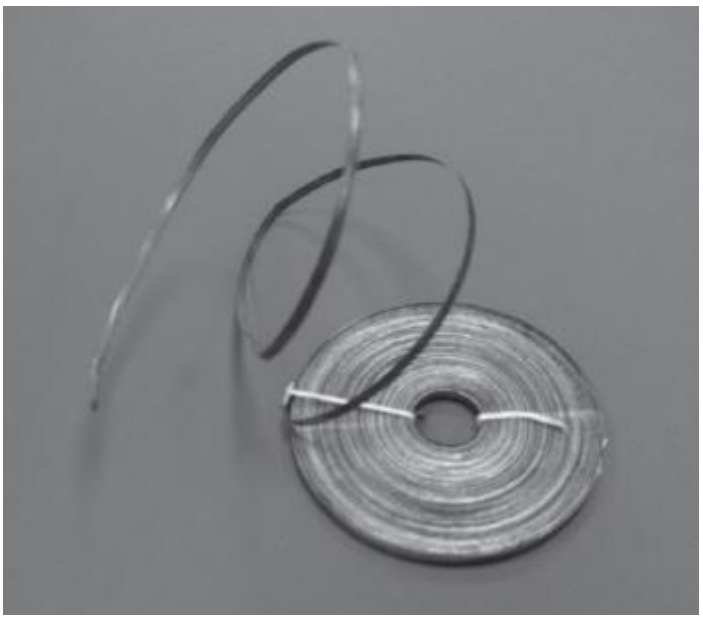


Diagram C

This magnesium atom is **Diagram** ☐

(1)

(b) Magnesium metal is shaped to make magnesium ribbon.



Tick (✓) **two** reasons which explain why metals can be shaped.

Reason why	Tick (✓)
The atoms are all joined by covalent bonds.	
The atoms can slide over each other.	
The atoms are large.	
The atoms are in layers.	

(2)

(c) Magnesium sulfate is a salt of magnesium.

It can be prepared by the reaction of magnesium metal with an acid. The equation for the reaction of magnesium with this acid is:

Mg(s)	+	H_2SO_4(aq)	→	$MgSO_4$(aq)	+	H_2(g)
magnesium		acid		magnesium sulfate solution		hydrogen

(i) Draw a ring around the name of the acid used in this reaction.

hydrochloric **nitric** **sulfuric**

(1)

(ii) Use the equation to help you to answer this question.

Tick (✓) **two** things that happen when this reaction takes place.

	Tick (✓)
Bubbles are produced.	
The magnesium disappears.	
A solid is formed.	
Water is formed.	

(2)

(iii) Draw a ring around a method to get solid magnesium sulfate from magnesium sulfate solution.

crystallisation **electrolysis** **oxidation**

(1)

(Total 7 marks)

Q45.

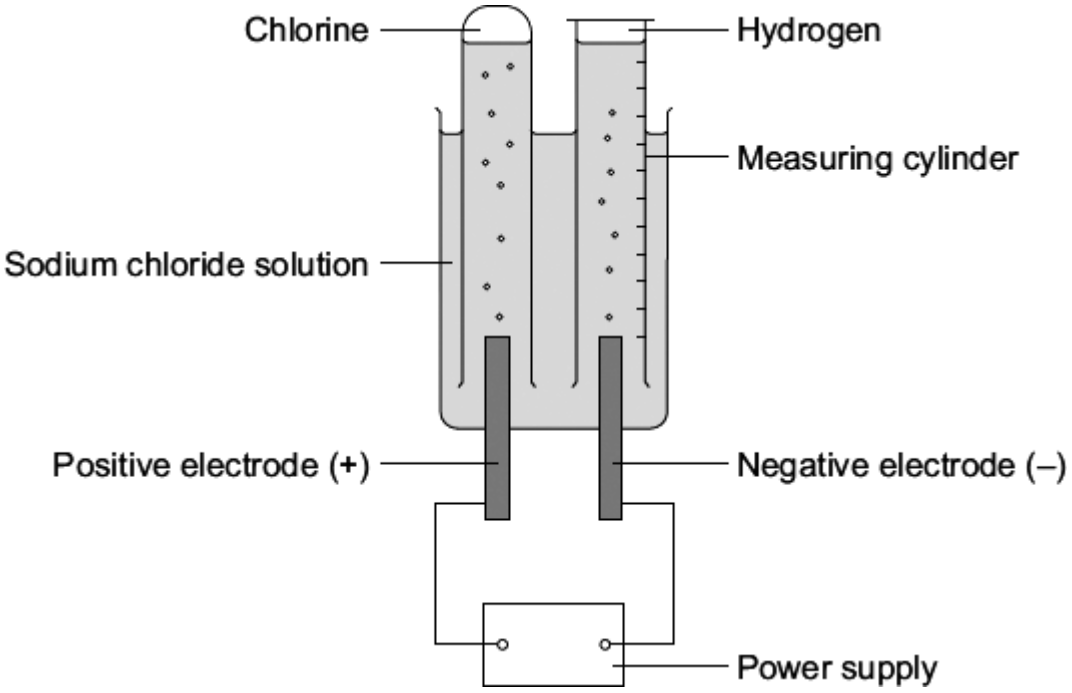
A student investigated the electrolysis of sodium chloride solution.

Five sodium chloride solutions were made. Each solution had a different concentration.

To make each solution the student:

- weighed the amount of sodium chloride needed
- dissolved it in water
- added more water until the total volume was one cubic decimetre (1 dm^3).

The solutions were placed one at a time in the apparatus shown below.



The student measured the volume of hydrogen gas produced in ten minutes.

The results are shown on the graph below.

(a) Sodium chloride does not conduct electricity when it is solid.

Explain, in terms of ions, why sodium chloride solution conducts electricity.

_____

_____

(1)

(b) Chlorine is produced at the positive electrode.

Why are chloride ions attracted to the positive electrode?

_____

(1)

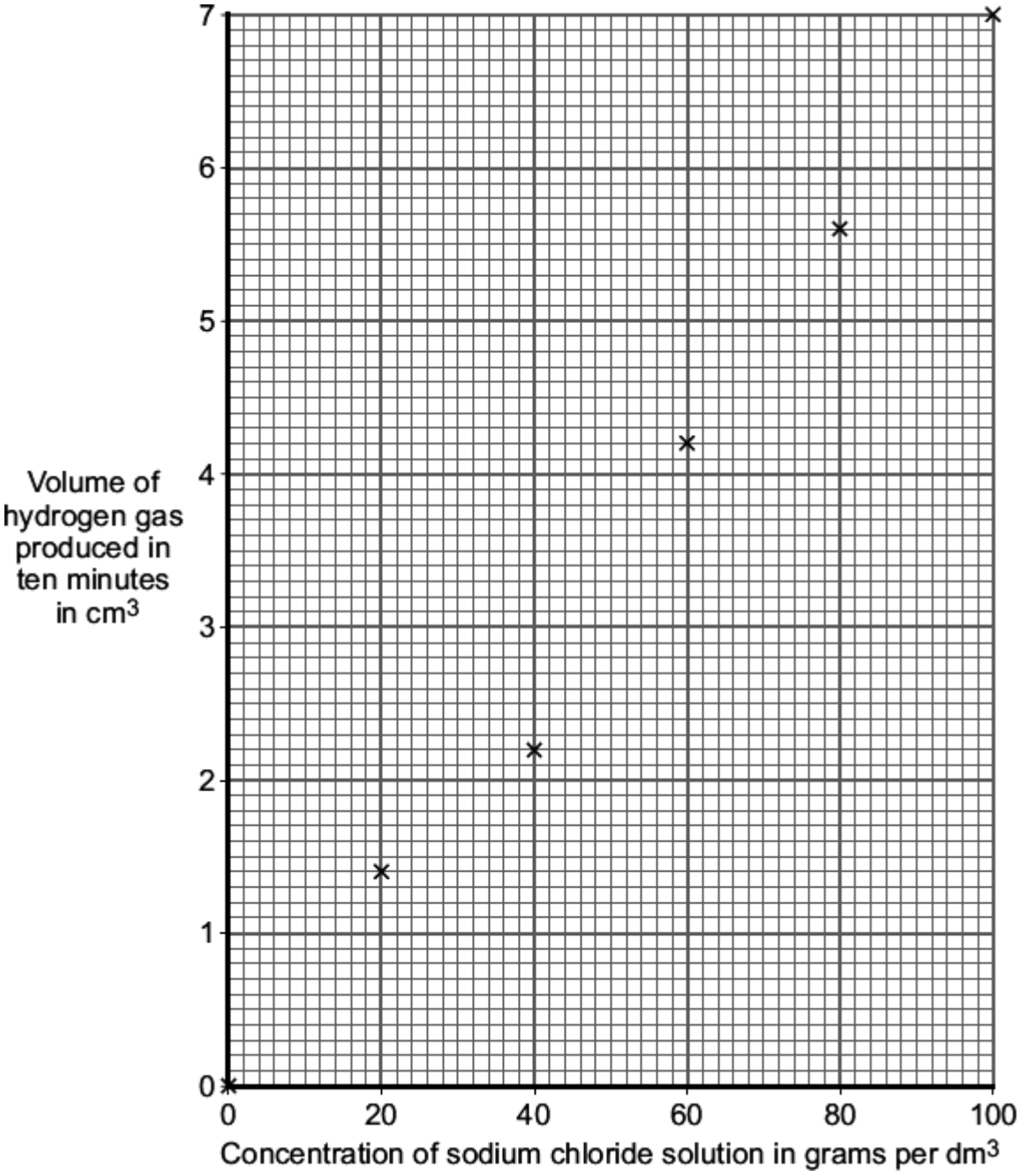
(c) The solution left at the end of each experiment contains sodium hydroxide.

Draw a ring around **one** number which could be the pH of this solution.

2 **5** **7** **13**

(1)

(d) The results for the experiment above are shown on the graph.



(i) Draw a line of best fit on the graph.

(1)

(ii) The result for one concentration is anomalous.
Which result is anomalous?

The result at concentration _____ grams per dm^3

(1)

(iii) Suggest **two** possible causes of this anomalous result.

1. _____

_____

2. _____

_____

(2)

(iv) Suggest how the student could check the reliability of the results.

_____

_____

(1)

(iv) How did an increase in the concentration of the sodium chloride solution affect the volume of hydrogen gas produced in ten minutes?

_____

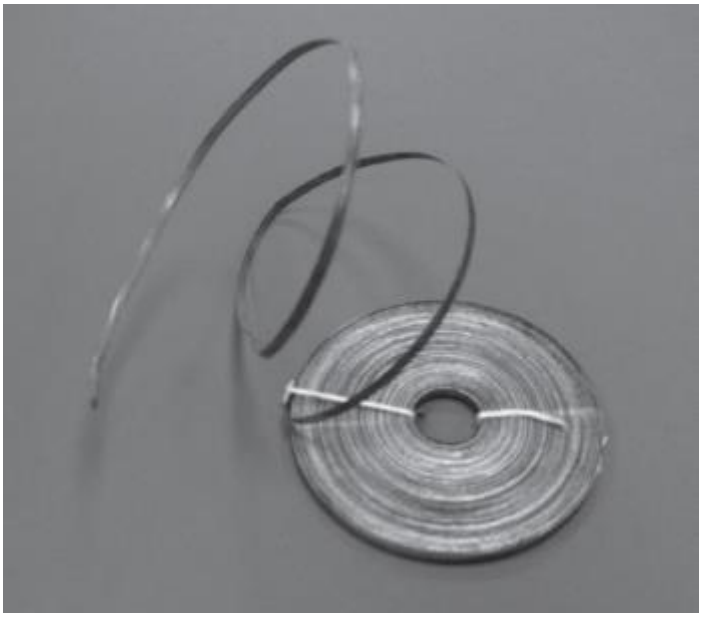
_____

(1)

(Total 9 marks)

Q46.

(a) Magnesium metal is shaped to make magnesium ribbon.



Explain why metals can be shaped.

_____

_____

_____

_____

_____

(2)

(b) Magnesium sulfate is a salt of magnesium.

It can be prepared by the reaction of magnesium metal with an acid. The equation for the reaction of magnesium with this acid is:

$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$

(i) Name the acid used to make magnesium sulfate.

_____ acid

(1)

(ii) Use the equation to help you to describe what you would **observe** when magnesium reacts with the acid.

_____

_____

_____

_____

_____

(2)

(iii) The magnesium sulfate is in solution.

How could you obtain solid magnesium sulfate from this solution?

_____

_____

(1)

(Total 6 marks)

Q47.

An ore contains zinc carbonate ($ZnCO_3$).

(a) Complete the table to show the number of atoms of each element in the formula of zinc carbonate.

Zinc has been done for you.

Element	**Number of atoms in the formula $ZnCO_3$**
Zinc, Zn	1
Carbon, C	
Oxygen, O	

(2)

(b) Draw a ring around the correct answer to complete the sentence and the word equation.

(i) Zinc carbonate decomposes in a similar way to calcium carbonate

water is added.

when | cooled. / heated.

(1)

(ii) zinc carbonate ⟶ zinc oxide + | carbon dioxide / hydrogen / oxygen |

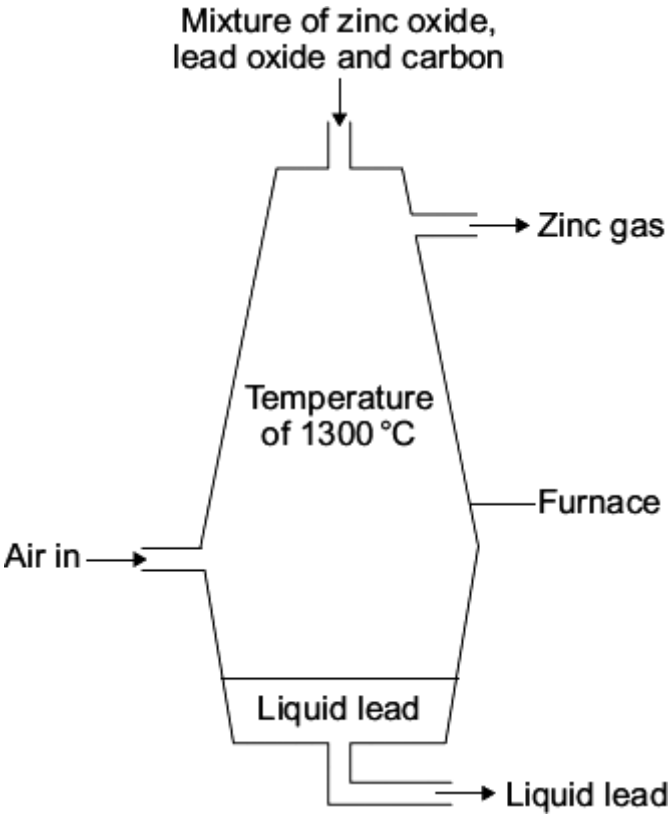
(1)

(c) Another ore contains a mixture of zinc carbonate and lead carbonate.

The metals zinc and lead are produced from this ore in two stages:

Stage 1 decomposing the carbonates to produce a mixture of zinc oxide and lead oxide.

Stage 2 mixing the oxides with carbon and heating in a furnace.



Some of the reactions in the furnace are:

zinc oxide + carbon ⟶ zinc + carbon dioxide

lead oxide + carbon ⟶ lead + carbon dioxide

carbon + oxygen ⟶ carbon dioxide

Use the information given to help you to answer these questions.

(i) Draw a ring around the correct answer to complete the sentence.

The reaction between carbon and oxygen that heats the furnace is called

combustion.
decomposition.
evaporation.

(1)

(ii) Tick (✓) **one** reason why carbon reacts with zinc oxide to produce zinc.

Reason	**Tick (✓)**
carbon is less reactive than zinc	
carbon is more reactive than zinc	
carbon is similar in reactivity to zinc	

(1)

(iii) In the furnace zinc is a gas but lead is a liquid.

Suggest why.

_____

_____

_____

_____

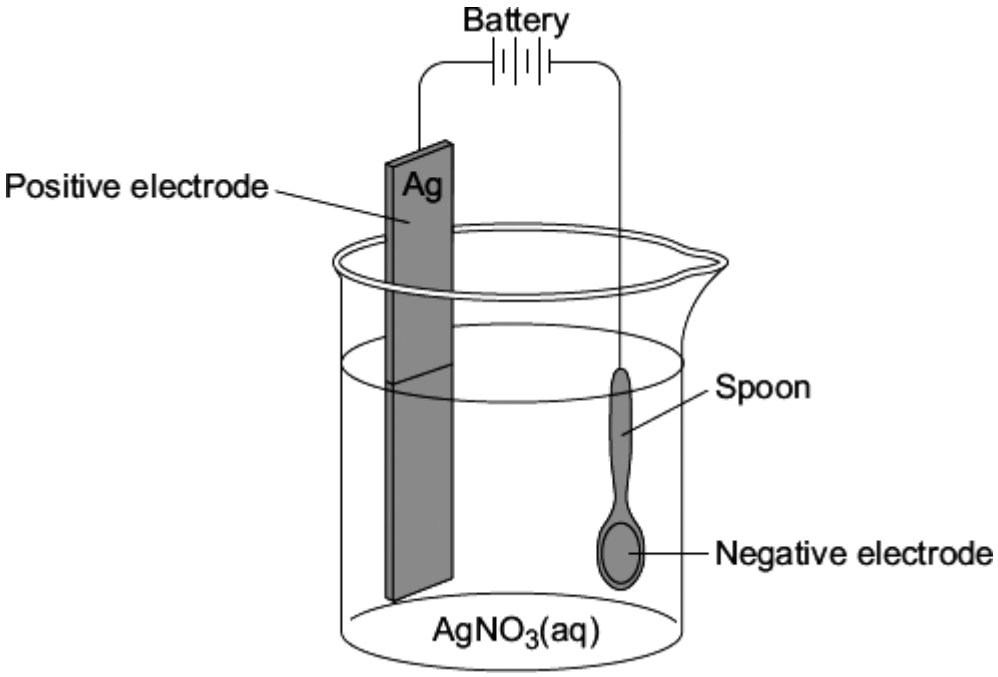
(2)

(Total 8 marks)

Q48.

Electroplating is used to coat a cheap metal with a thin layer of an expensive metal.

In the diagram a teaspoon made of nickel is being coated with silver.



Silver nitrate, $AgNO_3$, contains silver ions (Ag^+) and nitrate ions (NO_3^-).

(a) Solid silver nitrate, $AgNO_3(s)$, does **not** conduct electricity.

Choose the correct answer in the box to complete the sentence.

are too big	**cannot move**	**are too small**

Solid silver nitrate does **not** conduct electricity because the ions

_____

(1)

(b) What substance is added to $AgNO_3(s)$ to turn it into $AgNO_3(aq)$?

Draw a ring around the correct answer.

petrol **alcohol** **water**

(1)

(c) Draw a ring around the correct answer to complete each sentence.

(i) Silver ions move to the negative electrode because

they have

no charge.
a negative charge.
a positive charge.

(1)

(ii) When silver ions reach the negative electrode they turn into

atoms

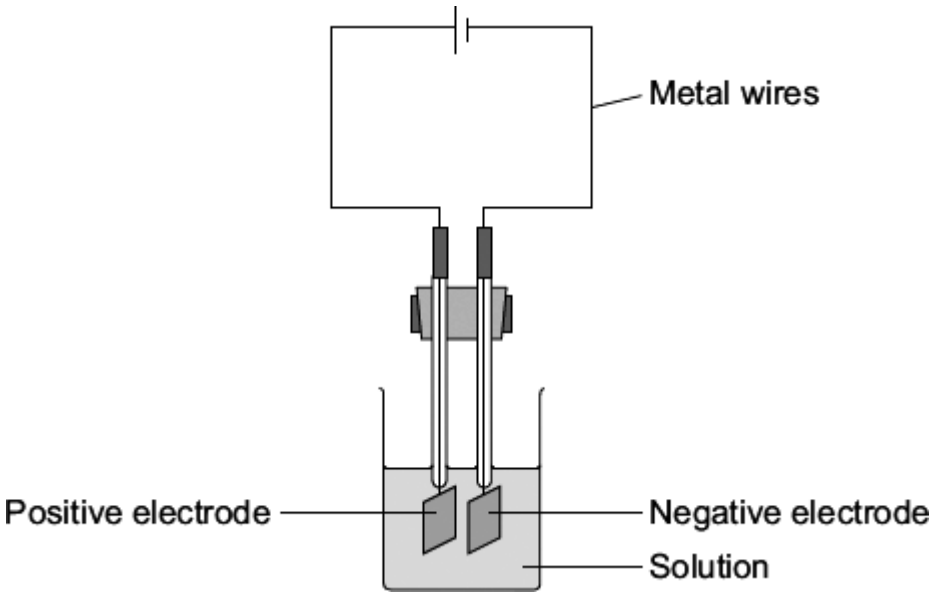
silver	compounds. molecules.

(1)

(Total 4 marks)

Q49.

The diagram shows apparatus used by a student to investigate electrolysis.



The student was given a solution by the teacher. The solution contained a mixture of ionic compounds.

(a) Name the particles which carry the electric current through:

(i) the metal wires _____

(1)

(ii) the solution. _____

(1)

(b) The table shows the ions in the solution.

Positive ions in the solution	Negative ions in the solution
Zinc ion (Zn^{2+})	Chloride ion (Cl^-)
Iron(III) ion (Fe^{3+})	Hydroxide ion (OH^-)
Hydrogen ion (H^+)	Nitrate ion (NO_3^-)
Copper(II) ion (Cu^{2+})	Sulfate ion (SO_4^{2-})

The reactivity series on the Data Sheet may help you to answer this question.

(i) Which element is most likely to be formed at the negative electrode?

_____

(1)

(ii) Explain, as fully as you can, why you have chosen this element.

_____

_____

_____

_____

(2)

(c) The electrolysis of sodium chloride solution is an industrial process.

(i) The reaction at one of the electrodes can be represented by the equation shown below.

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

The chloride ions (Cl^-) are oxidised.

Explain why.

_____

_____

(1)

(ii) The reaction at the other electrode can be represented by an equation.

Complete and balance the equation for the reaction at the other electrode.

$$H^+ \rightarrow H_2$$

(1)

(Total 7 marks)

Q50.

Humberstone was a town in the desert of Northern Chile in South America. It was built for the people who worked in the nearby sodium nitrate mines.

The sodium nitrate was used as a fertiliser.

The sodium nitrate was exported by ship to countries all around the world.

Today the mines have closed and nobody lives in Humberstone.

One of the reasons for the mines closing was the invention of the Haber process.

By Sznegra (Own work) [CC-BY-SA-3.0], via Wikimedia Commons

(a) The Haber process is used to make ammonia (NH_3).

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

The forward reaction is exothermic.

(i) Name the raw materials that are used to supply the nitrogen and hydrogen.

Nitrogen _____

Hydrogen _____

(2)

(ii) The Haber process uses a temperature of 450 °C.

Explain, as fully as you can, why a temperature of 450 °C is used rather than a much higher temperature or a much lower temperature.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(iii) Ammonia can be converted to ammonium nitrate by adding an acid.

Name this acid.

_____

(1)

(b) Suggest and explain why the invention of the Haber process caused the closure of the Humberstone mines in Chile.

_____

_____

_____

_____

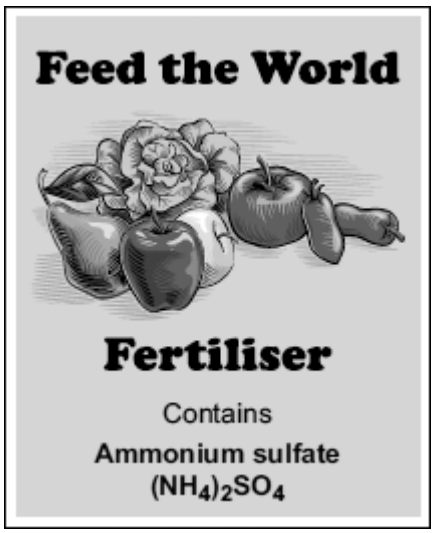
_____

(2)

(Total 8 marks)

Q51.

Ammonium sulfate is an artificial fertiliser.



(a) A student tested this fertiliser to prove that it contained ammonium ions and sulfate ions.

Draw a ring around the correct answer to complete each sentence.

(i) Test for ammonium ions (NH_4^+).

The student added | sodium chloride solution / sodium hydroxide solution / dilute sulfuric acid | to the fertiliser.

A gas called ammonia was produced.

Ammonia turns damp litmus paper | blue. / green. / red.

(2)

(ii) Test for sulfate ions (SO_4^{2-}).

The student added [barium chloride / silver nitrate / sodium chloride] solution to a solution of the fertiliser.

A [blue / red / white] precipitate was formed.

(2)

(b) Ammonium sulfate is made by reacting sulfuric acid with ammonia solution.

Sulfuric acid is a *strong* acid.

Draw a ring around the correct answer to complete the sentence.

The word *strong* means that the acid is [difficult to break. / very concentrated. / fully ionised in water.]

(1)

(c) Use the information about acids in the table to help you answer these questions.

Name of chemical	**Ions produced in aqueous solution**		**pH**	**Universal Indicator added**
Ethanoic acid	H^+	CH_3COO^-	5	Goes orange
Sulfuric acid	H^+	SO_4^{2-}	1	Goes red

Draw a ring around the correct answer to complete each sentence.

(i) Sulfuric acid and ethanoic acid are both acids because

they contain [CH_3COO^- ions. / H^+ ions. / SO_4^{2-} ions.]

(1)

(ii) Sulfuric acid is a stronger acid than ethanoic acid.

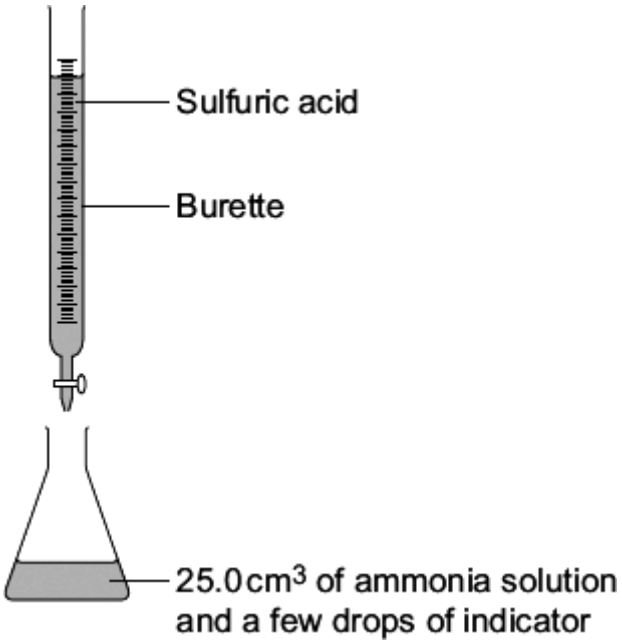
[higher than

The pH of stronger acids is	lower than the same as	the pH of weaker acids.

(1)

(d) The volume of sulfuric acid that reacts with 25.0 cm^3 of ammonia solution can be found by titration.

The diagram shows the apparatus used for the titration.



A student did the titration five times and recorded the following results.

Titration	1	2	3	4	5
Volume of acid added in cm^3	13.3	13.9	13.2	13.1	13.2

(i) How did the student know when enough sulfuric acid had been added to neutralise the ammonia solution?

_____

_____

(1)

(ii) The student did **not** use one of the results because it was anomalous.

Which result was anomalous? _____

(1)

(iii) Use the **other** four results to calculate the mean volume of sulfuric acid that reacted with the ammonia.

_____

_____

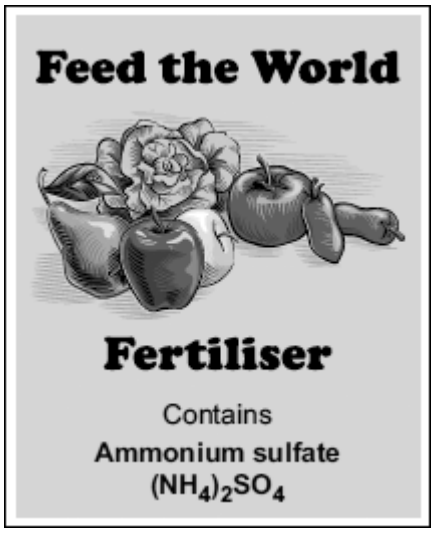
Mean volume = _____ cm^3

(1)

(Total 10 marks)

Q52.

Ammonium sulfate is an artificial fertiliser.



(a) (i) When this fertiliser is warmed with sodium hydroxide solution, ammonia gas is given off.
Describe and give the result of a test for ammonia gas.

Test _____

_____

Result _____

_____

(2)

(ii) Describe and give the result of a chemical test to show that this fertiliser contains sulfate ions (SO_4^{2-}).

Test _____

_____

Result _____

_____

(2)

(b) Ammonium sulfate is made by reacting sulfuric acid (a *strong* acid) with ammonia solution (a *weak* alkali).

(i) Explain the meaning of *strong* in terms of ionisation.

_____

(1)

(ii) A student made some ammonium sulfate in a school laboratory.

The student carried out a titration, using a suitable indicator, to find the

volumes of sulfuric acid and ammonia solution that should be reacted together.

Name a suitable indicator for strong acid-weak alkali titrations.

_____

(1)

(iii) The student found that 25.0 cm^3 of ammonia solution reacted completely with 32.0 cm^3 of sulfuric acid of concentration 0.050 moles per cubic decimetre.

The equation that represents this reaction is:

$$2H_2SO_4(aq) + 2NH_3(aq) \rightarrow (NH_4)_2SO_4\ (aq)$$

Calculate the concentration of this ammonia solution in moles per cubic decimetre.

_____

_____

_____

_____

_____

Concentration = _____ moles per cubic decimetre

(3)

(iv) Use your answer to (b)(iii) to calculate the concentration of ammonia in grams per cubic decimetre.

(If you did not answer part (b)(iii), assume that the concentration of the ammonia solution is 0.15 moles per cubic decimetre. This is **not** the correct answer to part (b)(iii).)

Relative formula mass of ammonia (NH_3) = 17.

_____

_____

_____

Concentration = _____ grams per cubic decimetre

(2)

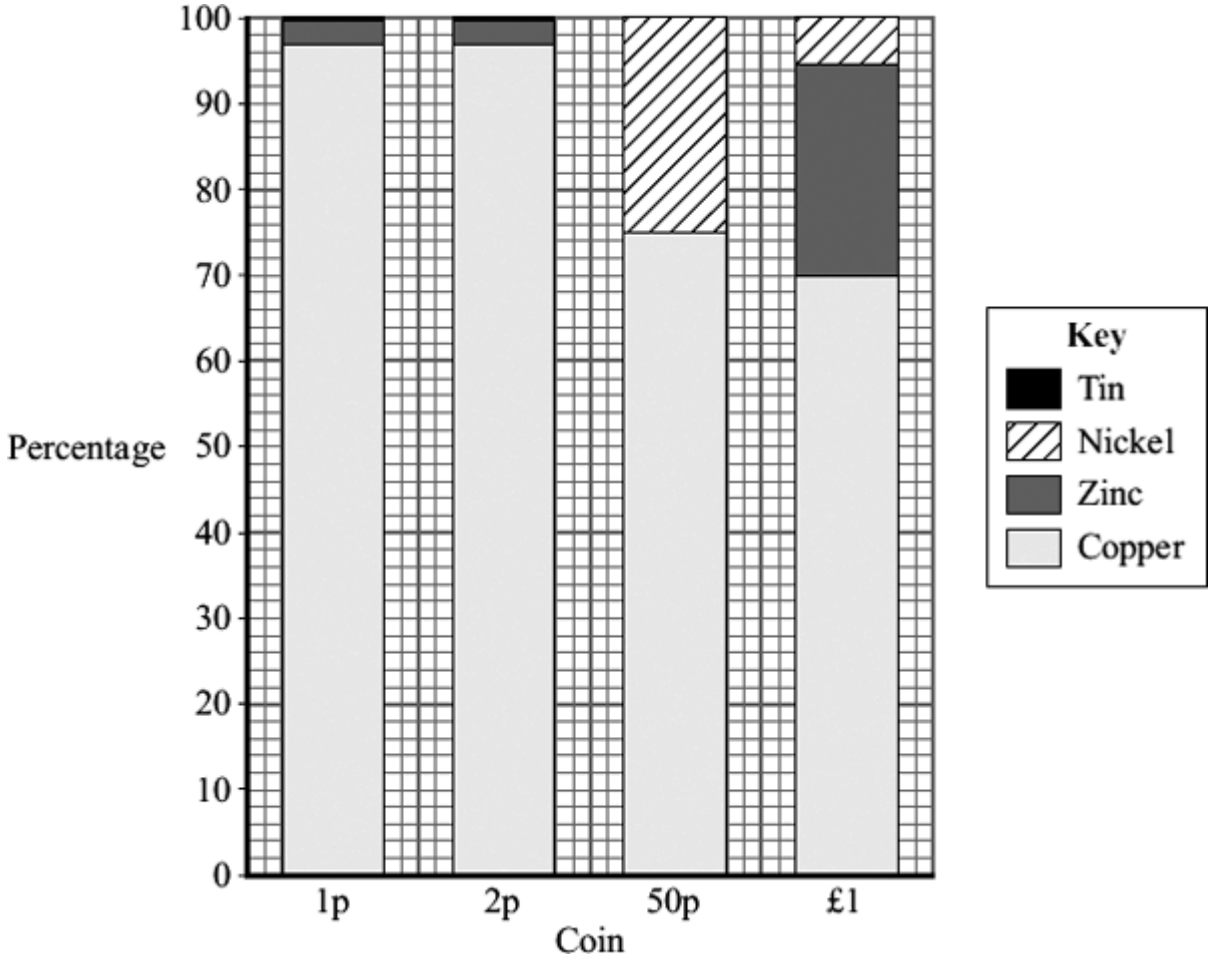
(Total 11 marks)

Q53.

This is the headline from a newspaper:

‘Why is a 2p coin worth 3.3p?’

(a) The bar chart shows the percentages of metals in UK coins in 1991.



Use the bar chart to answer these questions.

(i) Which metal is in all of these coins?

_____

(1)

(ii) Which coin does **not** contain zinc?

_____

(1)

(iii) What is the percentage of nickel in a 50p coin?

Percentage = _____ %

(1)

(iv) Draw a ring around the correct metal to complete the sentence.

Pure copper is too soft to be used for 1p and 2p coins.

Copper is mixed with zinc and | nickel / tin / iron | for 1p and 2p coins.

(1)

(b) The value of the metal in 2p coins which were made in 1991 is now 3.3p.

(i) Suggest why a 2p coin made in 1991 is worth 3.3p.

_____

_____

_____

(1)

(ii) Suggest why copper-plated steel is now used for 1p and 2p coins.

_____

_____

_____

(1)

(Total 6 marks)