Surname	Centre Number	Candidate Number
Other Names		0

GCSE – NEW

3410U20-1

S18-3410U20-1

CHEMISTRY – Unit 2:
Chemical Bonding, Application of Chemical Reactions and Organic Chemistry

FOUNDATION TIER

THURSDAY, 17 MAY 2018 – MORNING

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**12**	
2.	**10**	
3.	**10**	
4.	**9**	
5.	**6**	
6.	**13**	
7.	**8**	
8.	**12**	
Total	**80**	

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01

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 or 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. If you run out of space, use the additional page at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question **5** is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table is printed on the back cover of this paper and the formulae for some common ions on the inside of the back cover.

MAY183410U20101

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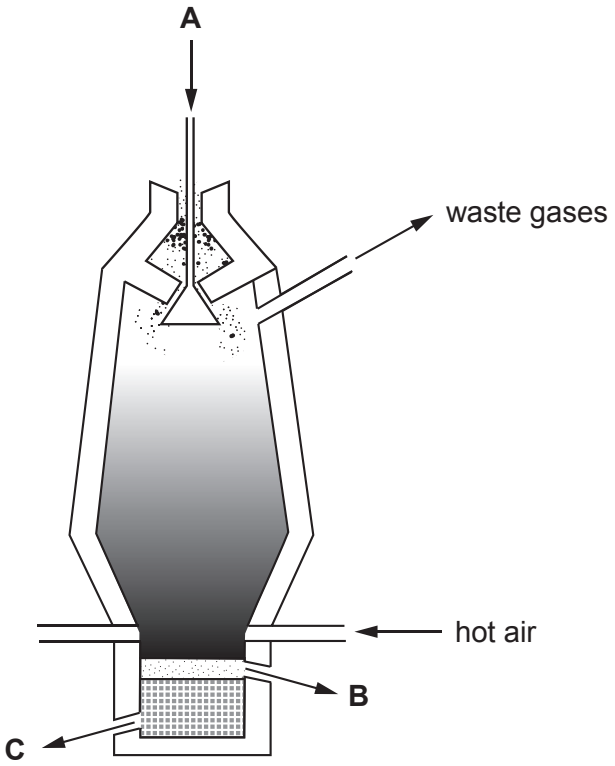
Answer **all** *questions*.

1. *(a)* The diagram shows where substances enter and leave the blast furnace in the extraction of iron from iron ore.



coke	**slag**	**iron**	**limestone**	**iron ore**

(i) Use the substances in the box to complete the following sentences. [3]

The **three** raw materials which enter the furnace at **A** are ..... ,

..... and ..... .

Product **B** is ..... and product **C** is ..... .

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(ii) One reaction that takes place in the furnace is

iron(III) oxide + carbon monoxide ⟶ iron + carbon dioxide

Underline the element which is removed from the iron(III) oxide during the reaction. [1]

iron **oxygen** **carbon**

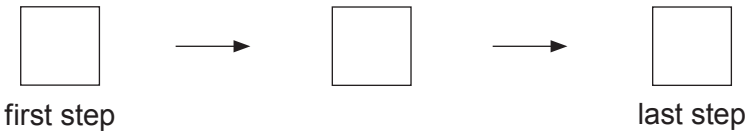
(b) Statements **D**, **E** and **F** show the three steps needed to prepare a sample of copper(II) chloride in the laboratory. The steps are **not** in the correct order.

D filter to remove excess copper(II) oxide

E leave the copper(II) chloride solution to evaporate at room temperature

F add excess copper(II) oxide to dilute hydrochloric acid

Complete the flow chart by putting the **letters** in the correct order. [2]



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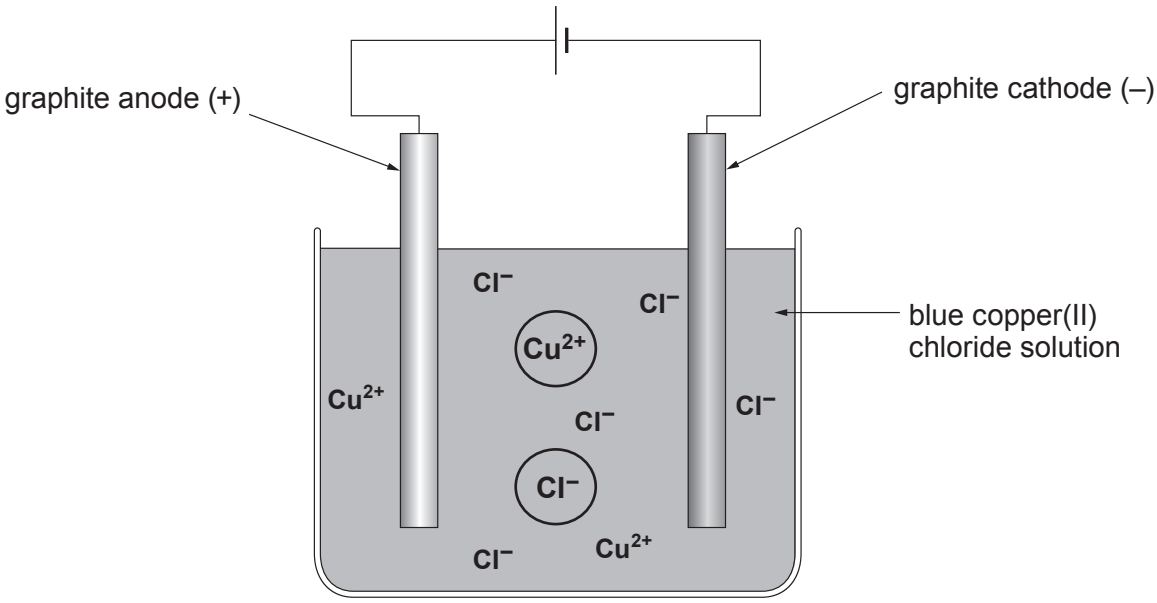
(c) The diagram shows the apparatus used to obtain copper from copper(II) chloride solution.



electrolyte	**electrodes**	**electricity**	**electrolysis**

(i) Choose words from the box to complete the following sentences. [2]

The breaking down of copper(II) chloride solution using an electric current is called

..... .

Electric current enters and leaves the copper(II) chloride solution by the

..... .

(ii) **By drawing arrows on the diagram**, show the direction in which the **circled** ions move during the process. [1]

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(iii) The reaction occurring at the cathode is:

$$Cu^{2+} + 2e^- \longrightarrow Cu$$

copper(II) ion → copper atom

I. Put a tick (✓) in the box next to what e^- represents in the equation. [1]

electricity ☐

electron ☐

ion ☐

atom ☐

II. Copper(II) ions, Cu^{2+}, are removed from the solution during the process.

Put a tick (✓) next to the statement which describes what, if anything, happens to the colour of the copper(II) chloride solution. [1]

the blue solution turns darker ☐

the blue solution turns paler ☐

the blue solution turns yellow ☐

nothing happens to the colour of the blue solution ☐

(iv) Put a tick (✓) next to the gas which is formed at the anode. [1]

oxygen ☐

hydrogen ☐

chlorine ☐

12

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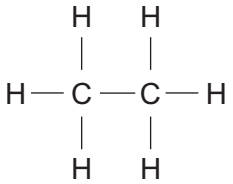
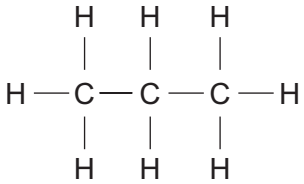
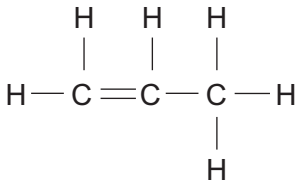
2. *(a)* The structural formulae of four carbon compounds are shown below.



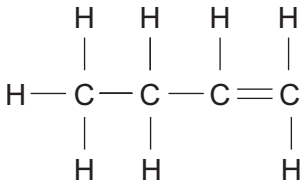
A



B



C



D

Complete the table by choosing the **letter A**, **B**, **C** or **D** which represents the structural formula of the named compounds. [2]

Name	Molecular formula	Structural formula
ethane	C_2H_6	.....
propene	C_3H_6	.....

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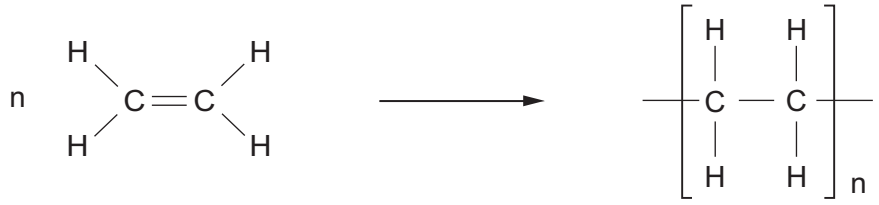
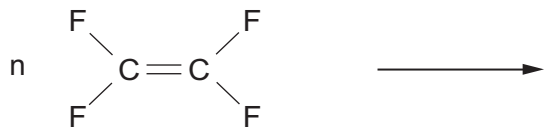
(b) The equation below shows the formation of polythene from ethene.



ethene polythene

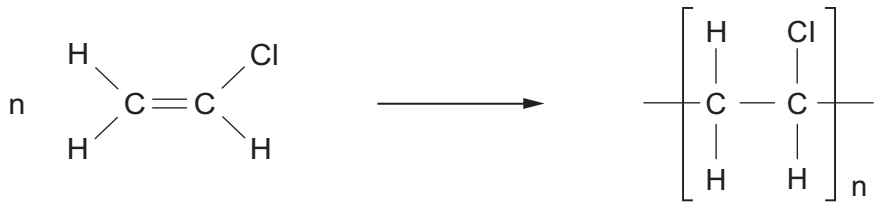
Use this information to complete parts (i) and (ii).

(i) Complete the equation for the formation of polytetrafluoroethene (PTFE) from tetrafluoroethene. [1]



tetrafluoroethene polytetrafluoroethene (PTFE)

(ii) Name monomer **E**. [1]



E polyvinylchloride (PVC)

E .....

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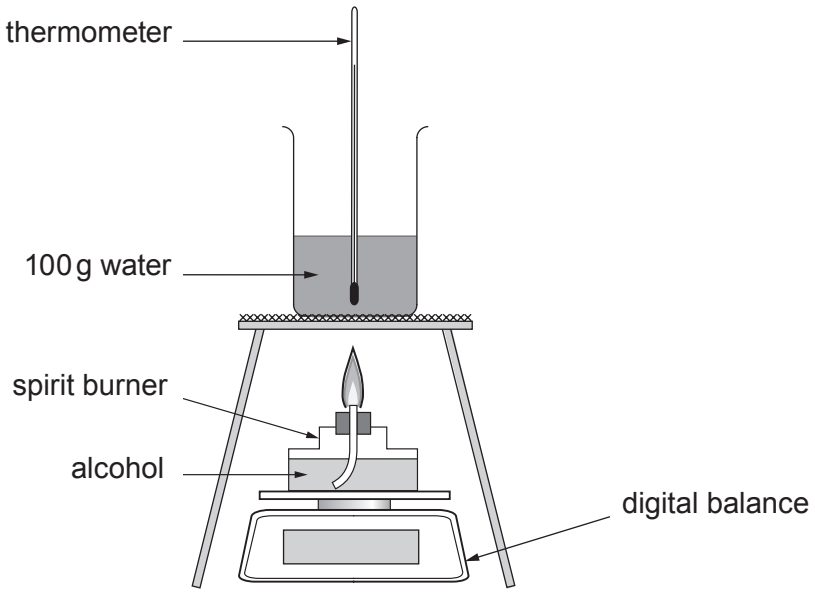
(c) A student carried out an investigation to find which alcohol gives out the most energy when burned.



100 g of water was heated by burning 1 g of each alcohol.

Alcohol	methanol	ethanol	propanol
Formula	CH_3OH	C_2H_5OH	C_3H_7OH
Relative molecular mass (M_r)	?	46	60
Temperature of water before heating (°C)	20	21	20
Temperature of water after heating (°C)	45	58	60
Energy given out (J)	?	15 700	17 200

(i) Calculate the relative molecular mass (M_r) of methanol, CH_3OH. [2]

A_r(H) = 1 A_r(C) = 12 A_r(O) = 16

M_r = ...

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(ii) The energy given out can be calculated using the formula:

energy given out = mass of water × 4.2 × temperature change

Use the data given to calculate the energy given out when burning methanol. [2]

Energy given out = ... J

(iii) Give the **letter** of the correct conclusion for the student's investigation. [1]

A all alcohols burn giving out the same amount of energy

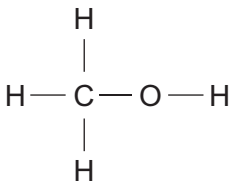
B the greater the number of carbon atoms in the alcohol molecule the less energy is given out

C the greater the number of carbon atoms in the alcohol molecule the more energy is given out

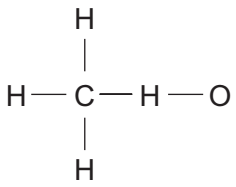
D as the number of carbon atoms doubles the amount of energy given out doubles

Letter .....

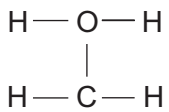
(iv) Give the **letter** of the structural formula of methanol, CH_3OH. [1]



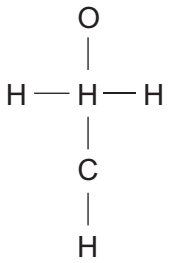
A



B



C



D

Letter .....

10

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3. *(a)* Crude oil can be separated into simpler mixtures called fractions. These fractions contain hydrocarbon compounds called alkanes. **Table 1** shows information about some of the fractions obtained from crude oil by fractional distillation.

Fraction	Boiling point range (°C)	Number of carbon atoms present in the alkanes
petroleum gases	< 20	C_1-C_4
petrol	30-75	C_5-C_{10}
naphtha	70-170	C_8-C_{12}
kerosene	170-250	C_{10}-C_{14}
diesel oil	250-340	C_{14}-C_{24}
lubricating oil	340-500	C_{21}-C_{30}
fuel oil	490-580	C_{25}-C_{35}
residue	> 580	>C_{35}

Table 1

Use **only** the information in **Table 1** to answer parts (i)-(iii).

(i) Hexane has a boiling point of 68 °C. Give the name of the fraction which contains hexane. [1]

.....

(ii) One alkane is found in kerosene and in diesel. Give the number of carbon atoms in this alkane. [1]

.....

(iii) Give the number of carbon atoms in the alkane which has the **lowest** boiling point. [1]

.....

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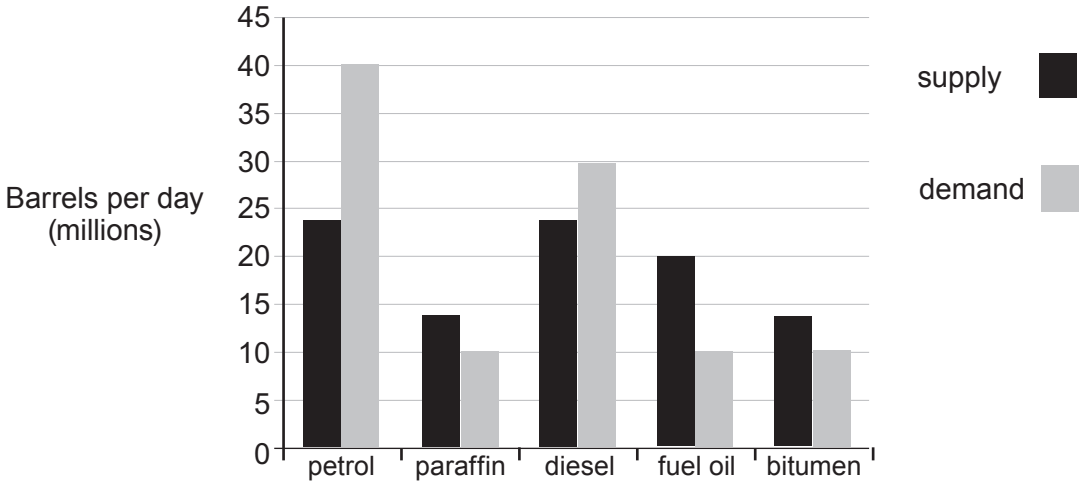
(b) The bar chart shows the **supply** and **demand** for some crude oil products.



Name the fractions for which the demand is greater than the supply. Suggest a reason why these fractions are in high demand. [2]

Fractions ..... and .....

Reason .....

.....

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(c) Plastic carrier bags are made from polythene. Each plastic carrier bag can take 500-1000 years to decompose and may never break down in landfill. Paper bags are not necessarily an environmentally friendly alternative. Manufacturing paper bags wastes a lot of natural resources. Even starch-based biodegradable bags use natural resources during their manufacture.

Supermarkets give customers a choice of buying single-use or re-usable polythene carrier bags.

Table 2 shows the number of both types of plastic bag sold in UK supermarkets from 2011 to 2013.

Year	2011	2012	2013
	Number of bags (millions)		
Single-use bags	7977	8079	8455
Re-usable bags	415	408	445

Table 2

(i) State **one** environmental problem related to the disposal of **all** types of carrier bag. [1]

.....

(ii) Calculate the percentage of plastic bags sold in 2013 that were single-use bags. [2]

Percentage = ... %

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(iii) Although more plastic carrier bags were sold in 2013 than 2012, the total **mass** of those bags changed from 70 400 tonnes to 67 300 tonnes.

Put a tick (✓) in **two** boxes next to statements which could explain the reason for the change in mass. [2]

- the bags were made the same thickness but from a less dense plastic ☐
- customers re-used their plastic bags more often ☐
- the bags were made from the same plastic but were thicker ☐
- the bags were made from the same plastic but were thinner ☐
- the bags were made the same thickness but from a more dense plastic ☐

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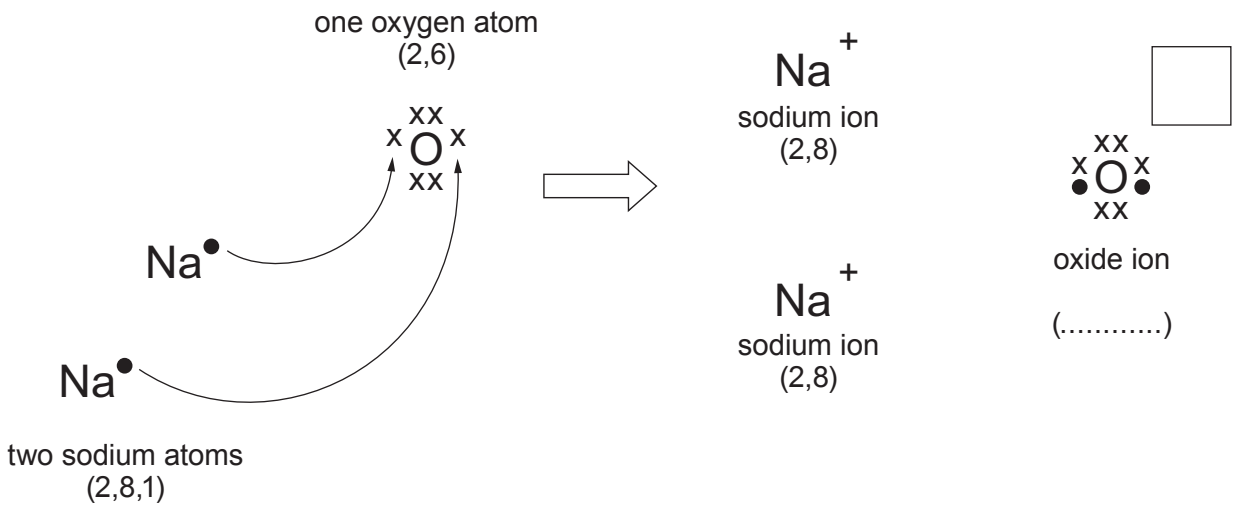
4. *(a)* The diagram shows the electronic changes that occur when sodium reacts with oxygen to form sodium oxide. The ● and x symbols are outer shell electrons.



(i) **Complete the diagram** by putting in the electronic structure **and** the charge of the oxide ion. [2]

(ii) Complete and balance the **symbol** equation for the reaction between sodium and oxygen. [2]

$$4Na + O_2 \longrightarrow \square \quad \text{.....}$$

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(b) The table shows the electronic structure of the elements present in water and hydrogen chloride.

Element	Electronic structure
hydrogen	1
oxygen	2,6
chlorine	2,8,7

The diagram shows the bonding in a water molecule.

Give the **letter** of the diagram which shows the bonding in a hydrogen chloride molecule. [1]

A **B** **C** **D**

Letter .....

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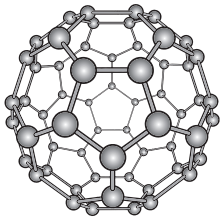
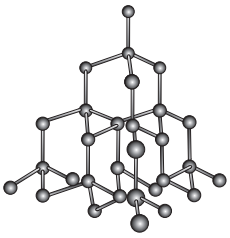
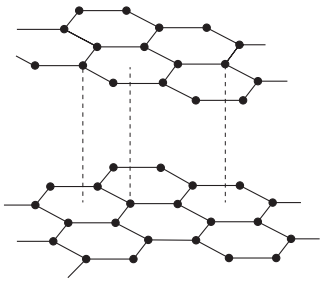
(c) Fullerene, diamond and graphite are different forms of carbon.



fullerene



diamond



graphite

(i) Underline the structure of these three forms of carbon. [1]

simple molecular **giant covalent** **giant ionic**

(ii) The box shows some properties of different forms of carbon.

transparent	**insoluble in water**	**conducts electricity**	
hollow	**soft**	**does not conduct electricity**	**hard**

Complete the table by choosing the property which makes the different forms of carbon suitable for the uses shown. [3]

Form of carbon	Use	Property
diamond	drill bits	
graphite	pencils	
fullerene	drug delivery	

9

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5. Every year thousands of acres of moorland are destroyed by fires in Wales. Firefighters use several methods to put out this type of fire.

State and explain, in terms of the fire triangle, **three** methods that are used to put out moorland fires. Each method must refer to a **different** part of the fire triangle. [6 QER]

.....

.....

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6

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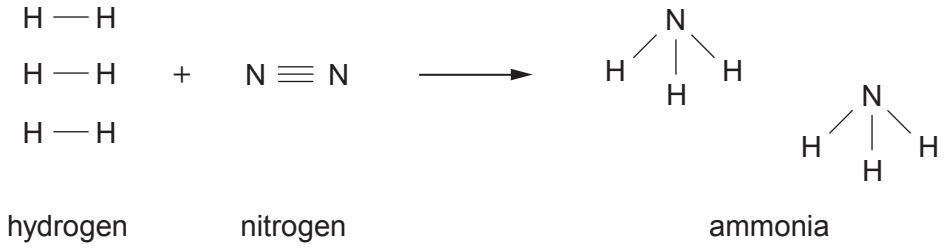
6. Ammonia is manufactured from hydrogen and nitrogen in the Haber Process.

(a) The equation shows the bonds which are broken and the bonds which are formed during the manufacture of ammonia.



The relevant bond energies are shown in the table.

Bond	Bond energy (kJ)
N≡N	945
H—H	436
N—H	391

(i) Calculate the **total** energy needed to break **all** the bonds in the hydrogen molecules and the nitrogen molecule. [2]

Energy = ... kJ

(ii) Calculate the **total** energy released when **all** the bonds in the ammonia molecules are formed. [2]

Energy = ... kJ

(iii) Use your answers to parts (i) and (ii) to calculate the overall energy change. [1]

Energy change = ... kJ

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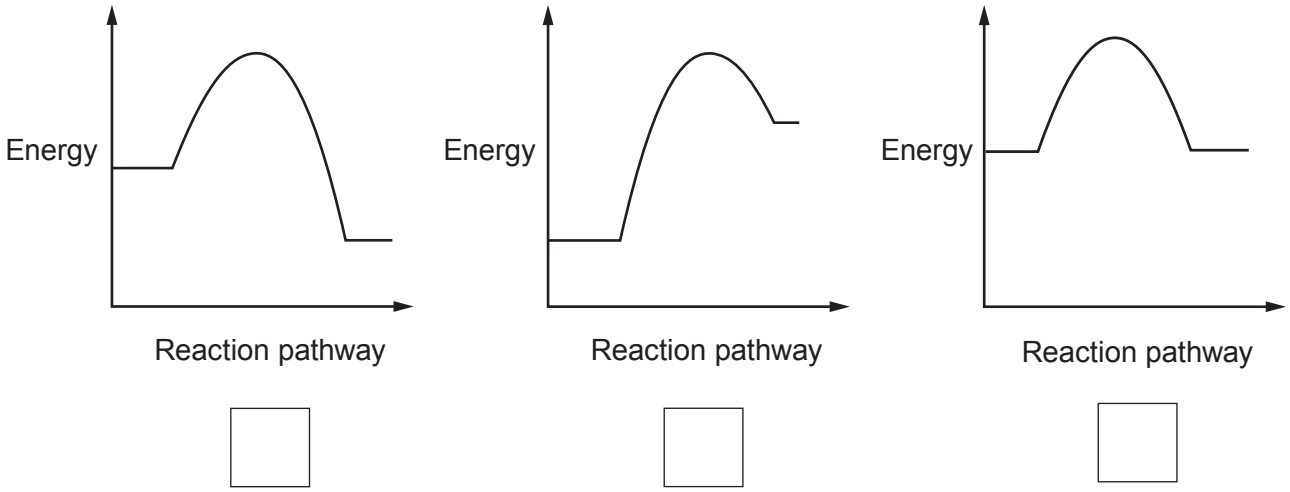
(b) The manufacture of ammonia is an exothermic reaction. Put a tick (✓) in the box next to the energy profile diagram that shows an exothermic reaction. [1]



(c) The table shows the percentage yield of ammonia under different pressure and temperature conditions.

Pressure (atm)	Temperature (°C)				
	100	200	300	400	500
	Yield of ammonia (%)				
100	96.7	81.7	52.5	25.2	10.6
200	98.4	89.0	66.7	40.0	18.3
400	99.4	94.6	79.7	55.4	31.9

Use the information in the table to answer parts (i) and (ii).

(i) State what happens to the yield of ammonia as the temperature increases. [1]

.....

(ii) One manufacturer carries out the Haber Process at 200 atm and 450 °C.

Underline the approximate percentage yield of ammonia formed under these conditions. [1]

10 % **30 %** **40 %** **58 %**

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(d) Ammonia is used in the manufacture of nitrogenous fertilisers. One example of a nitrogenous fertiliser is ammonium nitrate. Ammonium nitrate is formed by the reaction between an acid and ammonia.

(i) Complete the **word** equation by naming the acid used in this reaction. [1]

ammonia + ... ⟶ ammonium nitrate

(ii) When ammonium sulfate solution is warmed with sodium hydroxide solution a pungent gas is formed. Damp red litmus paper is used to test this gas.

I. Describe the change in colour of the litmus paper during the test. [1]

.....

II. State the property of this gas which causes the colour change. [1]

.....

III. Name the gas formed. [1]

.....

(iii) Nitrogenous fertilisers pollute streams and rivers. State how nitrogenous fertilisers get into these waterways. [1]

.....

.....

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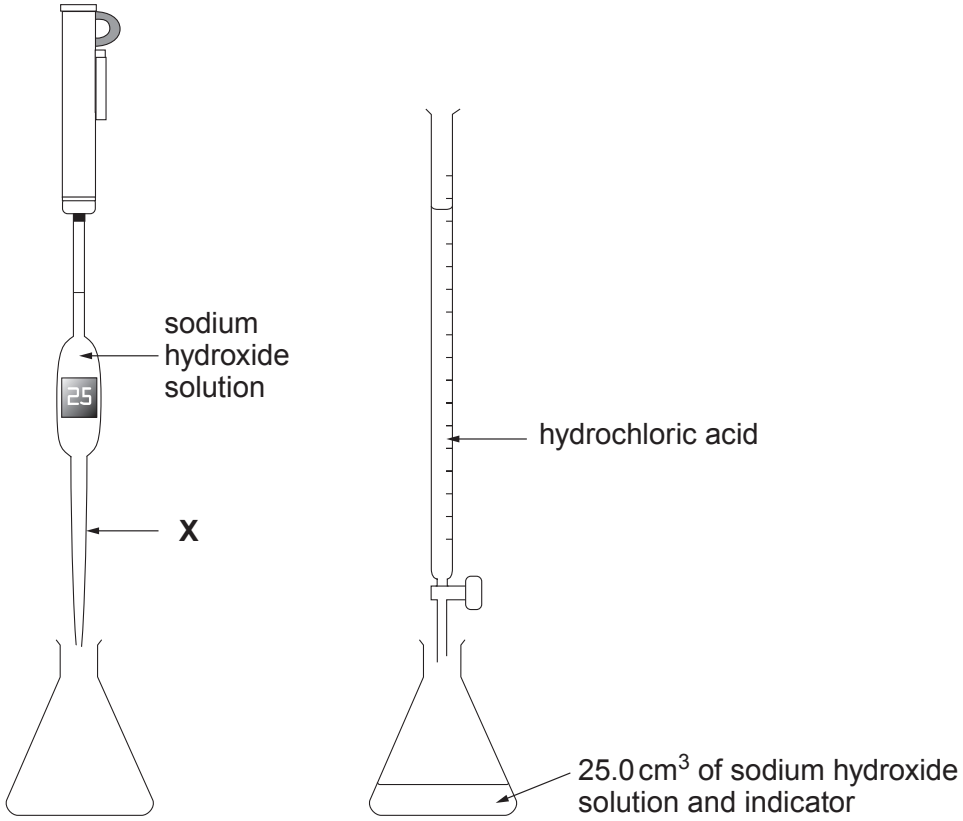
7. *(a)* Hydrochloric acid, HCl, reacts with sodium hydroxide solution to form sodium chloride and water only.

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

.....

(b) A group of students was asked to find the volume of hydrochloric acid solution needed to neutralise 25.0 cm^3 of sodium hydroxide solution. They decided to titrate sodium hydroxide with hydrochloric acid.

Apparatus



Results

Titre	1	2	3
Volume of hydrochloric acid needed (cm^3)	18.2	17.8	18.0

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(i) Name the piece of apparatus **X**. [1]

.....

(ii) Explain the purpose of the indicator. [1]

.....

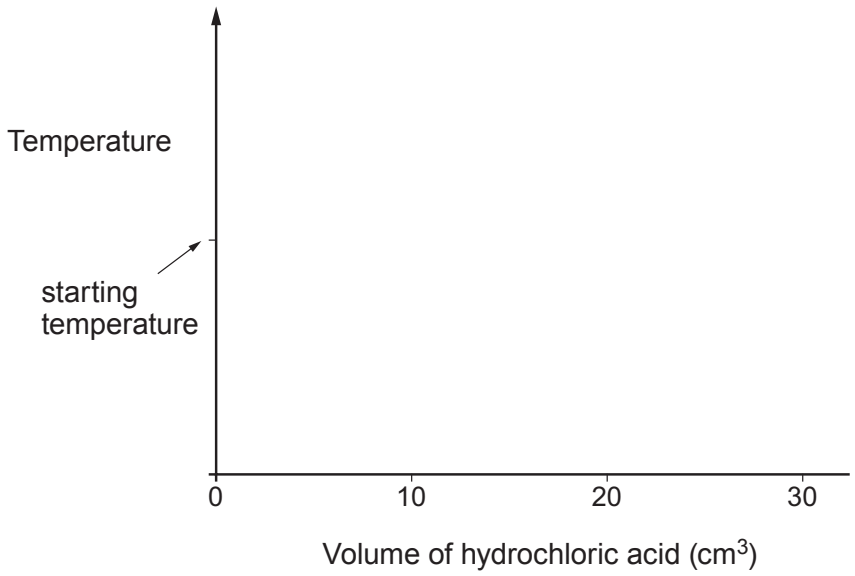
.....

(iii) Calculate the mean volume of hydrochloric acid needed to neutralise 25.0 cm^3 of the sodium hydroxide solution. [1]

Mean volume = ... cm^3

(iv) The change in temperature during the reaction can be monitored using a temperature sensor.

Sketch a graph on the axes below to show how the temperature changes as more and more acid up to a total of 30 cm^3 is added. [2]



(v) The experiment was repeated using hydrochloric acid of **half** the original concentration.

State the volume of hydrochloric acid that would be needed to change the indicator colour. [1]

Volume = ... cm^3

8

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8. *(a)* When a mixture of iron(III) oxide and aluminium powder (Thermit mixture) is heated, there is a violent reaction. The reaction is carried out in a tube surrounded by a mound of sand because the temperature reaches 2500 °C. A bead of iron is recovered from the sand. The picture below shows the reaction taking place in a darkened room.

(i) Give the reason why the iron formed in the reaction is molten. [1]

.....

.....

(ii) Complete and balance the **symbol** equation for this reaction. [2]

$$Fe_2O_3 + 2Al \longrightarrow \boxed{}\,Fe + \text{.....}$$

(iii) State which of the substances is oxidised. Give the reason for your choice. [1]

.....

.....

(iv) When a mixture of magnesium oxide and aluminium powder is heated, there is no reaction.

List iron, magnesium and aluminium in order of reactivity. [1]

Most reactive .....

.....

Least reactive .....

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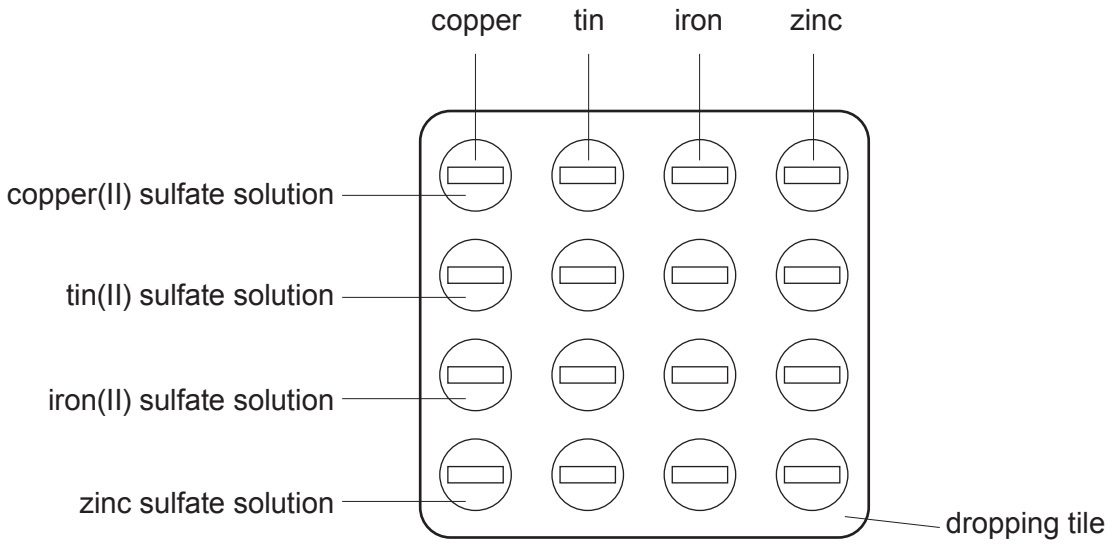
(b) Some metals are more reactive than others. A more reactive metal displaces a less reactive metal from its compounds.

A student was given tin, iron, copper and zinc and solutions of the metal sulfates. Using a dropping pipette, she put a little of one of the sulfate solutions in four of the depressions of the dropping tile. She did this for each solution in turn. She then put a piece of metal foil in each of the solutions, as shown below.



(i) Put a tick (✓) next to the question which **best** describes the investigation the student is carrying out. [1]

Which displacement is the most exothermic? ☐

Which metal can displace copper from solution? ☐

What is meant by the reactivity series? ☐

What are the positions of the four metals in the reactivity series? ☐

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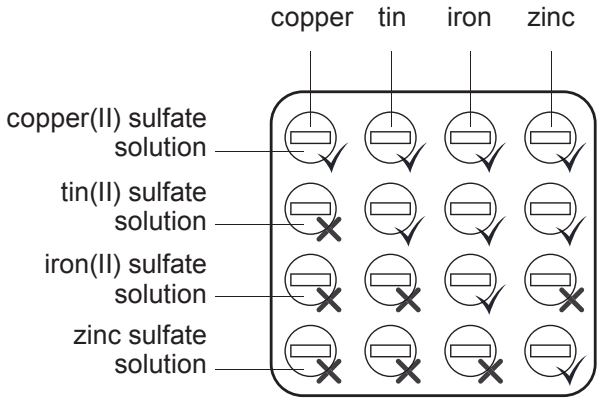
(ii) The student recorded the results by putting a tick (✓) next to a mixture which showed signs of a reaction and a cross (X) next to a mixture which showed no signs of a reaction.

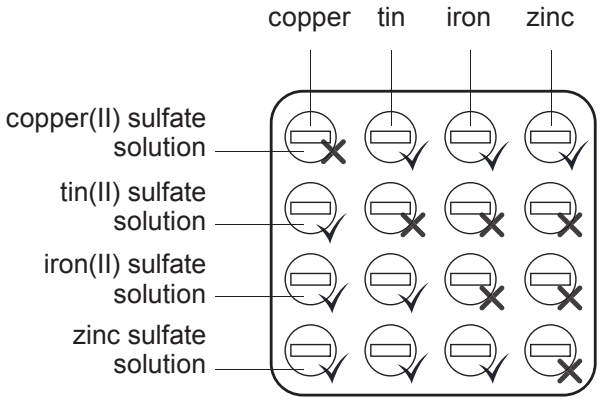
The student concluded that:
tin displaces copper
iron displaces tin
iron displaces copper
zinc displaces iron

Give the **letter** of the tile below which shows the results she recorded. [1]

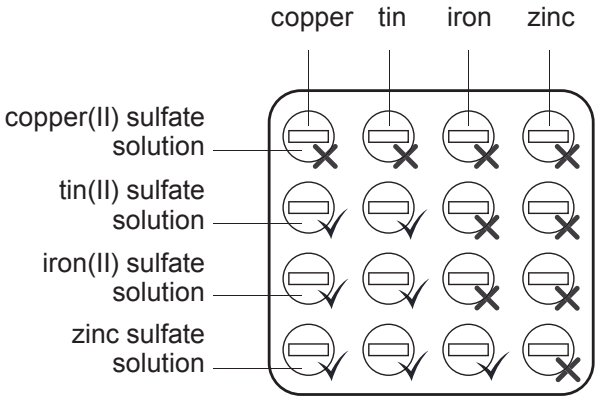
Letter .....



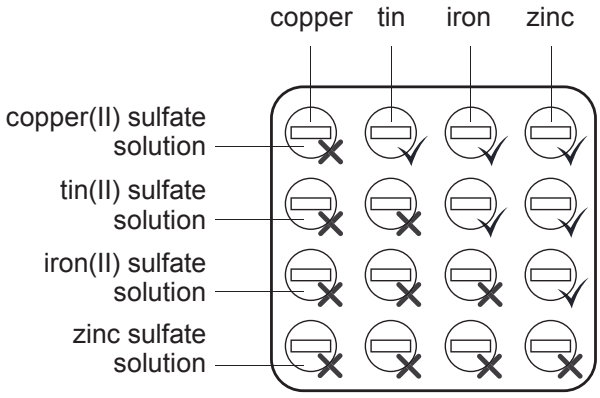
A



B



C



D

(iii) Another student said that not all of the tests were necessary. Give **one** example of a test not needed. Explain your choice. [2]

Example .....

Explanation .....

.....

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(c) Copper displaces silver from a solution of silver nitrate, $AgNO_3$, to form copper(II) nitrate solution.

(i) Describe **one** change the student would **see** during this displacement reaction. [1]

.....

.....

(ii) Write a balanced **symbol** equation for this reaction. [2]

.....

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END OF PAPER

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.	Examiner only

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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+}		

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THE PERIODIC TABLE

1	2											3	4	5	6	7	0
																	4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key

A_r	relative atomic mass
Symbol	
Name	
Z	atomic number

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