

Please check the examination details below before entering your candidate information

Candidate surname					Other names			
Centre Number					Candidate Number			
<b>Pearson Edexcel</b> <b>International GCSE (9–1)</b>					<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>			
<b>Thursday 9 January 2020</b>								
Morning (Time: 2 hours)					Paper Reference <b>4CH1/1CR 4SD0/1CR</b>			
<b>Chemistry</b> <b>Unit: 4CH1</b> <b>Science (Double Award) 4SD0</b> <b>Paper: 1CR</b>								
<b>You must have:</b> Calculator, ruler							Total Marks <input type="text"/>	

### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*
- Show all the steps in any calculations and state the units.
- Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

### Information

- The total mark for this paper is 110.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*

### Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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# The Periodic Table of the Elements

1	2	3	4	5	6	7	0																														
7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	11 <b>Na</b> sodium 11	12 <b>C</b> carbon 6	13 <b>Al</b> aluminium 13	14 <b>N</b> nitrogen 7	15 <b>P</b> phosphorus 15	16 <b>O</b> oxygen 8	17 <b>F</b> fluorine 9	18 <b>Ne</b> neon 10																												
19 <b>K</b> potassium 19	20 <b>Ca</b> calcium 20	23 <b>Sc</b> scandium 21	24 <b>Ti</b> titanium 22	25 <b>V</b> vanadium 23	26 <b>Cr</b> chromium 24	27 <b>Mn</b> manganese 25	28 <b>Fe</b> iron 26	29 <b>Co</b> cobalt 27	30 <b>Ni</b> nickel 28	31 <b>Cu</b> copper 29	32 <b>Zn</b> zinc 30	33 <b>Ga</b> gallium 31	34 <b>Ge</b> germanium 32	35 <b>As</b> arsenic 33	36 <b>Se</b> selenium 34	37 <b>Br</b> bromine 35	38 <b>Sr</b> strontium 38	39 <b>Y</b> yttrium 39	40 <b>Zr</b> zirconium 40	41 <b>Nb</b> niobium 41	42 <b>Mo</b> molybdenum 42	43 <b>Tc</b> technetium [98]	44 <b>Ru</b> ruthenium 44	45 <b>Rh</b> rhodium 45	46 <b>Pd</b> palladium 46	47 <b>Ag</b> silver 47	48 <b>Cd</b> cadmium 48	49 <b>In</b> indium 49	50 <b>Sn</b> tin 50	51 <b>Sb</b> antimony 51	52 <b>Te</b> tellurium 52	53 <b>I</b> iodine 53	54 <b>Xe</b> xenon 54				
55 <b>Cs</b> caesium 55	56 <b>Ba</b> barium 56	57 <b>La*</b> lanthanum 57	58 <b>Hf</b> hafnium 72	59 <b>Ta</b> tantalum 73	60 <b>W</b> tungsten 74	61 <b>Re</b> rhenium 75	62 <b>Os</b> osmium 76	63 <b>Ir</b> iridium 77	64 <b>Pt</b> platinum 78	65 <b>Au</b> gold 79	66 <b>Hg</b> mercury 80	67 <b>Tl</b> thallium 81	68 <b>Pb</b> lead 82	69 <b>Bi</b> bismuth 83	70 <b>Po</b> polonium [209]	71 <b>At</b> astatine [210]	72 <b>Rn</b> radon [222]	73 <b>Fr</b> francium 87	74 <b>Ra</b> radium 88	75 <b>Ac*</b> actinium 89	76 <b>Rf</b> rutherfordium 104	77 <b>Db</b> dubnium 105	78 <b>Sg</b> seaborgium 106	79 <b>Bh</b> bohrium 107	80 <b>Mt</b> meitnerium 109	81 <b>Ds</b> darmstadtium 110	82 <b>Rg</b> roentgenium [272]	83 <b>Uu</b> unnilium [277]	84 <b>Hs</b> hassium 108	85 <b>Mt</b> meitnerium [268]	86 <b>Ds</b> darmstadtium [271]	87 <b>Rg</b> roentgenium [272]	88 <b>Uu</b> unnilium [277]	89 <b>Hs</b> hassium 108	90 <b>Mt</b> meitnerium 109	91 <b>Ds</b> darmstadtium 110	92 <b>Rg</b> roentgenium 111
Elements with atomic numbers 112-116 have been reported but not fully authenticated																		[223]		[224]																	

1	<b>H</b> hydrogen 1
---	---------------------------

relative atomic mass
atomic symbol
name
atomic (proton) number

\* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

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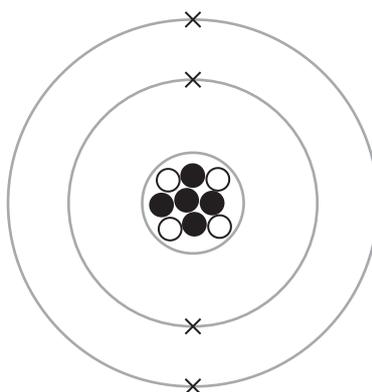
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**Answer ALL questions.**

1 The diagram shows the particles in the atom of an element.

**Key**

○ particle Y

● particle Z

(a) Particle Y is a proton.

What is particle Z?

(1)

- A an electron
- B a molecule
- C a neutron
- D a nucleus

(b) Which of these has the smallest mass?

(1)

- A an electron
- B a neutron
- C a nucleus
- D a proton

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(c) What is the mass number of this atom?

(1)

- A 4
- B 5
- C 9
- D 13

(d) What is the atomic number of this atom?

(1)

- A 4
- B 5
- C 9
- D 13

(e) (i) Identify the element that contains this atom.

(1)

(ii) State what is formed when this atom loses its outer shell electrons.

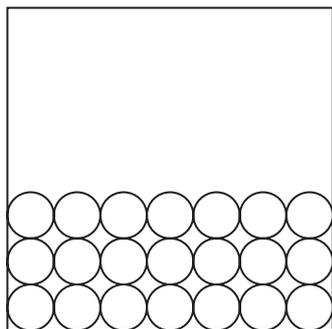
(1)

**(Total for Question 1 = 6 marks)**

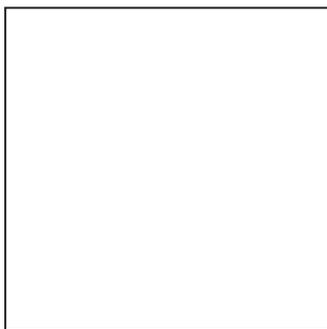


2 This question is about states of matter.

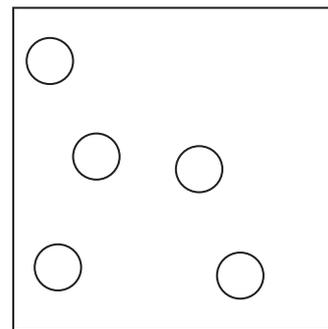
(a) The diagram shows how the particles of a substance are arranged in two different states.



solid



liquid



gas

(i) Complete the diagram to show how particles are arranged in the liquid state. (1)

(ii) Identify the state of matter in which the particles have the most energy. (1)

(b) The state symbols (s), (l), (g) and (aq) are often used in chemistry.

The table shows some physical changes.

Complete the table by giving the state symbol before and after each change. (3)

Physical change	State symbol	
	before change	after change
water evaporates		
crystals of iodine sublime		
ice melts		

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(c) Explain why hot water evaporates more quickly than cold water.

(2)

**(Total for Question 2 = 7 marks)**

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3 The Group 7 elements are called halogens.

Halogens form compounds called halides.

Three of the halogens are represented by the formulae  $X_2$ ,  $Y_2$  and  $Z_2$

Solutions of these halogens are added separately to solutions of sodium halides,  $NaX$ ,  $NaY$  and  $NaZ$ .

The table shows whether or not a reaction occurs.

	$X_2$	$Y_2$	$Z_2$
$NaX$	no	yes	yes
$NaY$	no	no	yes
$NaZ$	no	no	no

(a) Use the information in the table to deduce the order of reactivity of the halogens  $X_2$ ,  $Y_2$  and  $Z_2$

(1)

most reactive .....

.....

least reactive .....

(b) An aqueous solution of halogen  $Y_2$  is orange.

This solution is decolourised when it reacts with an alkene.

Deduce the identity of halogen  $Y_2$

(1)

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(c) (i) The table shows some physical properties of the halogens.

Complete the table by predicting a boiling point for chlorine, the state of fluorine at room temperature and the colour of astatine.

(3)

Halogen	Boiling point in °C	State at room temperature	Colour
fluorine	-188		yellow
chlorine		gas	green
bromine	59	liquid	red-brown
iodine	sublimes	solid	grey
astatine	337	solid	

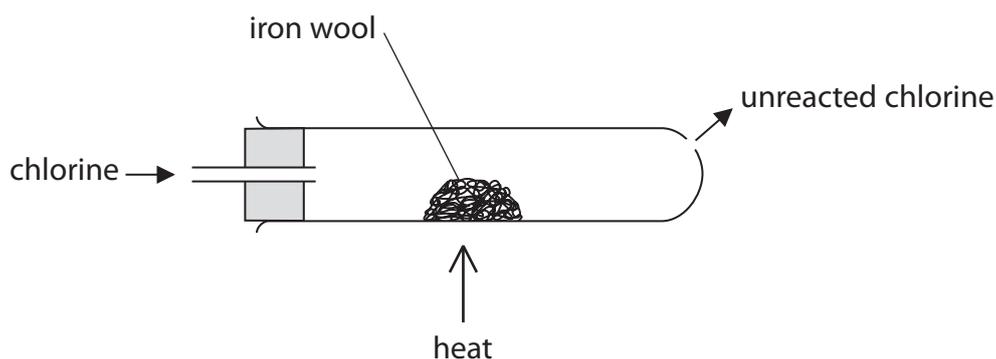
(ii) Why do the halogens have similar chemical properties?

(1)

- A they are non-metals
- B they are molecules
- C they have the same number of outer shell electrons
- D they are in the same period of the Periodic Table



- (d) A teacher uses this apparatus to demonstrate the reaction between chlorine gas and iron wool. The teacher does the reaction in a fume cupboard.



- (i) Suggest why the teacher does the reaction in a fume cupboard.

(1)

- (ii) The product of the reaction between iron and chlorine is iron(III) chloride.

The ions in iron(III) chloride are  $\text{Fe}^{3+}$  and  $\text{Cl}^-$

Use this information to give the chemical equation for this reaction.

(2)

**(Total for Question 3 = 9 marks)**



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4 This question is about ammonium chloride.

(a) Give the formula of the ammonium ion.

(1)

(b) Describe a test to show that ammonium chloride contains ammonium ions.

(3)

(c) The equation shows the thermal decomposition of ammonium chloride.



State what the  $\rightleftharpoons$  symbol indicates about this reaction.

(1)

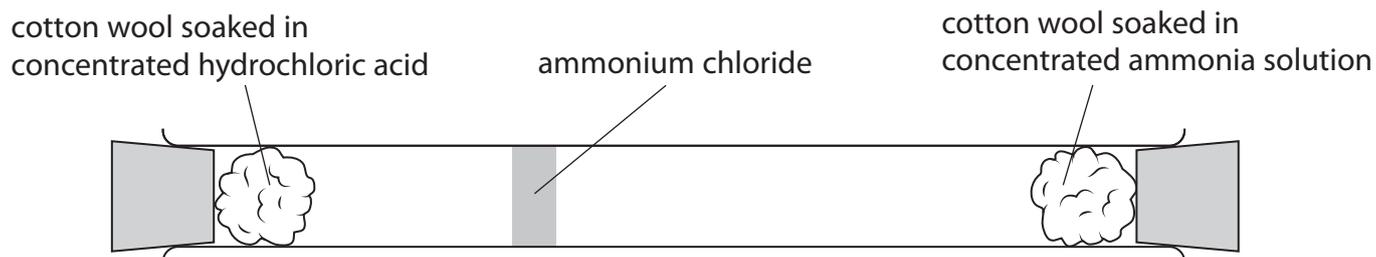
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(d) The diagram shows the formation of ammonium chloride in a glass tube.



(i) Explain how the mean speed of ammonia molecules compares with the mean speed of hydrogen chloride molecules.

(2)

(ii) Gas particles travel very quickly.

Give two reasons why it takes several minutes for the ammonium chloride to form.

(2)

1 .....

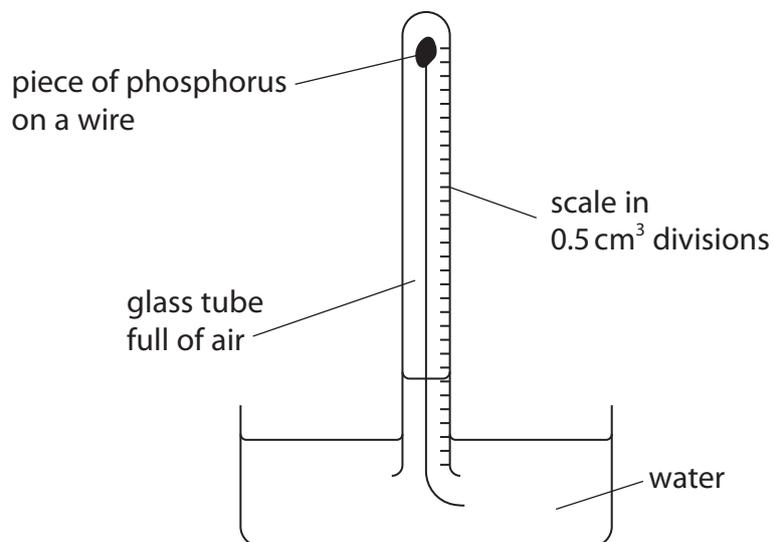
2 .....

**(Total for Question 4 = 9 marks)**



- 5 A teacher uses the reaction between phosphorus and oxygen to calculate the percentage of oxygen in air.

She uses this apparatus and excess phosphorus.



The volume of gas in the tube decreases as the phosphorus reacts with oxygen.

The teacher measures the volume of gas in the tube at one-minute intervals.

The table shows the teacher's results.

Time in minutes	Volume of gas in tube in cm <sup>3</sup>
0	48.5
1	41.0
2	38.0
4	37.5
5	37.0
6	37.0
7	37.0

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(a) State how the results show that all the oxygen has reacted.

(1)

(b) Give one change to this experiment that would make the results more accurate.

(1)

(c) Use the results to calculate the percentage of oxygen in air.

Give your answer to one decimal place.

(3)

percentage = ..... %

**(Total for Question 5 = 5 marks)**

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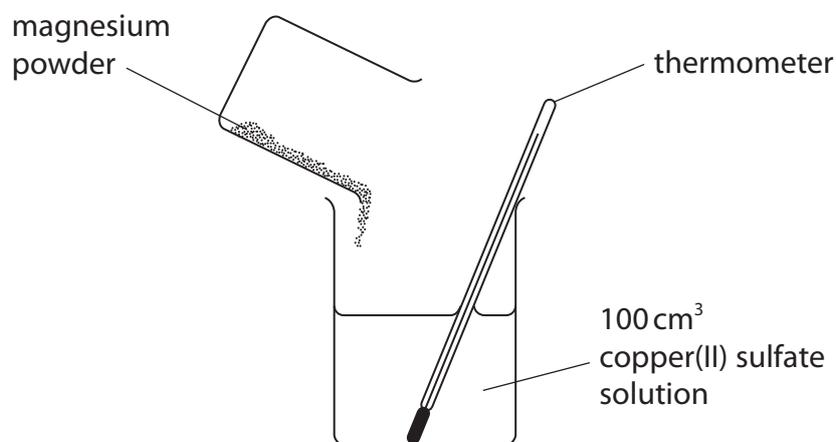
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6 The reaction between magnesium and copper(II) sulfate solution is exothermic.

This apparatus is used to measure the temperature increase when excess magnesium is added to 100 cm<sup>3</sup> of copper(II) sulfate solution.



(a) (i) State why a reaction occurs when magnesium is added to copper(II) sulfate solution. (1)

(ii) Complete the word equation for this reaction. (1)

magnesium + copper(II) sulfate → ..... + .....

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(b) The temperature at the start of the reaction is 20.2 °C.

The maximum temperature recorded is 56.3 °C.

(i) Calculate the heat energy change, in joules, for the reaction.

[mass of 1.00 cm<sup>3</sup> of solution = 1.00 g]

[c for the solution = 4.2 J/g/°C]

(2)

heat energy change = ..... J

(ii) Explain why it is better to use a polystyrene cup rather than a glass beaker in this experiment.

(2)

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(c) The reaction between zinc and copper(II) sulfate solution is also exothermic.

(i) A mass of 0.500 g of zinc is reacted with an excess of copper(II) sulfate solution.

The heat energy change is 1.67 kJ.

Calculate the molar enthalpy change,  $\Delta H$ , in kJ/mol.

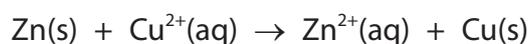
Include a sign in your answer.

Give your answer to three significant figures.

(3)

$\Delta H = \dots\dots\dots$  kJ/mol

(ii) The ionic equation for the reaction between zinc and copper(II) sulfate is



Explain why this is a redox reaction.

(3)

**(Total for Question 6 = 12 marks)**



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7 A student investigates the reaction between sodium hydroxide solution and hydrochloric acid.

He uses this method.

Step 1 add  $50\text{ cm}^3$  of dilute hydrochloric acid to a conical flask

Step 2 add a  $5\text{ cm}^3$  portion of sodium hydroxide solution to the conical flask

Step 3 test the pH of the mixture using both universal indicator paper and a pH meter

The student repeats step 2 and step 3 until a total of  $50\text{ cm}^3$  of sodium hydroxide solution has been added.

(a) (i) State the piece of apparatus that should be used to measure  $50\text{ cm}^3$  of hydrochloric acid.

(1)

(ii) Name the type of reaction that occurs between hydrochloric acid and sodium hydroxide.

(1)

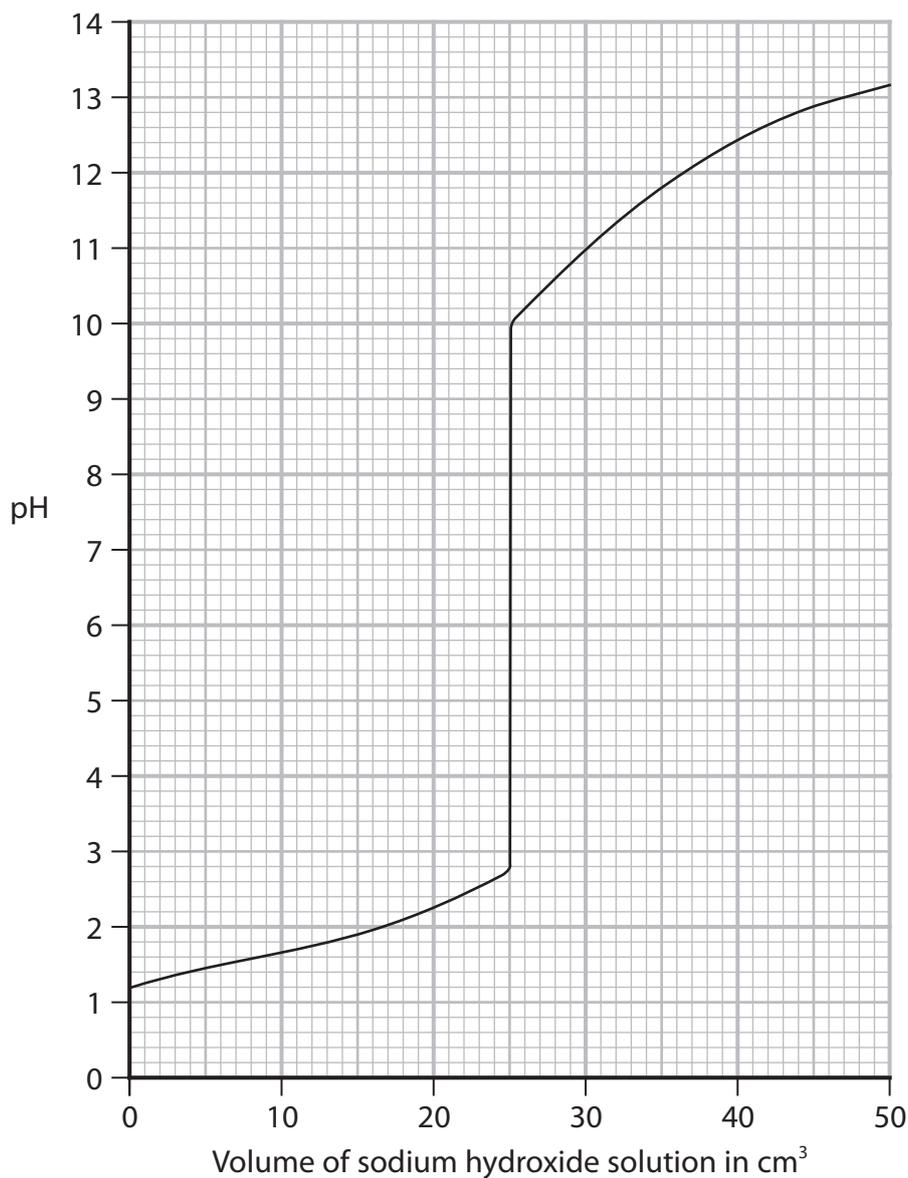
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(b) Graph 1 shows how the pH of the mixture changes as the sodium hydroxide solution is added.



**Graph 1**

(i) Determine the pH after 40 cm<sup>3</sup> of sodium hydroxide solution has been added.

(1)

(ii) Suggest the colour of the universal indicator paper when these volumes of sodium hydroxide solution have been added.

(2)

15 cm<sup>3</sup> .....

30 cm<sup>3</sup> .....

(iii) Give the formula of the ion that causes sodium hydroxide to be alkaline.

(1)

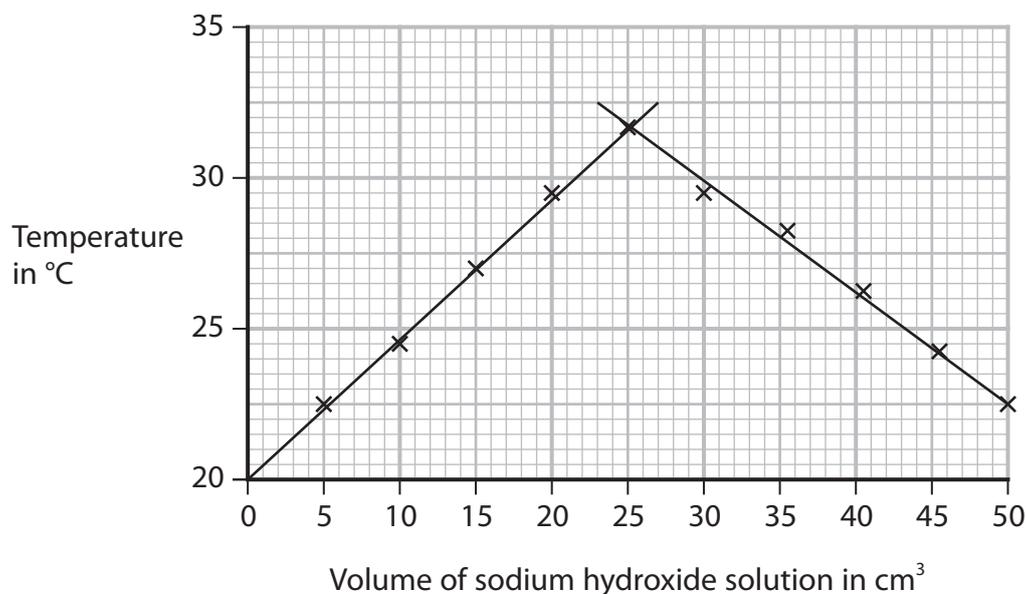


- (c) Another student investigates how the temperature changes when the sodium hydroxide solution is added to the hydrochloric acid.

The hydrochloric acid and the sodium hydroxide solution are at the same temperature at the start of the investigation.

The student records the temperature of the mixture after adding each 5 cm<sup>3</sup> portion of sodium hydroxide solution.

Graph 2 shows her results.



**Graph 2**

Explain the shape of graph 2.

(3)

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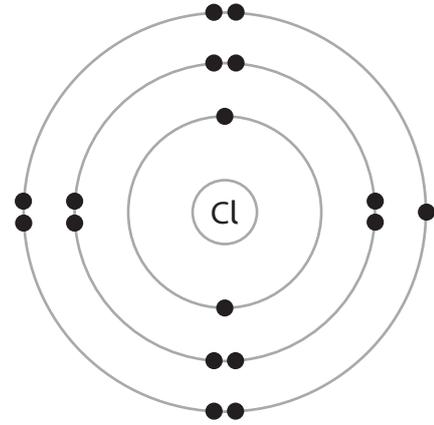
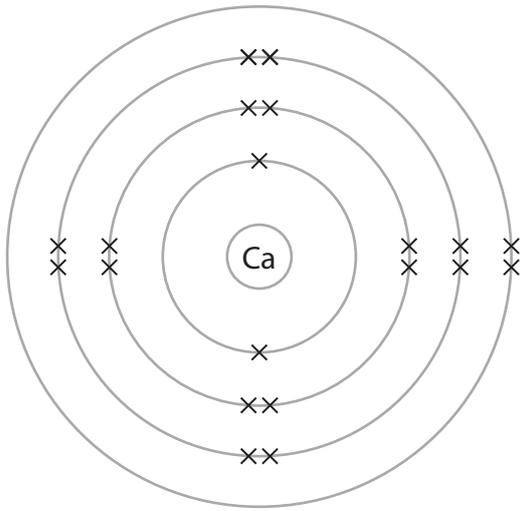
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**(Total for Question 7 = 9 marks)**



- 8 (a) The diagram shows the arrangement of electrons in an atom of calcium and in an atom of chlorine.



Describe, in terms of electrons, what happens when calcium reacts with chlorine to form the ionic compound calcium chloride,  $\text{CaCl}_2$

(3)

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(b) Describe tests to show that an aqueous solution of calcium chloride contains calcium ions and chloride ions.

(4)

calcium ions.....

.....

.....

.....

chloride ions.....

.....

.....

.....

(c) Solid calcium chloride does not conduct electricity. Aqueous solutions of calcium chloride do conduct electricity.

A student uses this method to investigate how the conductivity of a solution changes when calcium chloride is dissolved in pure water.

Step 1 add 100 cm<sup>3</sup> of pure water to a beaker

Step 2 add one spatula of solid calcium chloride to the beaker

Step 3 stir the solution

Step 4 measure the conductivity of the solution

Step 5 repeat until nine spatulas of solid calcium chloride have been added

The table shows the student's results.

Number of spatulas of calcium chloride	Conductivity of solution in arbitrary units
0	0
1	6
2	12
3	12
4	24
5	30
6	36
7	36
8	36
9	36

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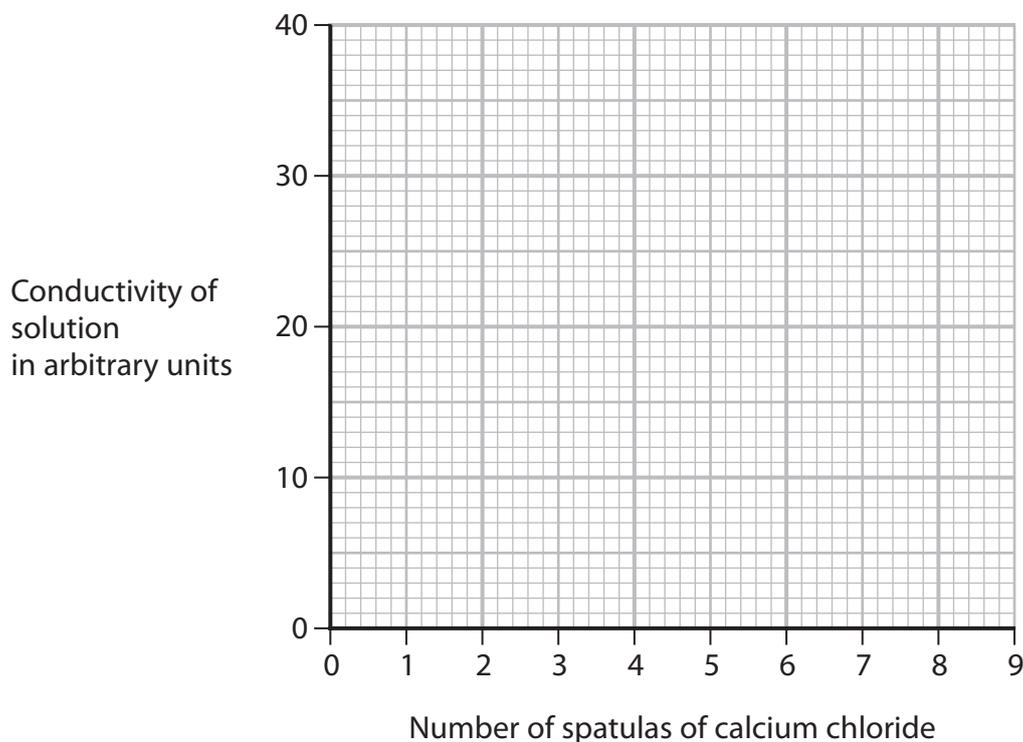
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- (i) Plot the results on the grid and draw two straight lines of best fit.

Ignore the anomalous result.

(3)



- (ii) State the trend shown on the graph for the first six spatulas of calcium chloride.

(1)

- (iii) Suggest an error the student could have made to cause the anomalous result.

(1)

- (d) Describe another way to make solid calcium chloride conduct electricity.

(2)

**(Total for Question 8 = 14 marks)**



9 This question is about alkenes and polymers.

(a) (i) Ethene ( $C_2H_4$ ) can be represented by different types of formula.

Complete the table by giving the missing information.

(2)

<b>Molecular formula</b>	$C_2H_4$
<b>Empirical formula</b>	
<b>General formula</b>	

(ii) Ethene is a member of the homologous series of alkenes.

All members of the same homologous series have the same general formula.

Give two other characteristics of a homologous series.

(2)

1 .....

2 .....

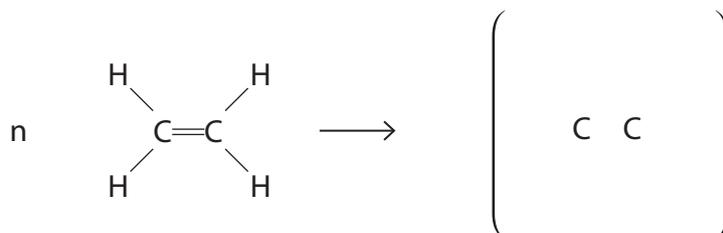
(b) Ethene is used to make poly(ethene).

(i) State the type of polymerisation used to form poly(ethene).

(1)

(ii) Complete the equation for the polymerisation of ethene.

(2)



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(iii) Poly(ethene) is used to make plastic bags.

Corn starch from plants can also be used to make polymers for plastic bags.

The table gives some information about poly(ethene) and polymers made from corn starch.

	Poly(ethene)	Polymers from corn starch
Cost per tonne	£1500	£3700
Relative strength	100	50
Time to decompose	estimated 450 years	3–6 months

Use the information in the table and your knowledge to discuss the advantages and disadvantages of using poly(ethene) to make plastic bags.

(5)

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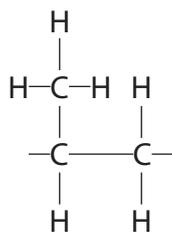


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(c) The diagram shows the repeat unit of another polymer.



Draw the displayed formula of the monomer used to make this polymer.

(1)

(Total for Question 9 = 13 marks)



**10** This question is about carbon and its compounds.

- (a) (i) Draw a dot-and-cross diagram to show the outer shell electrons in a molecule of carbon dioxide,  $\text{CO}_2$

(2)

- (ii) The atoms in carbon dioxide are held together by covalent bonds.

Describe the forces of attraction in a covalent bond.

(2)

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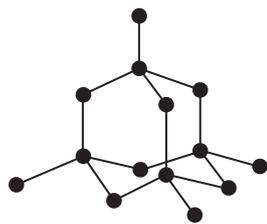
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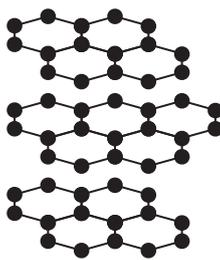
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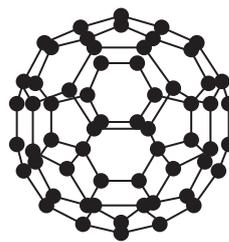
(b) The diagram shows three different structures of carbon.



diamond



graphite



C<sub>60</sub> fullerene

(i) Explain why graphite conducts electricity.

(2)

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(ii) Explain why diamond has a much higher melting point than  $C_{60}$  fullerene.

Refer to structure and bonding in your answer.

(5)

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**(Total for Question 10 = 11 marks)**



11 This question is about the reduction of metal oxides.

(a) Solid oxides of copper can be reduced by reacting them with methane gas.

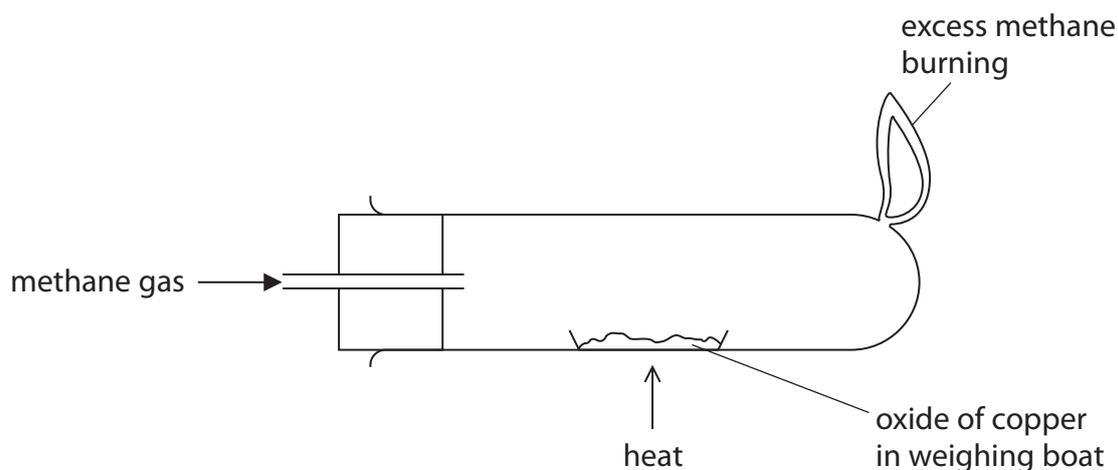
Complete the equation for the reaction between copper(II) oxide and methane.

Include state symbols.

(2)



(b) A teacher uses this apparatus to demonstrate the reaction between a different oxide of copper and methane.



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- (i) The teacher heats the oxide of copper until the reaction is complete.

The table shows the teacher's results.

	Mass in g
empty weighing boat	15.05
weighing boat + oxide of copper	18.63
weighing boat + copper	18.23

Use the teacher's results to show that the empirical formula of this oxide of copper is  $\text{Cu}_2\text{O}$

(4)

- (ii) The teacher wears safety glasses and a lab coat during the demonstration.

Give one other safety precaution that she should take.

(1)

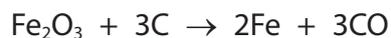
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(c) Iron forms when iron(III) oxide is heated with carbon.

The equation for the reaction is



(i) State how the equation shows that iron(III) oxide is reduced.

(1)

(ii) State why carbon monoxide should not be released into the atmosphere.

(1)

(iii) Calculate the maximum mass, in tonnes, of iron that can be produced when 30.0 tonnes of iron(III) oxide are reacted with an excess of carbon.

[1 tonne =  $1.0 \times 10^6$  g]

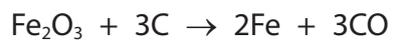
(4)

mass = ..... tonnes



(iv) A mixture of 25 000 mol of iron(III) oxide and 840 000 g of carbon is heated.

Use this equation to show that the iron(III) oxide is in excess.



(2)

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**(Total for Question 11 = 15 marks)**

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**TOTAL FOR PAPER = 110 MARKS**

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