Candidate Name	Centre Number					Candidate Number				

GCSE COMBINED SCIENCE

COMPONENT 2

Concepts in Chemistry

FOUNDATION TIER

SAMPLE PAPER

(1 hour 45 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1	**9**	
2	**3**	
3	**6**	
4	**8**	
5	**8**	
6	**7**	
7	**9**	
8	**11**	
9	**6**	
10	**12**	
11	**11**	
Total	**90**	

ADDITIONAL MATERIALS

In addition to this examination paper you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

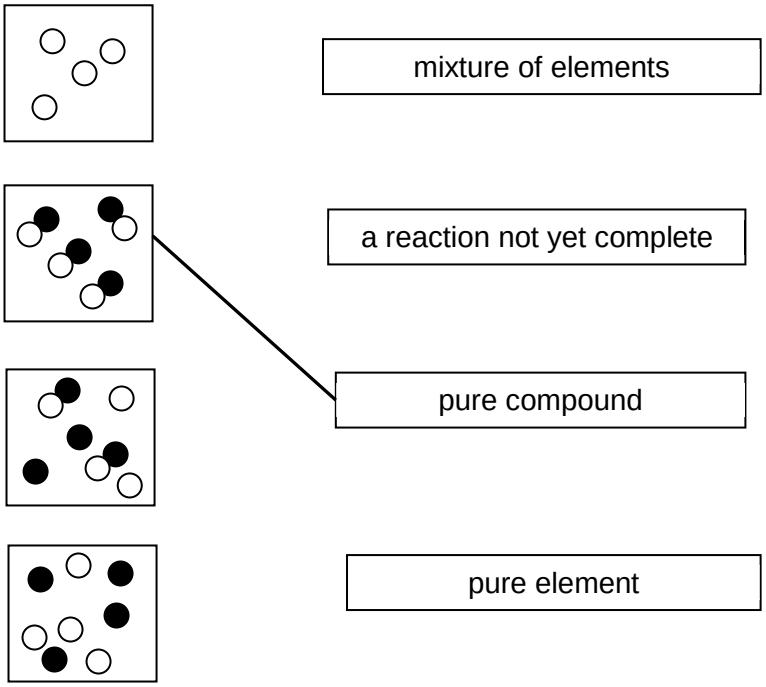
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

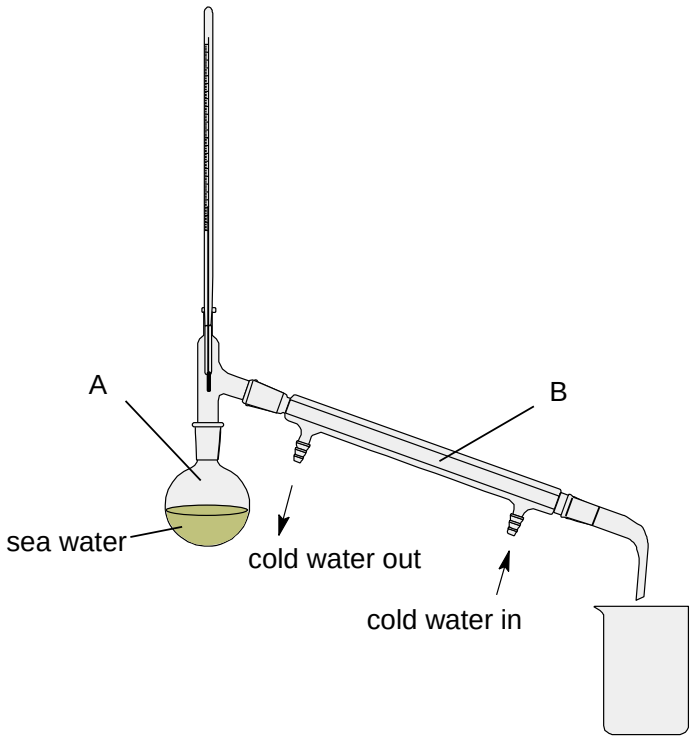
The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question **9.**

Answer **all** *questions.*

1. (a) Draw lines to match each diagram below with the correct description. One has been done for you. [2]



(b) The following diagram shows the apparatus that can be used to collect pure water from sea water.



(i) Underline the name given to this method of separation. [1]

distillation **filtration** **crystallisation**

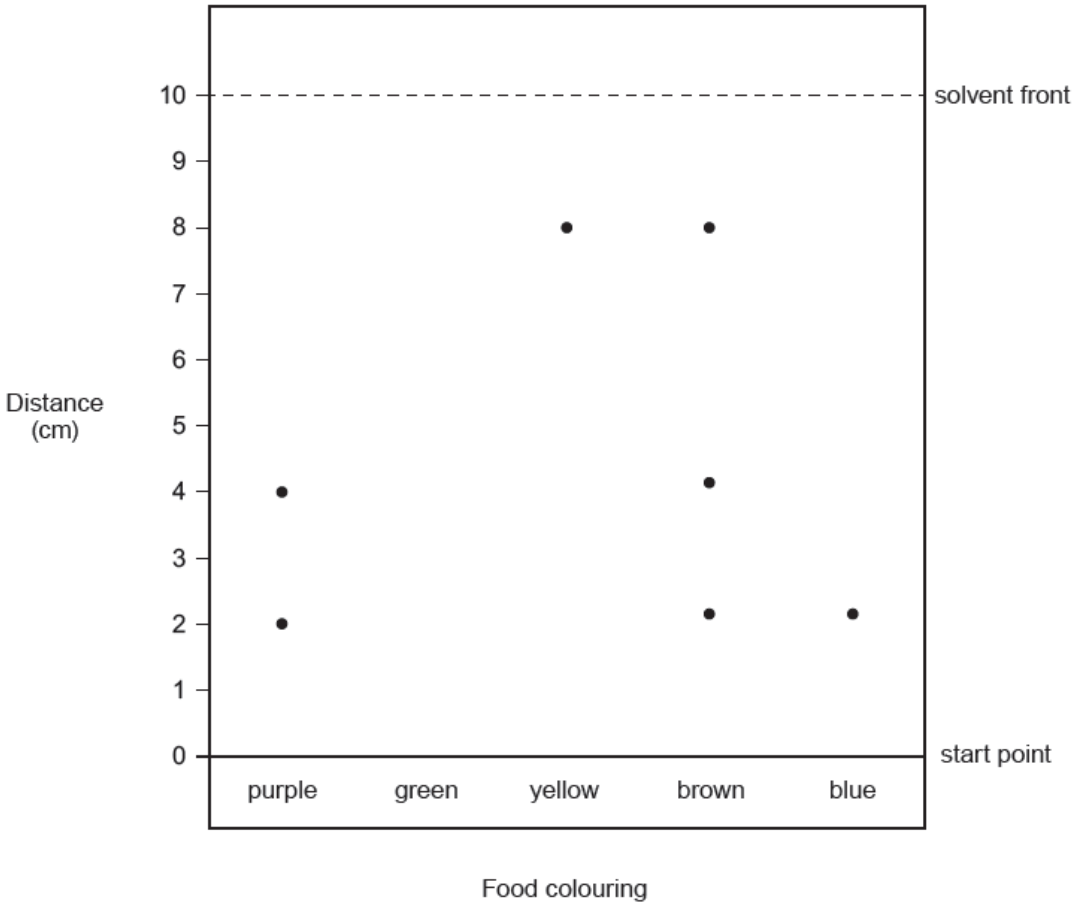
(ii) Choose from the box below, the changes of state that take place at **A** and **B** in the apparatus. [2]

boiling	**freezing**	**condensing**	**melting**

A .....

B .....

(c) Paper chromatography was used to show the pigments present in different food colourings.



(i) Give the **two** food colourings that are mixed to make **brown** food colouring. [1]

..…….. and ……..……..

(ii) Green food colouring is made by mixing together blue and yellow food colourings.
Draw on the diagram the result that you would expect to see for the green food colouring. [1]

(iii) The R_f value of a substance can be used to identify that substance. The R_f value for the pigment in red food colouring is 0.4.

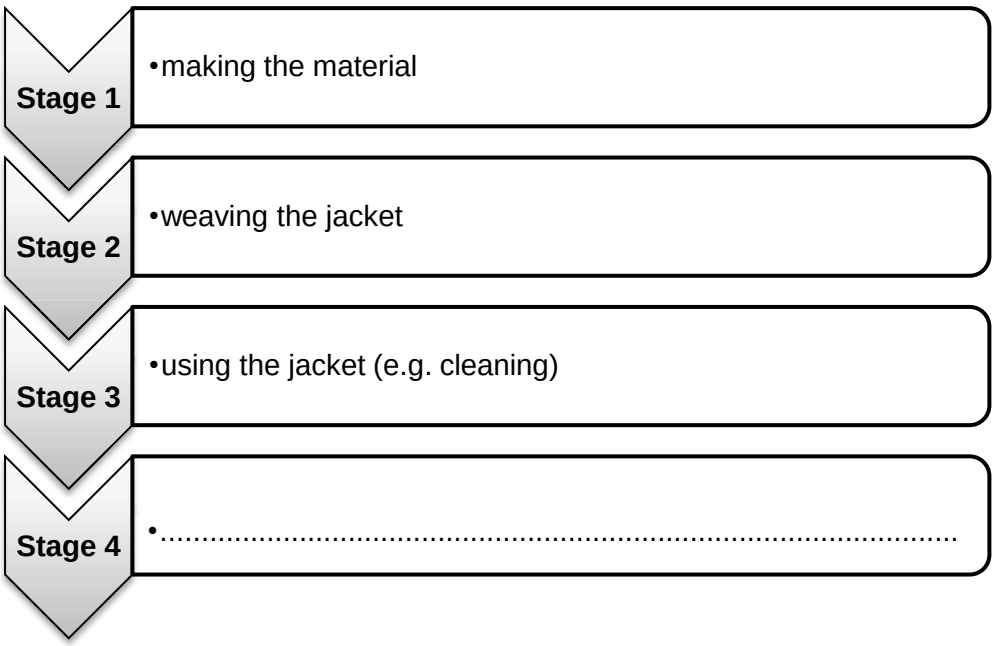
Use the equation below to calculate the distance this red food colouring would have moved on the diagram. [2]

distance moved = R_f × distance moved by the solvent

distance moved = …… cm

9

2. (a) Life cycle assessment (LCA) is used to measure the impact of a product on the environment. The diagram below shows the main stages of the LCA of a jacket.



Add the correct statement from the box below to **Stage 4** of the LCA. [1]

disposing of the jacket	**buying the jacket**	**designing the jacket**

(b) Jackets can be made from either cotton or polyester.

The table below gives data for the complete life cycle assessment of jackets made from cotton and polyester.
Use this information to answer the following question.

Factor	Polyester per kg	Cotton per kg
energy used (MJ)	171.3	140.1
fuel (oil or gas) used (kg)	1.53	0
fertilisers used (kg)	0	467
emissions:		
carbon dioxide (kg)	3.8	5.3
sulfur dioxide (g)	0.2	4.0
water used (dm^3)	1 900	26 700

Give **one** advantage and **one** disadvantage of using cotton rather than polyester to make jackets. [2]

Advantage: ……

……

Disadvantage: ……

……

3

3. (a) Crude oil is an important raw material obtained from the Earth's crust. It is formed from the remains of simple marine organisms.

(i) **Circle** below the time it takes to form crude oil. [1]

hundreds of years **millions of years** **tens of years** **thousands of years**

(ii) Choose from the box the name given to the type of compound present in crude oil. [1]

hydrocarbons	**monomers**	**plastics**	**polymers**

Answer ……

(b) A barrel of crude oil contains 42 gallons. It is separated into fractions which have different uses. The following table shows the amount of each fraction obtained from this barrel.

Fraction obtained	Number of gallons obtained from this 42 gallon barrel
gases	2.9
petrol	21.0
kerosene	……
diesel fuel	8.6
lubricants	0.6
fuel oil	3.7
bitumen	1.2

(i) Use the figures in the table to calculate the number of gallons of kerosene that are obtained from this barrel. Show your working. [2]

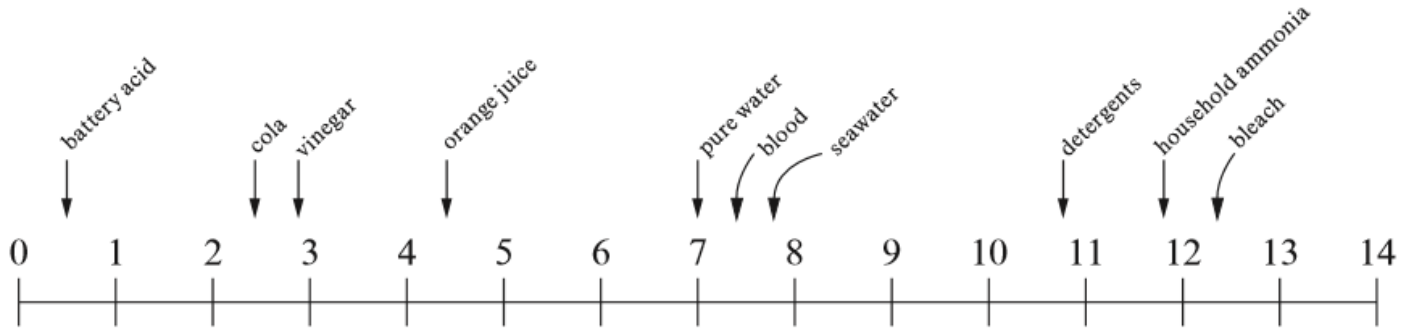
number of gallons = ……

(ii) Calculate the percentage of petrol present in this barrel of crude oil. Show your working. [2]

percentage of petrol = …….. %

6

4. (a) The following diagram shows the pH values of some common substances.



Complete the following table by choosing the substance that matches each description. [2]

Description	Substance
the strongest acid	
a neutral substance	

(b) John added hydrochloric acid to three different substances **A**, **B** and **C**. He recorded his observations and temperature changes in a table.

Substance	Observations	Temperature change (°C)
A	bubbles of gas produced the gas turned limewater milky a blue solution formed	+4
B	no gas produced a blue solution formed	0
C	no visible change	+8

Identify **A**, **B** and **C** from the substances in the box. [3]

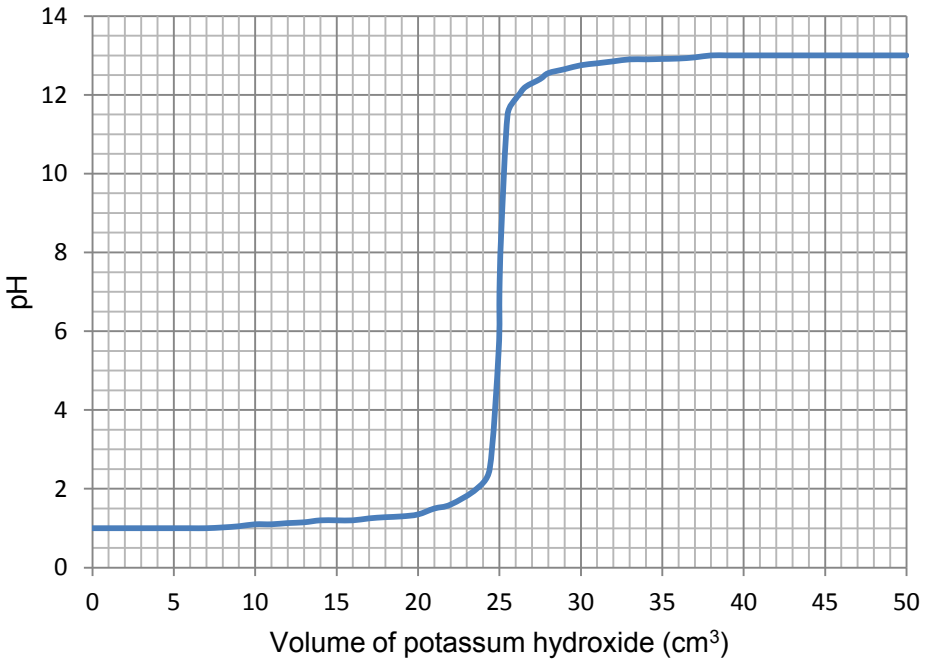
copper(II) carbonate	**copper(II) oxide**	**magnesium**
copper(II) chloride	**copper**	**sodium hydroxide**

A ……

B ……

C ……

(c) Syra investigated how pH changed during the reaction between hydrochloric acid and potassium hydroxide.
She slowly added potassium hydroxide solution to 25 cm^3 of dilute hydrochloric acid and recorded the pH using a pH sensor.
Her results are shown in the graph.



(i) Use the graph to find the pH of the hydrochloric acid before any potassium hydroxide was added. [1]

……

(ii) Use the graph to find the volume of potassium hydroxide required to neutralise the acid. [1]

…… cm^3

(iii) Give **one** advantage of using a pH sensor to investigate changes in pH. [1]

.....

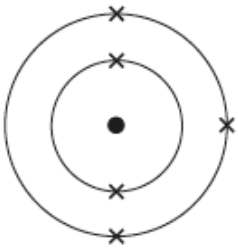
.....

8

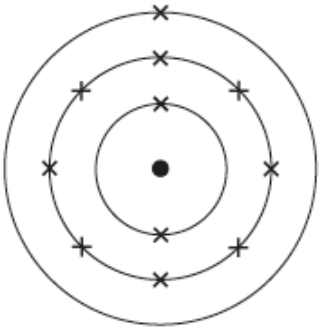
5. (a) The following diagrams represent atoms of 5 different elements, **A**, **B**, **C**, **D** and **E**.

A, **B**, **C**, **D** and **E** are **not** chemical symbols.

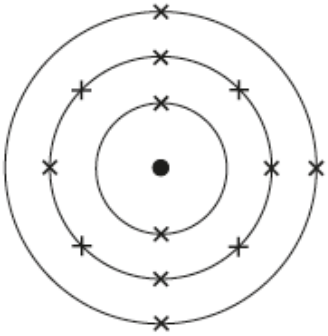
A



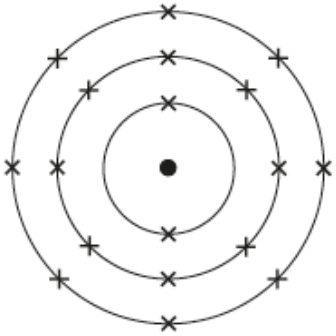
B



C



D



E

(i) Give the electronic structure of **E.** ……..…….. [1]

(ii) Which **letter** represents aluminium? ..... [1]

(iii) Give the letters of the **two** elements which are found in the same group of the Periodic Table and give a reason for your choice. [2]

.....

.....

(b) (i) Calculate the relative formula mass (M_r) of sodium carbonate, Na_2CO_3. [2]

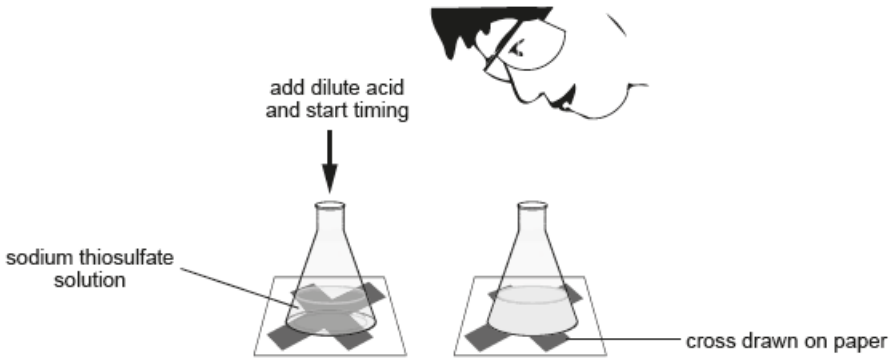
relative formula mass = ……

(ii) Using your answer to part (i), calculate the percentage by mass of oxygen in sodium carbonate, Na_2CO_3. [2]

percentage by mass of oxygen = …….. %

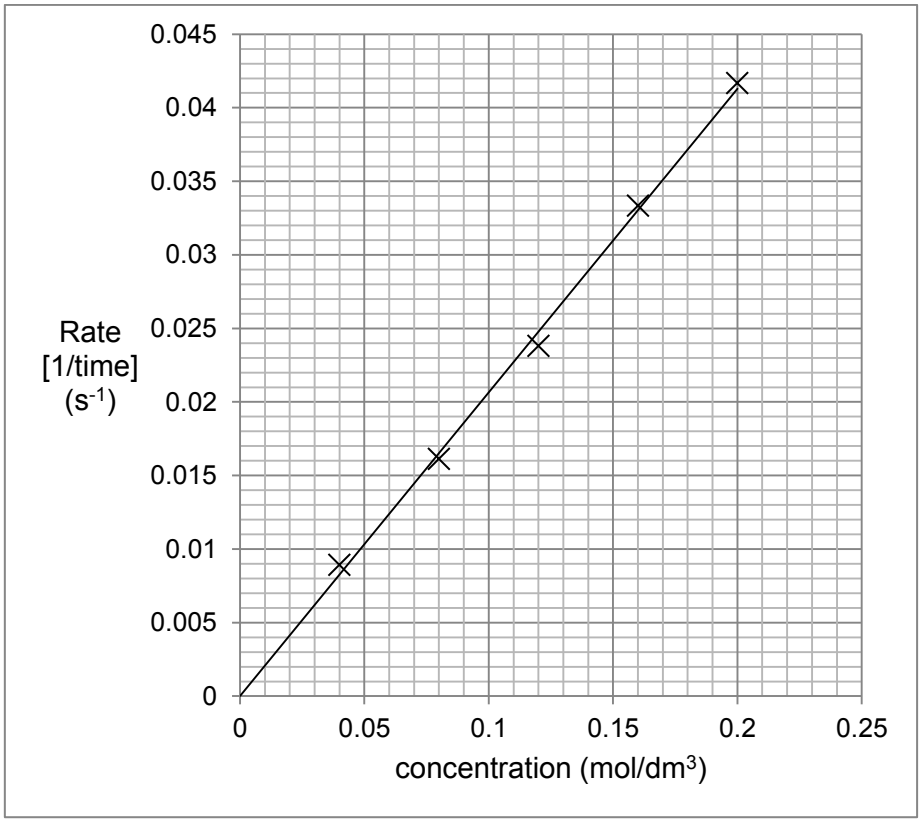
8

6. When sodium thiosulfate solution reacts with dilute acid, the solution becomes cloudy. The rate of reaction can be measured using the 'disappearing cross' method.



(a) Katie studied the effect of concentration of sodium thiosulfate on the rate of the reaction.
Her results table and the graph she plotted are shown below.

Concentration	Time for cross to disappear (s)	Rate 1/time (s^{-1})
0.2	24	0.042
0.16	30	0.033
0.12	42	0.024
0.08	62	0.016
0.04	112	0.009



(i) I Write down the intercept on the *y*-axis of the straight line in Katie's graph. [1]

intercept = …….

II Katie measured the gradient of the line in the graph to be **0.2**.
Show that her value is correct to one decimal place.
You must show your workings. [1]

`

III **Circle** the equation of the straight line in Katie's graph. [1]

A rate = concentration + 0.2

B rate = 0.2 x concentration

C concentration = 0.2 x rate

D concentration = rate + 0.2

(ii) I Katie predicts the **reaction rate** to be **0.052 s^{-1}** when the concentration of the thiosulfate is 0.25 mol/dm^3.
Estimate how long it would take for a cross to disappear at this concentration. Your estimate should be to the nearest whole number.
Show your workings.

[2]

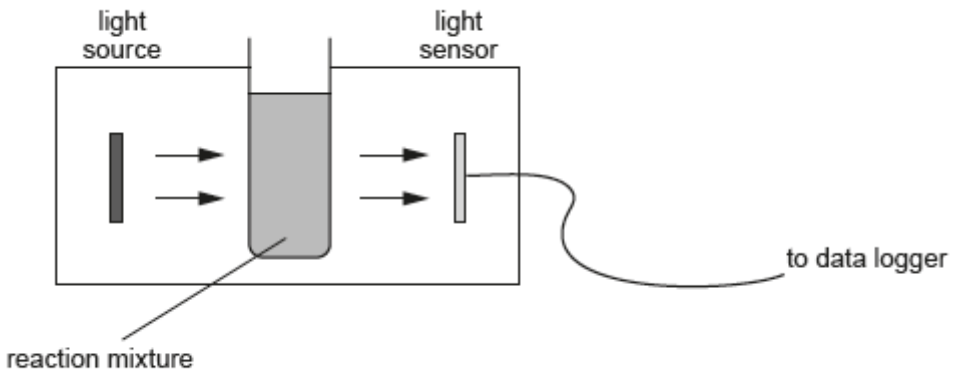
time = …….s

II Give **one** reason why this value is unlikely to be exactly the same as the one measured experimentally. [1]

……

……

(b) Another pupil used a light sensor and data logger to study the reaction.



Describe **one** advantage of using the light sensor and data logger to follow the rate of reaction in preference to judging the disappearance of the cross by eye. [1]

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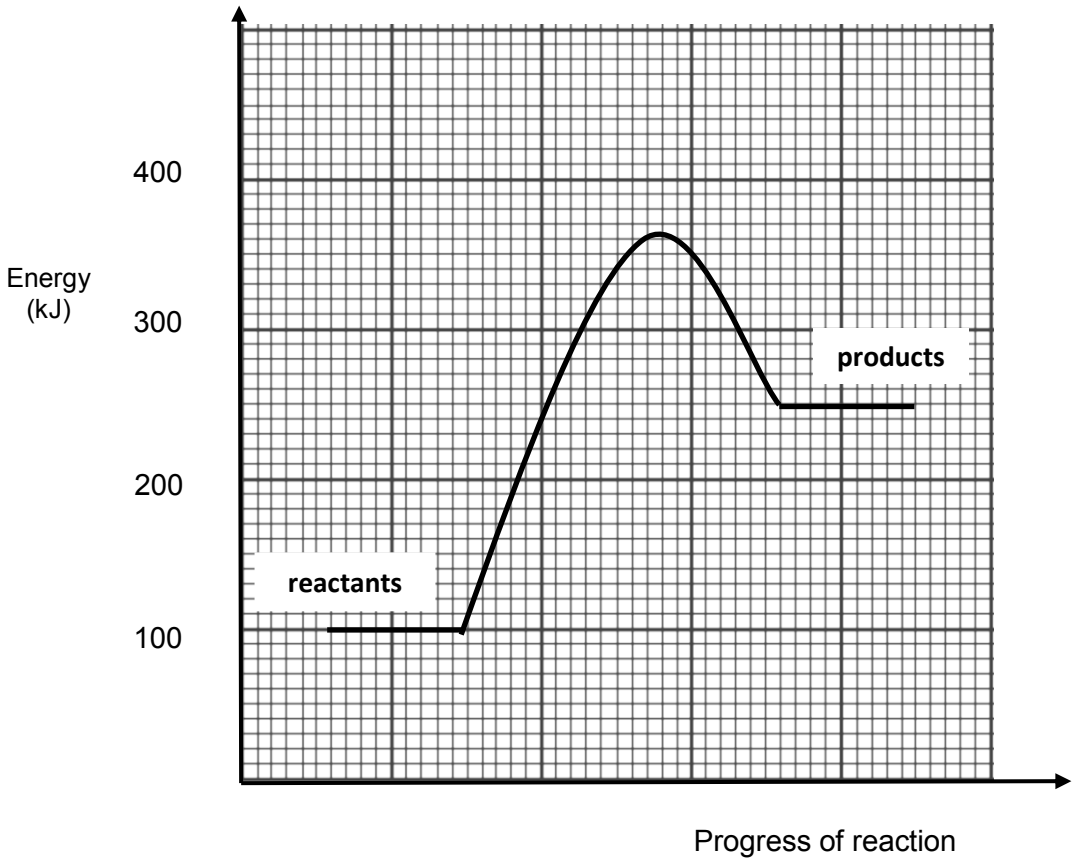
7

7. Reactions can be described as either being exothermic or endothermic, depending upon whether they give out or take in heat.
The grid below shows the energy profile diagram of an endothermic reaction.



(a) (i) Use the diagram to calculate the activation energy for the reaction. [2]

activation energy = …… kJ

(ii) Put a tick(✓) in the box next to the statement which describes an endothermic reaction. [1]

energy of the reactants < energy of products ☐

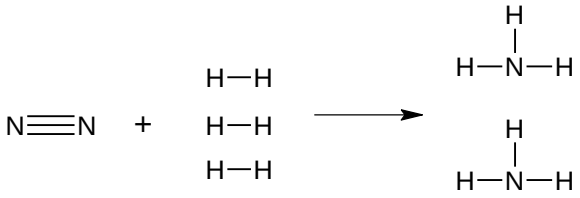
energy of the reactants > energy of products ☐

energy of reactants = energy of products ☐

energy of the products ~ energy of reactants ☐

(b) **Sketch on the diagram** the energy profile that you would expect to see if the reaction were carried out using a catalyst. [2]

(c) When chlorine reacts with hydrogen, hydrogen chloride is formed.



The relative energies of these bonds are given in the table below.

Bond	Bond energy (kJ)
H – H	436
N≡N	941
N—H	391

(i) Calculate the energy needed to break all the bonds in the reactants.[1]

energy needed = ……. kJ

(ii) Calculate the energy released when all the bonds in the product are formed. [1]

energy released = ……. kJ

(iii) Calculate the overall energy change for the reaction. State whether the reaction is exothermic or endothermic and give a reason for your answer. [2]

energy change = ... kJ

.....

.....

8. (a) Atoms consist of particles called protons, neutrons and electrons.
Complete the table below. [2]

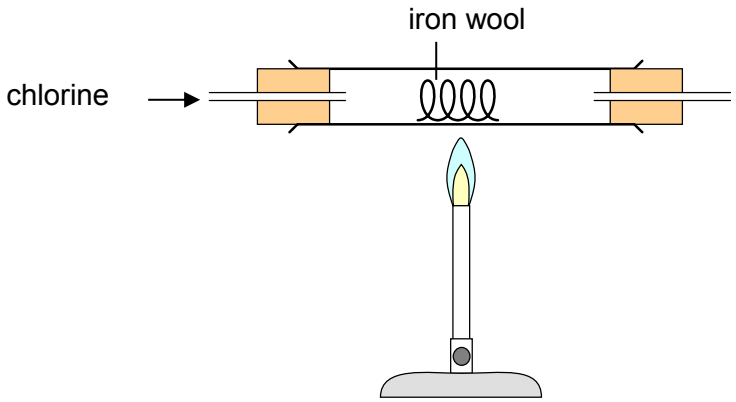
Particle	Mass	Charge
proton	1	positive (+)
neutron	.....	neutral (0)
electron	negligible	.....

(b) Potassium is represented as $^{39}_{19}\mathrm{K}$.
Element X has 9 electrons, 10 neutrons and 9 protons.

Write the information for element X in the same form as above. [1]

$$\overset{.....}{\underset{.....}{\mathrm{X}}}$$

(c) The diagram below shows chlorine gas passing over hot iron wool.



(i) Iron turns into iron(III) chloride.
Iron(III) chloride contains Fe^{3+} and Cl^- ions.

Write the formula for iron(III) chloride. ……. [1]

(ii) Give the reason why the experiment is carried out in a fume cupboard. [1]

…..……...

(iii) Give the name of a Group 7 element that will react more vigorously with iron. Give a reason for your choice. [2]

.....

.....

(iv) Sodium also reacts with chlorine.
Put a tick (✓) in the box next to the correct equation for this reaction.
[1]

Na	+	Cl	⟶	NaCl	☐
Na	+	Cl_2	⟶	$NaCl_2$	☐
2Na	+	Cl_2	⟶	2NaCl	☐
2Na	+	2Cl	⟶	2NaCl	☐

(d) The labels on sodium and potassium bottles have come off.
Describe an experiment a technician could carry out to identify the metals in each bottle.
Include the observations the technician will use to identify each metal.
[3]

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11

9. Elements can be classified as metals or non-metals. The table below describes some physical properties of silicon.

Element	**Melting point (°C)**	**Boiling point (°C)**	**Appearance**	**Density (g/cm^3)**	**Electrical conductivity**	**Behaviour when hit with a hammer**
silicon	1414	3265	shiny	2.3	good	brittle

Note: The density of iron is 7.9 g/cm^3 while that of phosphorus is 1.8 g/cm^3.
Use **all** the information above to discuss the classification of silicon. [6 QER]

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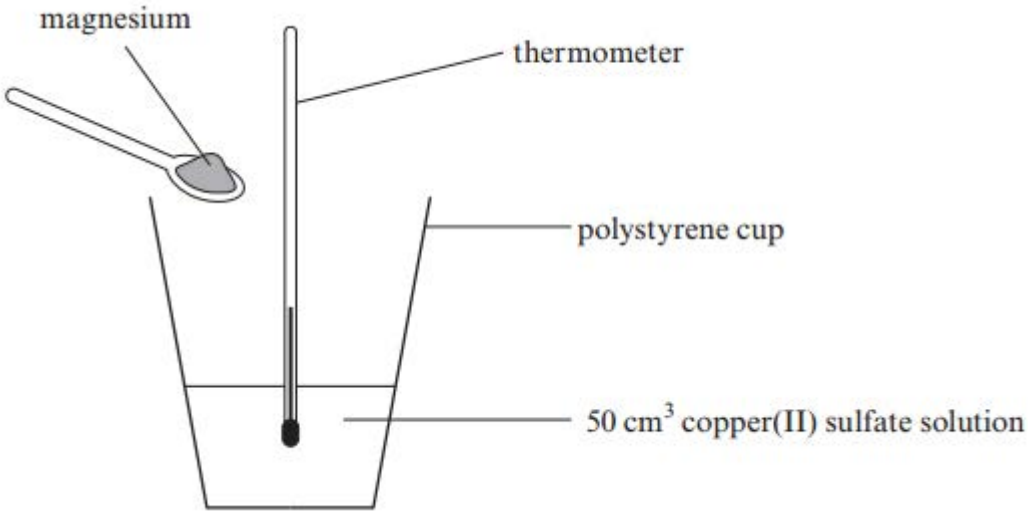
10. Four pupils investigated the temperature change which occurred when powdered magnesium was added to 50 cm^3 of copper(II) sulfate solution in a polystyrene cup.



- In the first experiment, each pupil weighed 0.2 g of magnesium.
- 50 cm^3 of copper(II) sulfate solution was then added to a polystyrene cup and the temperature of the solution recorded.
- Magnesium was then added to the solution while the polystyrene cup was swirled. The maximum temperature rise was recorded.
- The experiment was repeated using 0.4, 0.6, 0.8 and 1.0 g of magnesium powder with new copper(II) sulfate solution each time.

The table shows the results recorded.

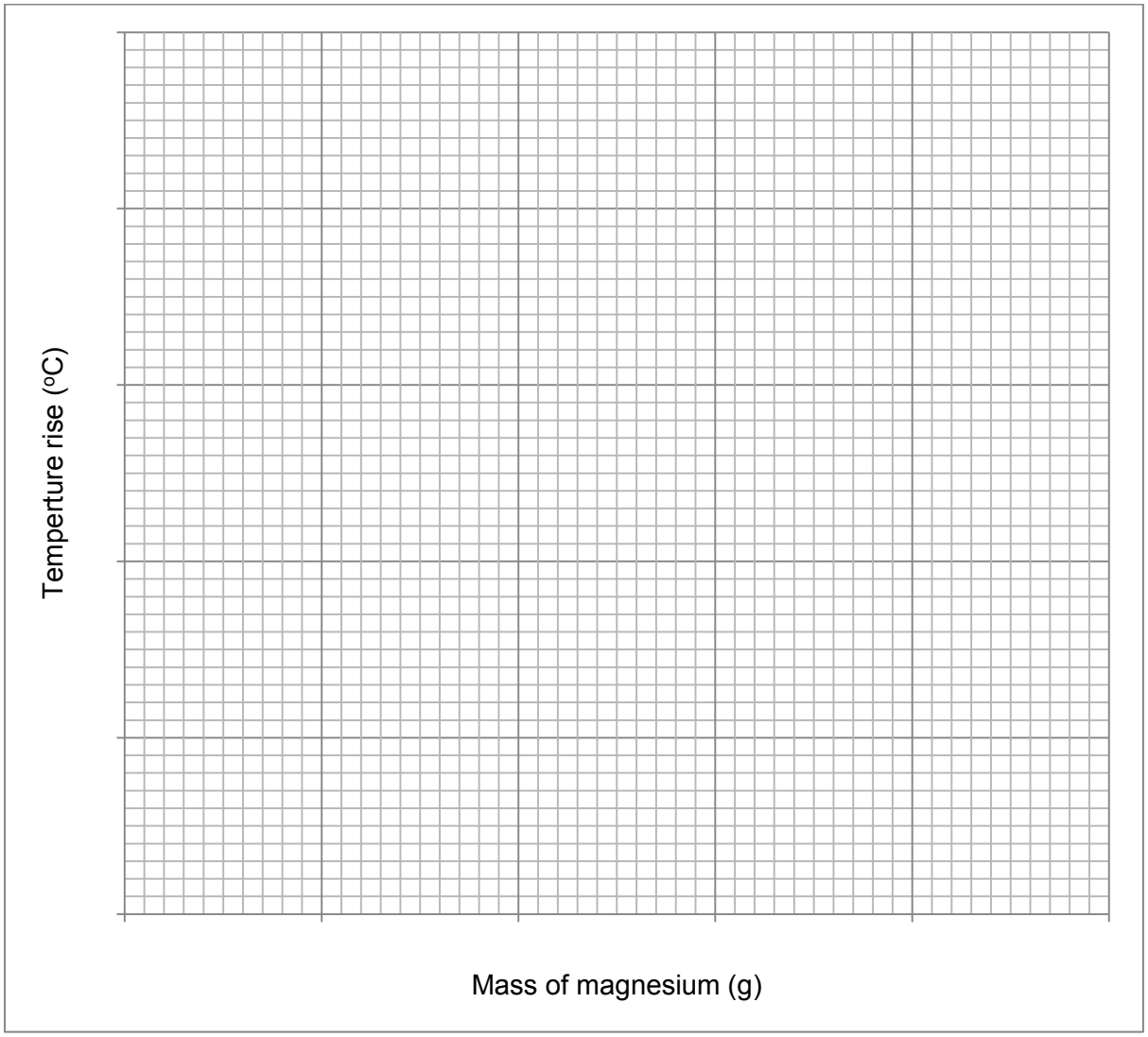
Mass of powdered magnesium (g)	**Maximum temperature rise (°C)**				
	Pupil A	**Pupil B**	**Pupil C**	**Pupil D**	**Mean**
0.2	3.5	3.5	3.7	3.7	3.6
0.4	6.0	5.9	6.1	6.0	6.0
0.6	7.8	8.0	8.2	8.0	8.0
0.8	9.1	9.0	3.0	8.9	9.0
1.0	8.8	9.1	8.9	9.2	9.0

(a) (i) **Circle** the anomalous result **not** used in calculating one of the mean temperature rises. [1]

(ii) Suggest **one** possible cause for this anomalous result. [1]

.....

(b) (i) On the grid below, plot the mean temperature rise against the mass of magnesium added. Draw a suitable line. [3]



(ii) Find the smallest mass of magnesium needed to react with all of the copper(II) sulfate. Give a reason for your answer. [1]

.....

.....

(c) In north Wales, there is a large copper mine called Parys Mountain. Unwanted rock from mining has been dumped forming waste tips. As rainwater passed through the waste tips, it dissolved copper salts such as copper(II) sulfate. This water filled large pits.

In the 18th century scrap iron was placed into the water and after a few months the pits were drained and copper-rich sludge was collected.

(i) Explain the reaction taking place in the pits. [2]

……..…..

……..……

……..…….

(ii) Write the **word** equation for the reaction taking place. [2]

…….. + ……..…….. → ……..…..… + ……...…….

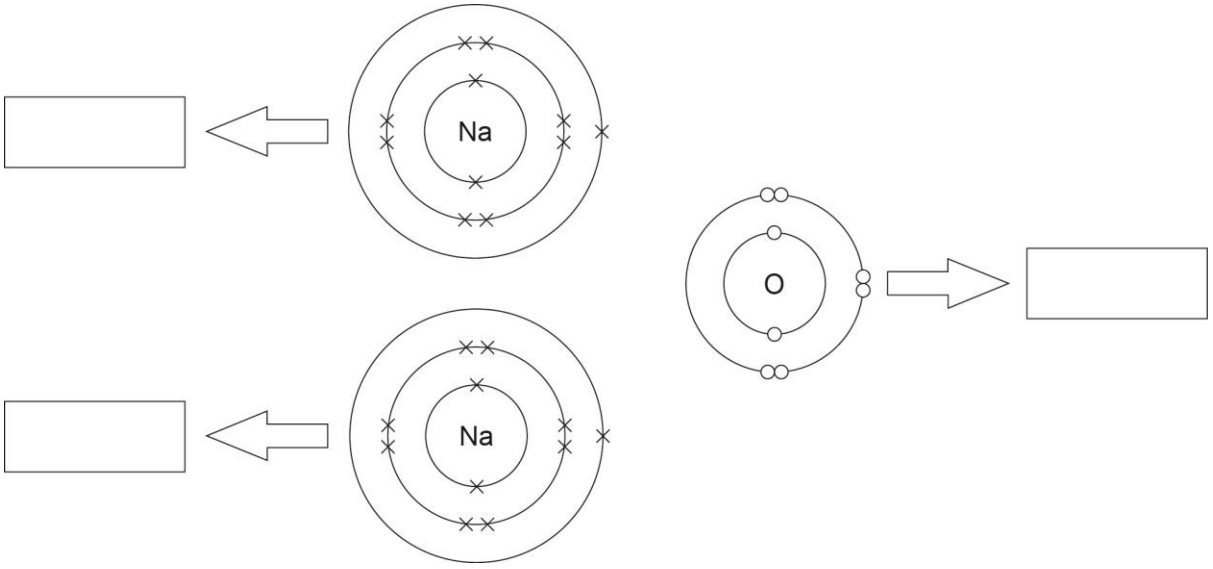
(d) A similar reaction takes place between copper and silver nitrate. One of the products formed is copper(II) nitrate, $Cu(NO_3)_2$.

Write the balanced **symbol** equation for this reaction. [2]

…….. + ……..…….. → ……..…..… + ……...…….

12

11. (a) Sodium reacts with oxygen to form sodium oxide.
The diagram below can be used to show the electronic changes that occur as sodium oxide is formed.



(i) **Draw arrows on the diagram** to show the movement of electrons that leads to the formation of ions. [1]

(ii) **Write in the boxes**, the electron configurations of the sodium and oxide **ions** that are formed. Include the charges on these ions. [2]

(iii) Explain why the ions become joined together. [2]

.....

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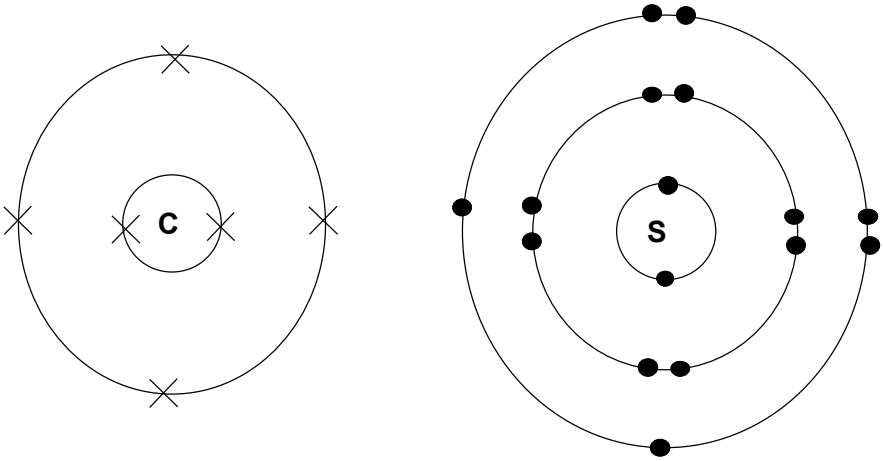
(iv) The electronic configuration of carbon and sulfur are shown below.



Circle the letter **A**, **B**, **C** or **D** next to the correct statement about the compound formed between carbon and sulfur. [1]

A Electrons are transferred from carbon to sulfur to form a covalent compound with the formula CS_2.

B Electrons are shared between carbon and sulfur to form a covalent compound with the formula CS_2.

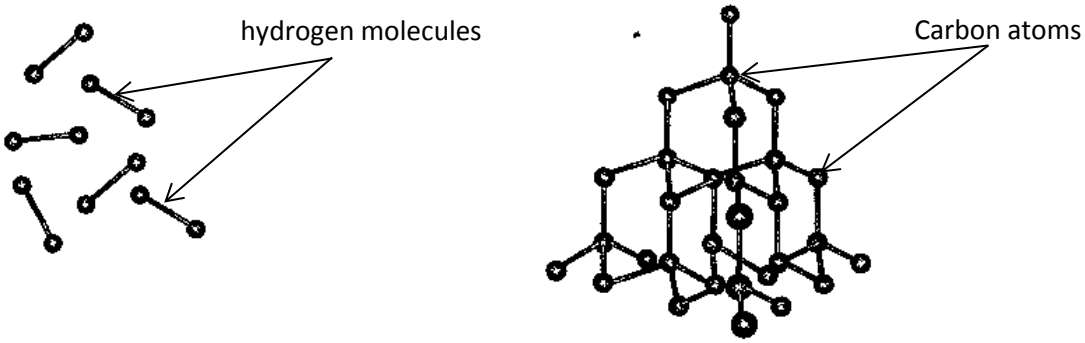
C Electrons are transferred from carbon to sulfur to form a covalent compound with the formula CS.

D Electrons are shared between carbon and sulfur to form a covalent compound with the formula CS.

(b) Using the electronic structures given, draw a dot and cross diagram to show the bonding in a molecule of water, H_2O. [2]

hydrogen = 1 oxygen = 2,6

(c) The following diagrams show the structures of hydrogen and diamond.



Explain why diamond has a higher melting point than hydrogen. [3]

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11

FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	Formula	Name	Formula
Aluminium	Al^{3+}	Bromide	Br^{-}
Ammonium	NH_4^{+}	Carbonate	CO_3^{2-}
Barium	Ba^{2+}	Chloride	Cl^{-}
Calcium	Ca^{2+}	Fluoride	F^{-}
Copper(II)	Cu^{2+}	Hydroxide	OH^{-}
Hydrogen	H^{+}	Iodide	I^{-}
Iron(II)	Fe^{2+}	Nitrate	NO_3^{-}
Iron(III)	Fe^{3+}	Oxide	O^{2-}
Lithium	Li^{+}	Sulfate	SO_4^{2-}
Magnesium	Mg^{2+}		
Nickel	Ni^{2+}		
Potassium	K^{+}		
Silver	Ag^{+}		
Sodium	Na^{+}		
Zinc	Zn^{2+}		

Avogadro's number, $L = 6 \times 10^{23}$

THE PERIODIC TABLE