Candidate Name	Centre Number					Candidate Number				

GCSE COMBINED SCIENCE

COMPONENT 2

Concepts in Chemistry

HIGHER TIER

SAMPLE PAPER

(1 hour 45 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1	**12**	
2	**11**	
3	**9**	
4	**7**	
5	**16**	
6	**9**	
7	**20**	
8	**6**	
Total	**90**	

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

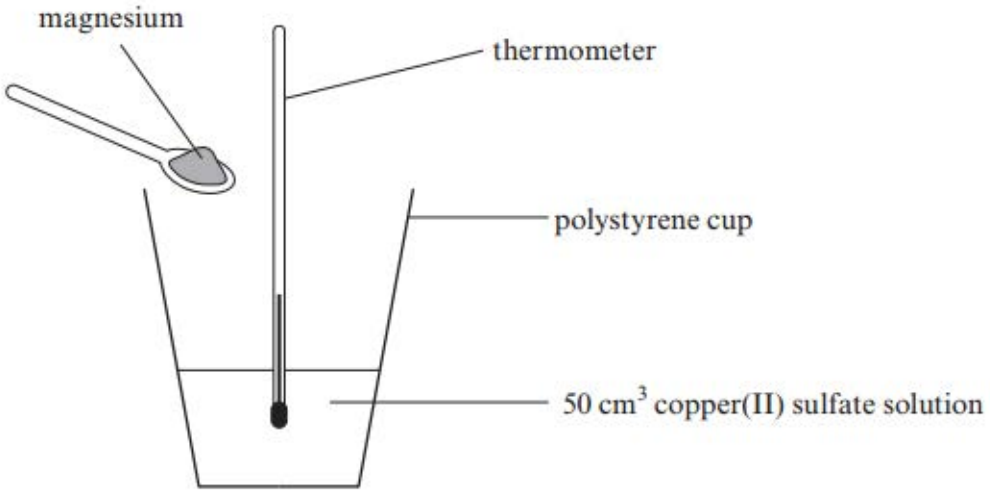
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

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 **8**.

Answer **all** *questions*

1. 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 50 cm^3 of copper(II) sulfate solution each time.

The table shows the results recorded.

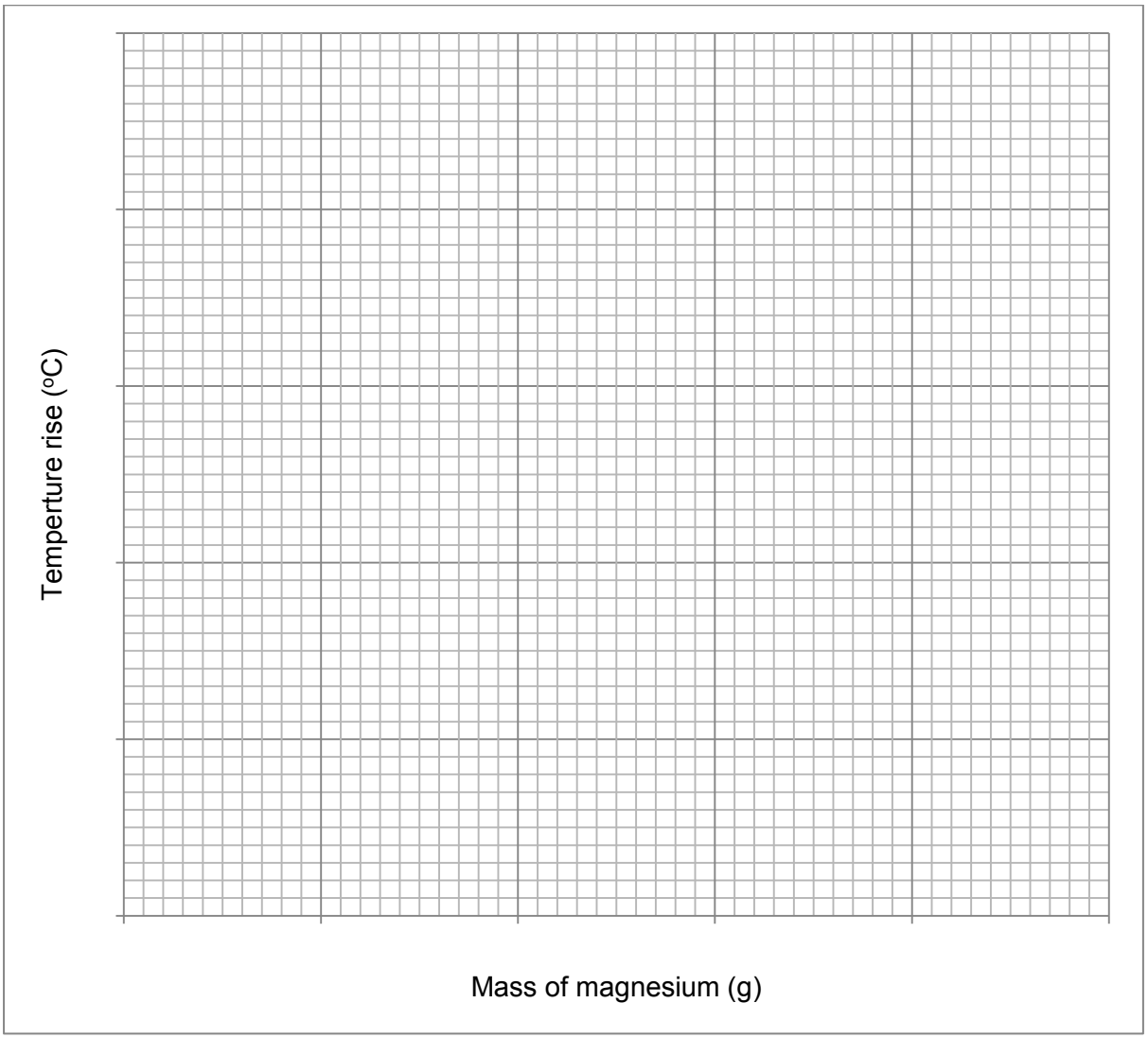
Mass of powdered magnesium (g)	**Maximum temperature rise (°C)**				
	Pupil A	**Pupil B**	**Pupil C**	**Pupil D**	**Mean**
0.2	3.5	3.5	3.7	3.7	3.6
0.4	6.0	5.9	6.1	6.0	6.0
0.6	7.8	8.0	8.2	8.0	8.0
0.8	9.1	9.0	3.0	8.9	9.0
1.0	8.8	9.1	8.9	9.2	9.0

(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 the mining process 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 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]

…….. + ……..…….. → ……..….. + ……...…….

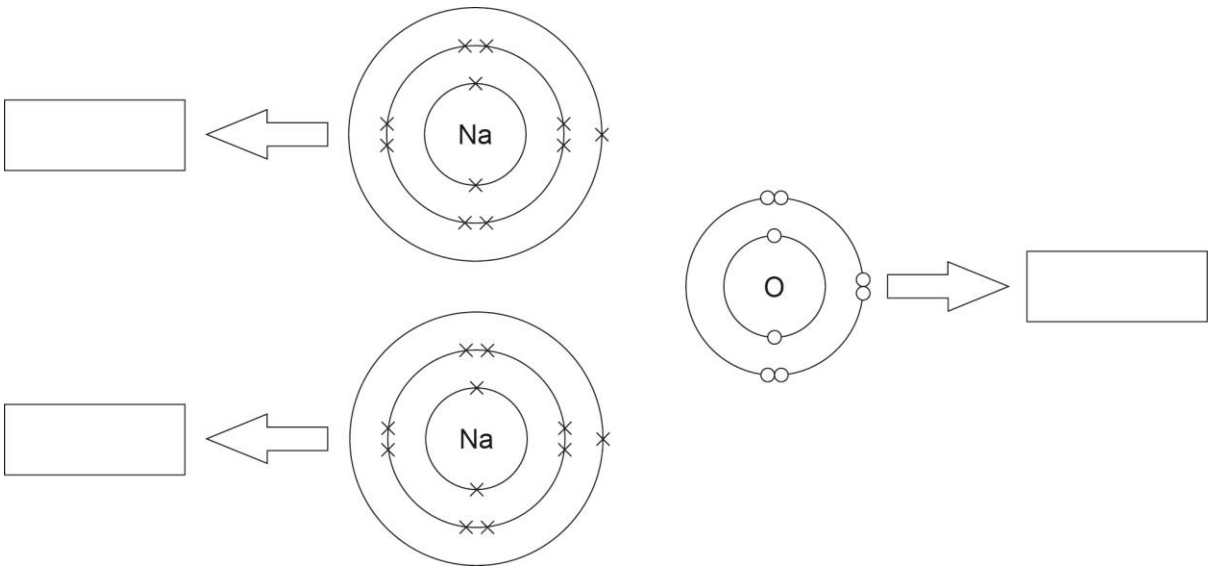
(d) A similar reaction takes place between copper and silver nitrate. One of the products formed is copper(II) nitrate, $Cu(NO_3)_2$.

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

…….. + ……..…….. → ……..….. + ……...…….

12

2. (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]

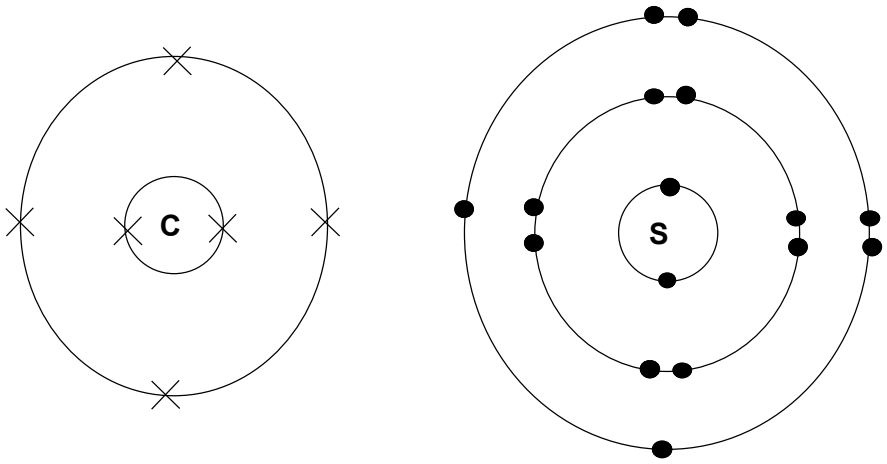
(ii) **Write in the boxes**, the electron configurations of the sodium and oxide **ions** that are formed. Include the charges on these ions. [2]

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

.....

.....

(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.

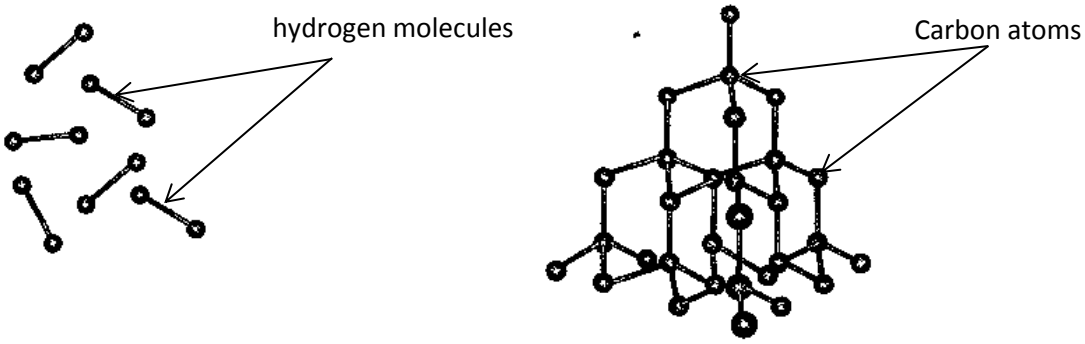
C Electrons are transferred from carbon to sulfur to form a covalent compound with the formula CS.

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, which is a form of carbon.



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

.....

.....

.....

.....

11

3. The following table contains information about the number of particles contained within atoms and ions **A** - **G**.

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

	A	**B**	**C**	**D**	**E**	**F**	**G**
Number of electrons	8	10	9	10	10	11	10
Number of neutrons	10	10	10	10	12	12	12
Number of protons	8	8	9	10	10	11	11

(a) State the atomic number of **C**. ..... [1]

(b) Using the number of electrons, state to which group and period of the Periodic Table element **A** belongs. Explain your answer. [3]

Group ..... Period .....

.....

.....

(c) Choose a letter **A** - **G** which represents: [2]

a positive ion .....

a negative ion .....

(d) Give the letter **A** - **G** which represents an atom/ion with a mass number of 20. [1]

.....

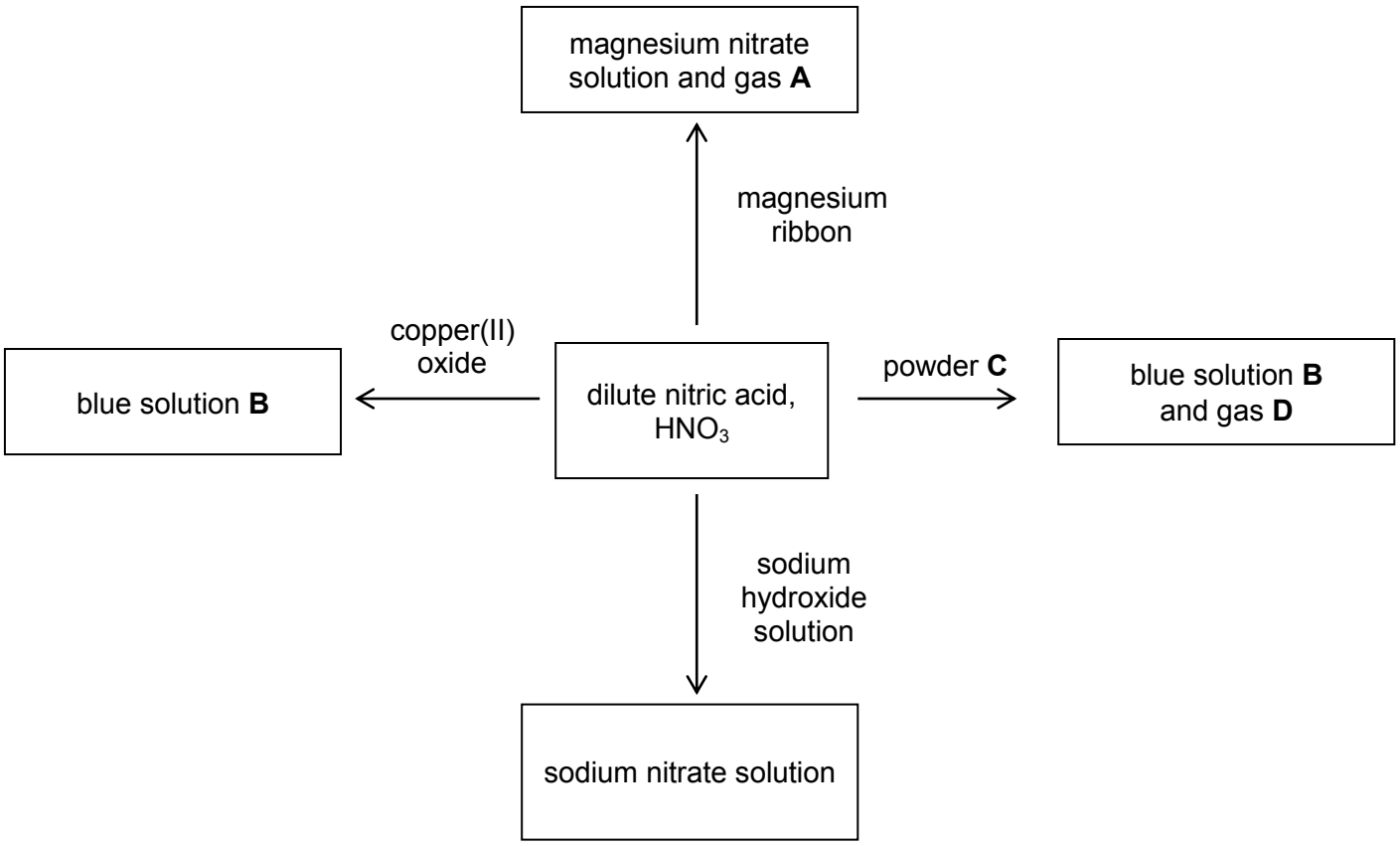
(e) State what is meant by the term isotope. Use information from the table to exemplify your answer. [2]

.....

.....

9

4. The following diagram shows some reactions of dilute nitric acid.



(a) Name the following substances. [3]

powder **C** …….

solution **B** …….

gas **D** …….

(b) Name gas **A** and describe how it can be identified. [2]

…….....

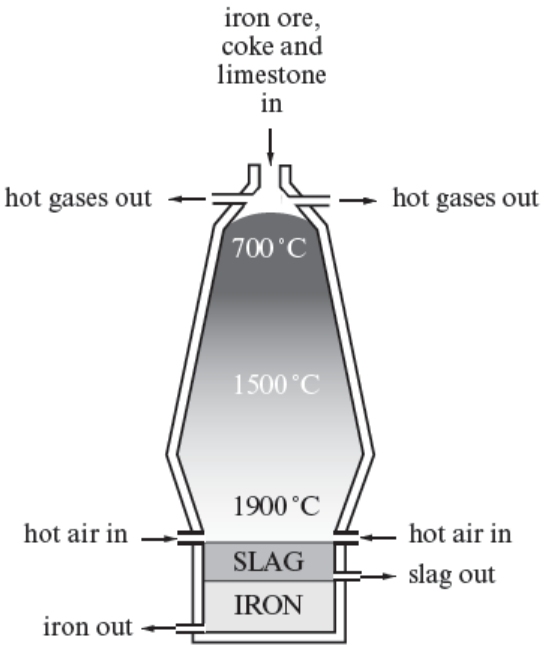
…….....

(c) Write a balanced **symbol** equation for the reaction between nitric acid and sodium hydroxide to form sodium nitrate. [2]

……..

7

5. (a) Iron can be extracted from its ore in the blast furnace.



In extracting the iron from its ore, the following reactions take place inside the furnace.

Reaction 1 $C + O_2 \rightarrow CO_2$

Reaction 2 $CO_2 + C \rightarrow 2CO$

Reaction 3 $2Fe_2O_3 + 3CO \rightarrow 4Fe + 3CO_2$

Reaction 4 $CaCO_3 \rightarrow CaO + CO_2$

Reaction 5 $CaO + SiO_2 \rightarrow CaSiO_3$

Explain the terms *reduction* and *neutralisation* with reference to suitable reactions occurring in the blast furnace. [5]

(i) reduction
*In your answer you need to refer to **two** reactions.*

.....

.....

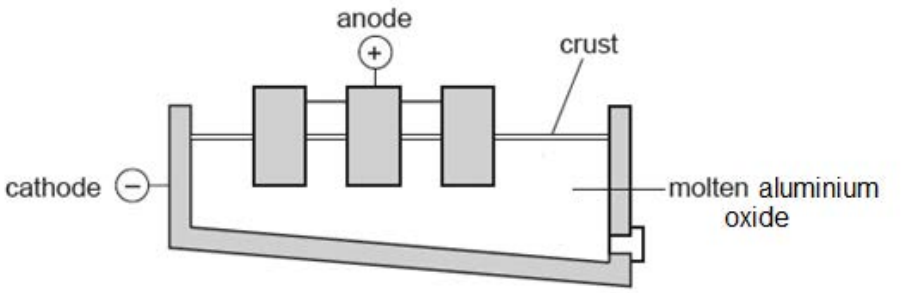
.....

(ii) neutralisation
*In your answer you need to refer to **one** reaction.*

.....

.....

(b) Aluminium is obtained by the electrolysis of molten aluminium oxide.



(i) Explain why aluminium is formed at the cathode. Include an electrode equation in your answer. [3]

.....

.....

.....

(ii) The equation below shows the overall reaction that takes place during electrolysis of aluminium oxide.

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Aluminium oxide is obtained from the ore bauxite. Bauxite from one mine contains 45 % aluminium oxide. Calculate the maximum mass of aluminium that could be produced from 1.02×10^6 kg of this bauxite.

[4]

mass = ... kg

(iii) Aluminium is a good electrical conductor and is therefore used to make power cables.

Give **two** *different* properties of aluminium and a use which relies on **both** of these properties. [2]

……

……

……

(c) The table below shows some information about three compounds which can be electrolysed to form chlorine.

Compound	Melting point (°C)	Solubility
lead(II) chloride	501	insoluble
sodium chloride	808	soluble
lead(II) chloride	373	insoluble

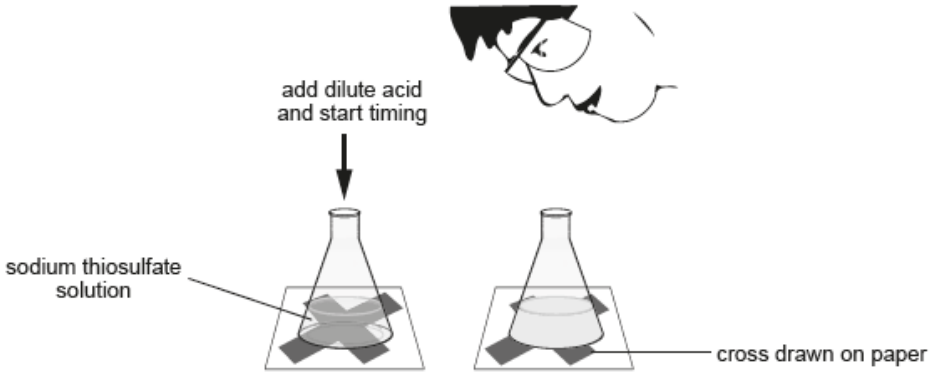
A teacher wanted her students to obtain a sample of chlorine by electrolysis. Explain which compound would be the **safest** for the students to use. [2]

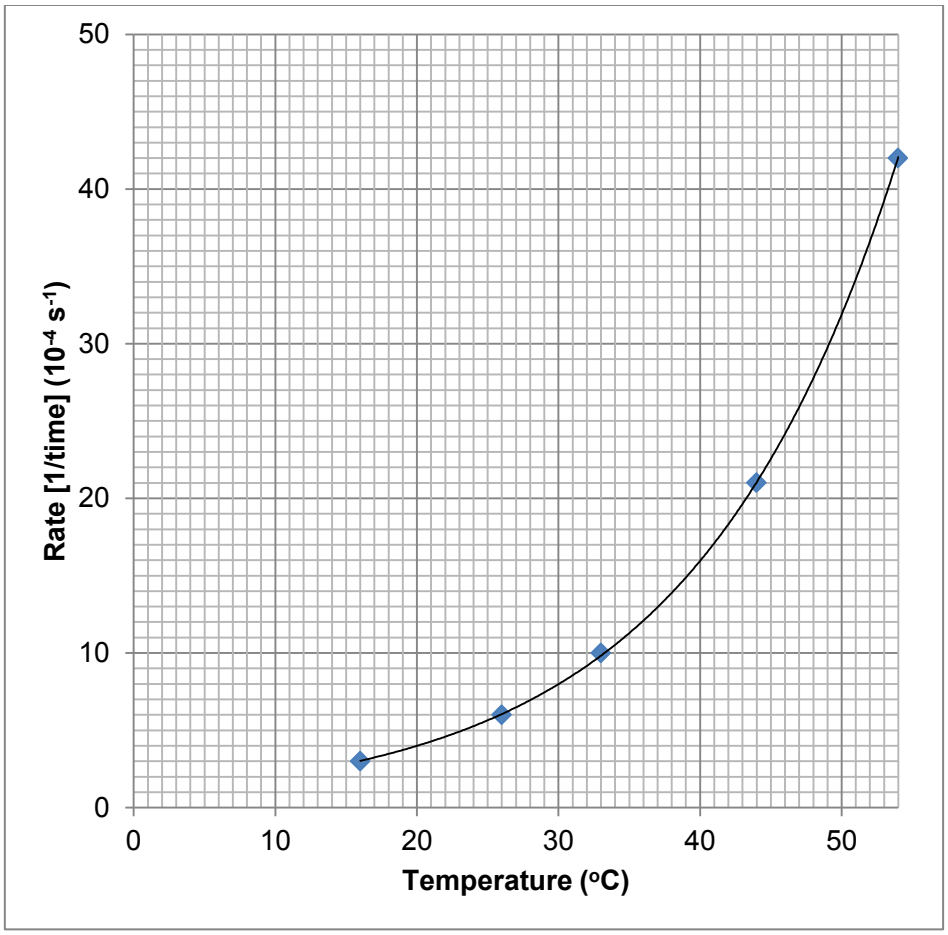
.....

.....

16

6. (a) The graph below shows how the rate of reaction between sodium thiosulfate solution and dilute hydrochloric acid changes with temperature.
The rate of reaction was measured by the 'disappearing cross'.





(i) Account for the relationship shown in the graph using particle theory.
[3]

……

……

……

……

(ii) Use the graph to find the time taken, in seconds, for the cross to disappear at 50 °C. *Show your workings.* [2]

time taken = ……..seconds

(iii) Use the graph to find the temperature increase that is needed to double the rate. *Show your reasoning*. [2]

……

……

……

temperature increase = ……°C

(b) Nitric acid can be manufactured industrially in a reaction involving a platinum catalyst. Explain why using the platinum catalyst makes the reaction economic. [2]

……

……

……

9

7. (a) Crude oil is a mixture of hydrocarbon compounds. Crude oil can be separated into simpler mixtures called fractions. Each fraction contains hydrocarbons of similar chain lengths.

(i) Explain how oil is separated into fractions. [2]

.....

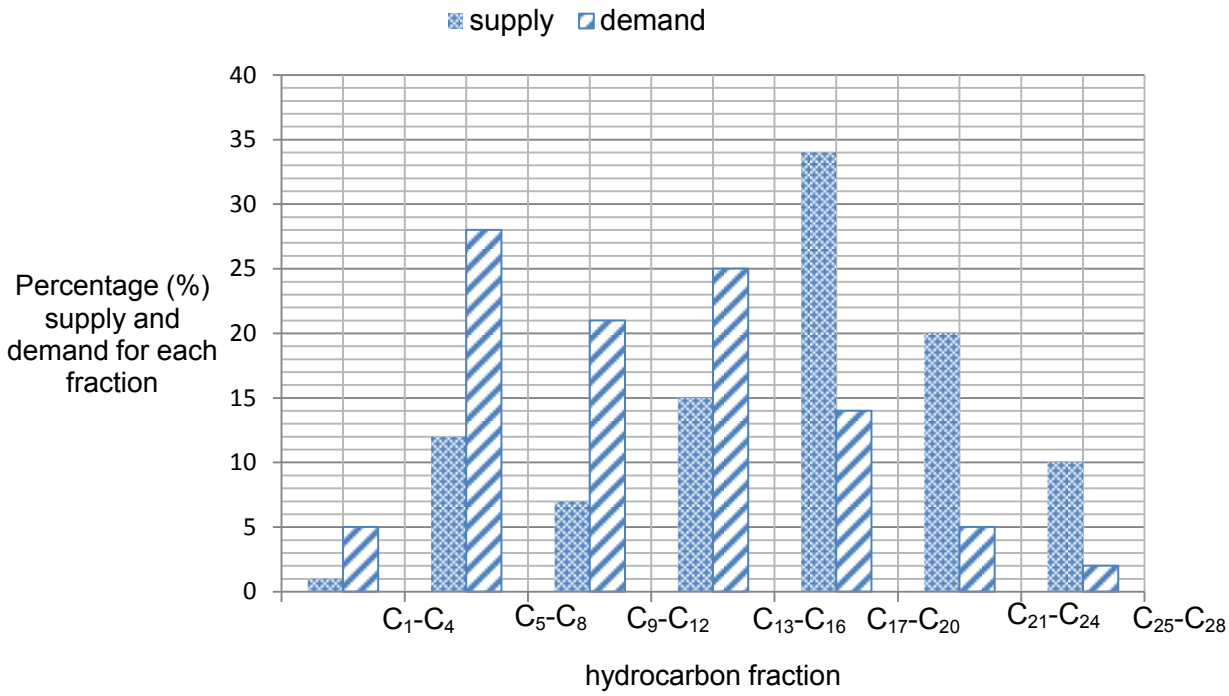
.....

.....

(ii) The C_{17}-C_{20} fraction contains a number of different alkanes. Give the formulae of an alkane found in this fraction. [1]

.....

(iii) The bar chart below shows the relative amounts of 'supply' and 'demand' for some hydrocarbon fractions.



Explain how oil companies process crude oil to address the differences in supply and demand of each fraction. [3]

.....

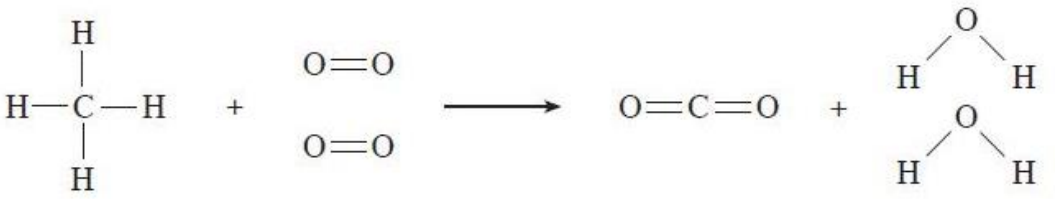
.....

.....

.....

(b) Methane and propane are used as fuels.

The burning of methane in air can be represented by the following equation.



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

Bond	Bond energy (kJ)
C – H	413
O = O	498
O – H	464
C = O	805

Calculate the overall energy change for the reaction. State whether the reaction is exothermic or endothermic and give a reason for your answer. [4]

energy change = ... kJ

…….....

…….....

(c) Propane is another fuel that burns in air.

(i) A sample of propane contains 0.72 g of carbon and 0.16 g of hydrogen.

Use this information to show that the formula of propane is C_3H_8. [3]

(ii) Calculate how many molecules there are in 132 g of propane. [3]

number of molecules = ...

(d) Polyester is produced from compounds formed from crude oil. Cotton is grown from plants.
The table below gives data for the complete life cycle assessment of jackets made from cotton and polyester.

Factor	Polyester per kg	Cotton per kg
energy used (MJ)	171.3	140.1
fuel (oil or gas) used (kg)	1.53	0
fertiliser used (kg)	0	467
sulfur dioxide emissions (g)	0.2	4.0

Jacqueline claims that making jackets from cotton rather than polyester is better for the environment because cotton comes from plants.
Use information from the table to discuss whether Jacqueline's claim is correct. [4]

……..……..……..

……

……..……..……..

……..……..……..

……...……..

……..……

20

8. Potassium chloride can be made by reacting an acid with an alkali.

Describe a laboratory method for making **crystals** of potassium chloride from a suitable acid and alkali. [6 QER]

Include a chemical equation in your answer.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

6

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