

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	

### 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	Key										7	0																																					
			relative atomic mass atomic symbol name atomic (proton) number																																																
7	Li lithium 3	9	Be beryllium 4	11	Na sodium 11	12	Mg magnesium 12	13	Al aluminium 13	14	Si silicon 14	15	P phosphorus 15	16	S sulfur 16	17	Cl chlorine 17	18	Ar argon 18																																
19	K potassium 19	20	Ca calcium 20	21	Sc scandium 21	22	Ti titanium 22	23	V vanadium 23	24	Cr chromium 24	25	Mn manganese 25	26	Fe iron 26	27	Co cobalt 27	28	Ni nickel 28	29	Cu copper 29	30	Zn zinc 30	31	Ga gallium 31	32	Ge germanium 32	33	As arsenic 33	34	Se selenium 34	35	Br bromine 35	36	Kr krypton 36																
37	Rb rubidium 37	38	Sr strontium 38	39	Y yttrium 39	40	Zr zirconium 40	41	Nb niobium 41	42	Mo molybdenum 42	43	Tc technetium 43	44	Ru ruthenium 44	45	Rh rhodium 45	46	Pd palladium 46	47	Ag silver 47	48	Cd cadmium 48	49	In indium 49	50	Sn tin 50	51	Sb antimony 51	52	Te tellurium 52	53	I iodine 53	54	Xe xenon 54																
55	Cs caesium 55	56	Ba barium 56	57	La* lanthanum 57	58	Ce cerium 58	59	Pr praseodymium 59	60	Nd neodymium 60	61	Pm promethium 61	62	Sm samarium 62	63	Eu europium 63	64	Gd gadolinium 64	65	Tb terbium 65	66	Dy dysprosium 66	67	Ho holmium 67	68	Er erbium 68	69	Tm thulium 69	70	Yb ytterbium 70	71	Lu lutetium 71	72	Hf hafnium 72	73	Ta tantalum 73	74	W tungsten 74	75	Re rhenium 75	76	Os osmium 76	77	Ir iridium 77	78	Pt platinum 78	79	Au gold 79	80	Hg mercury 80
87	Fr francium 87	88	Ra radium 88	89	Ac* actinium 89	90	Th thorium 90	91	Pa protactinium 91	92	U uranium 92	93	Np neptunium 93	94	Pu plutonium 94	95	Am americium 95	96	Cm curium 96	97	Bk berkelium 97	98	Cf californium 98	99	Es einsteinium 99	100	Fm fermium 100	101	Mendelevium 101	102	Nobelium 102	103	Lr lawrencium 103	104	Rf rutherfordium 104	105	Db dubnium 105	106	Sg seaborgium 106	107	Bh bohrium 107	108	Hs hassium 108	109	Mt meitnerium 109	110	Ds darmstadtium 110	111	Rg roentgenium 111		
[223]	Fr francium 87	[226]	Ra radium 88	[227]	Ac* actinium 89	[261]	Rf rutherfordium 104	[262]	Db dubnium 105	[266]	Sg seaborgium 106	[264]	Bh bohrium 107	[277]	Hs hassium 108	[268]	Mt meitnerium 109	[271]	Ds darmstadtium 110	[272]	Rg roentgenium 111	201	Hg mercury 80	204	Tl thallium 81	207	Pb lead 82	209	Bi bismuth 83	[210]	At astatine 85	[209]	Po polonium 84	128	Te tellurium 52	127	I iodine 53	131	Xe xenon 54	[222]	Rn radon 86										
Elements with atomic numbers 112-116 have been reported but not fully authenticated																																																			

\* 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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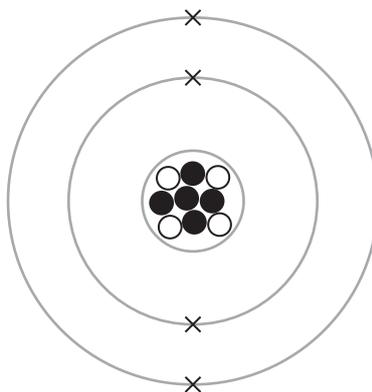
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**Answer ALL questions.**

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.

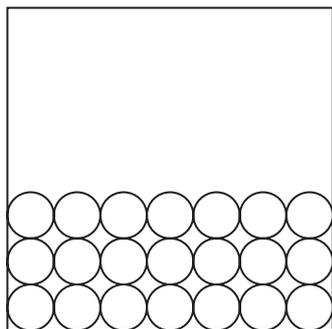
(1)

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

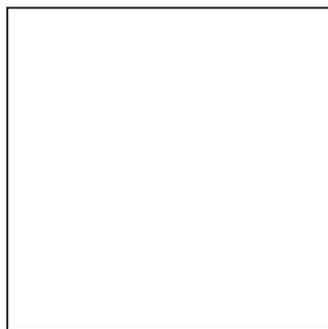


2 This question is about states of matter.

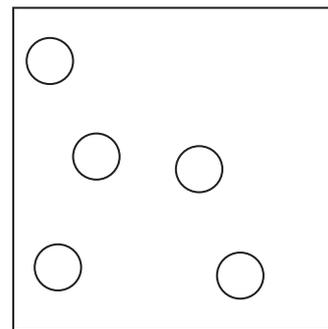
(a) The diagram shows how the particles of a substance are arranged in two different states.



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)

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**(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	

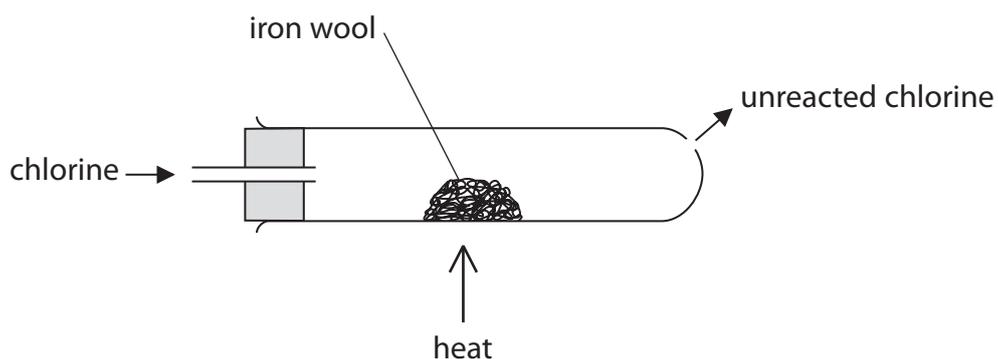
(ii) Why do the halogens have similar chemical properties?

(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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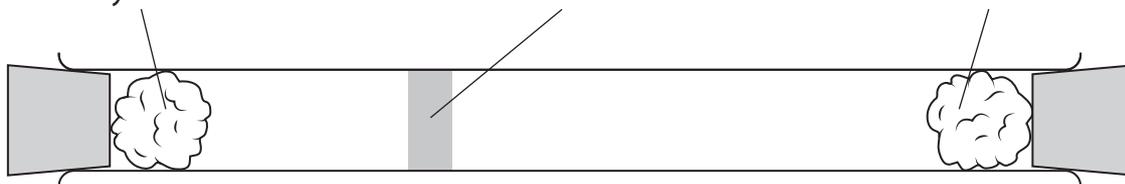


(d) The diagram shows the formation of ammonium chloride in a glass tube.

cotton wool soaked in  
concentrated hydrochloric acid

ammonium chloride

cotton wool soaked in  
concentrated ammonia solution



(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 .....

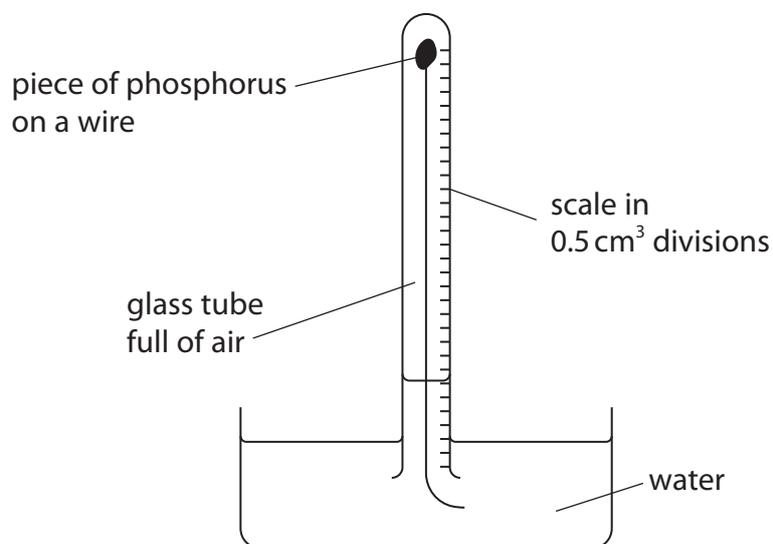
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**(Total for Question 4 = 9 marks)**



- 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 $\text{cm}^3$
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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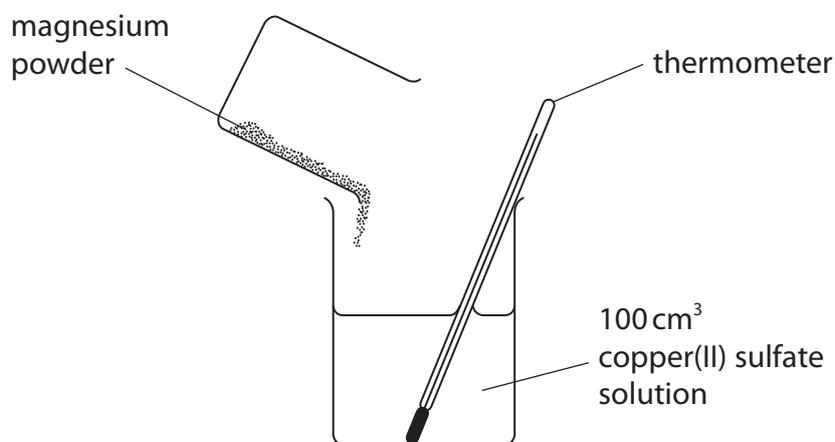
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6 The reaction between magnesium and copper(II) sulfate solution is exothermic.

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.

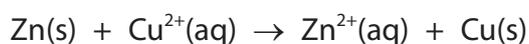
Include a sign in your answer.

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)

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**(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)

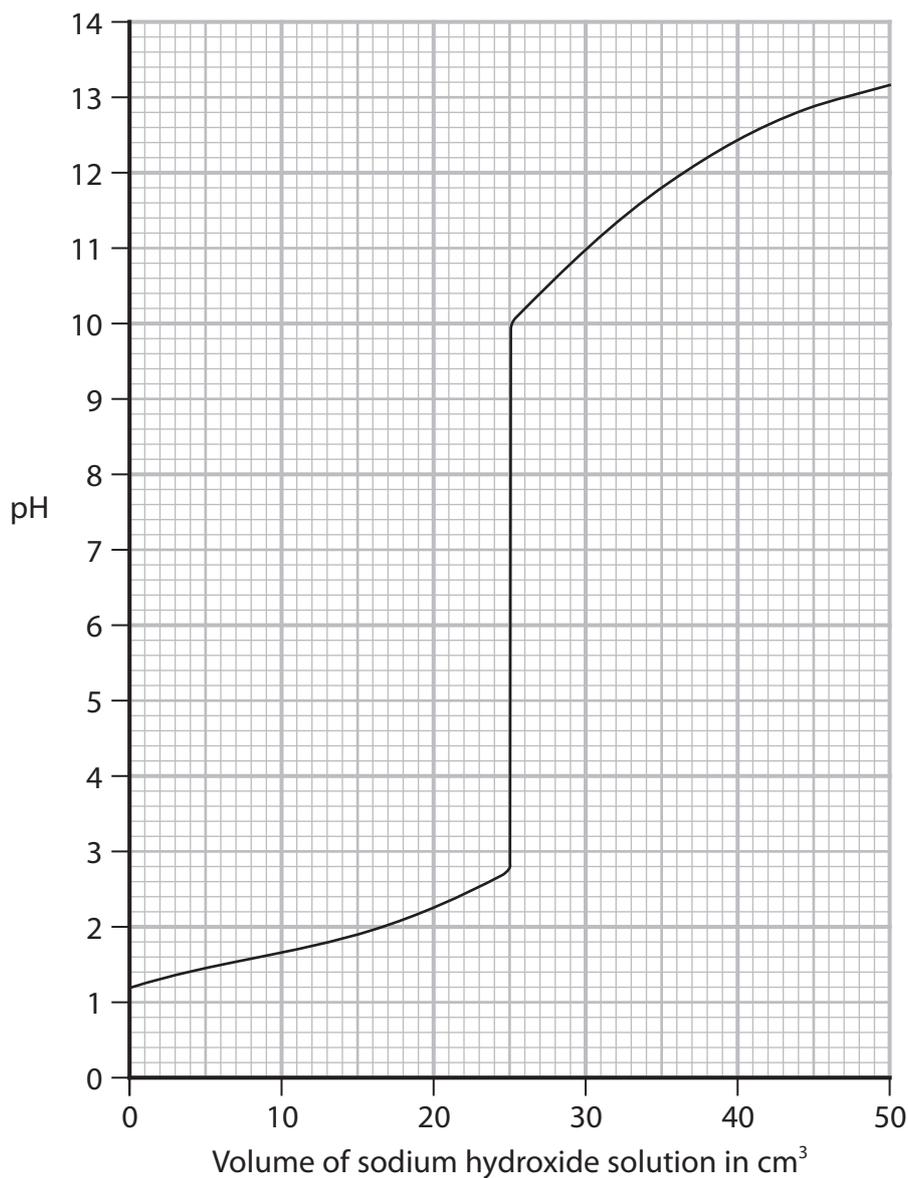
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(b) Graph 1 shows how the pH of the mixture changes as the sodium hydroxide solution is added.



**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>

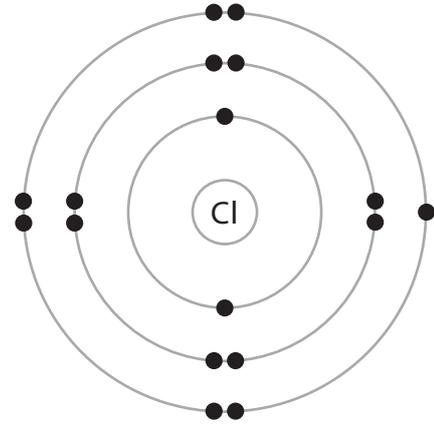
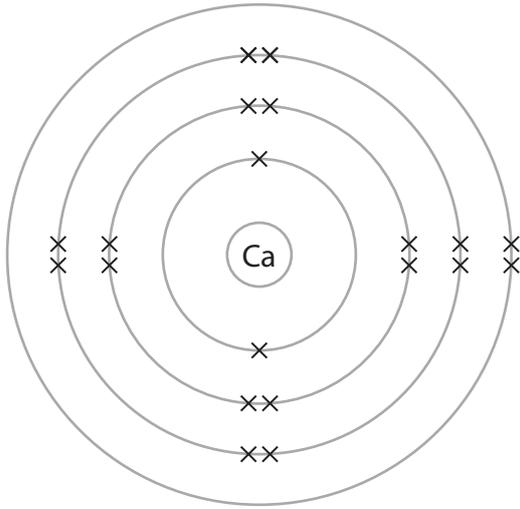
(iii) Give the formula of the ion that causes sodium hydroxide to be alkaline.

(1)





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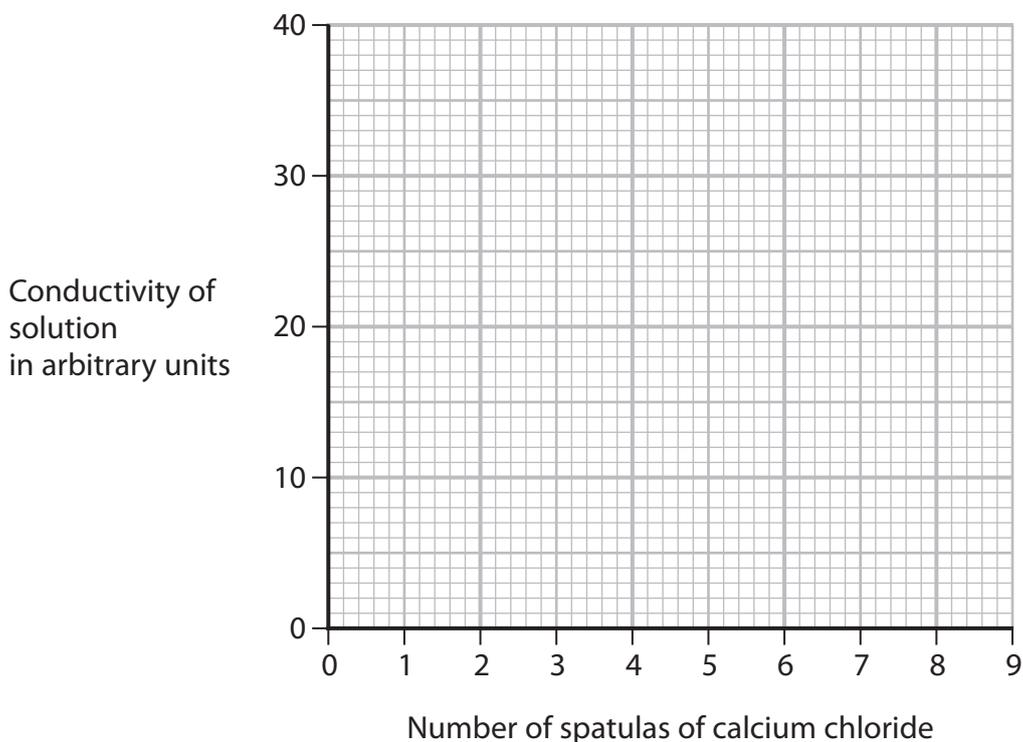
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- (i) Plot the results on the grid and draw two straight lines of best fit.

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 .....

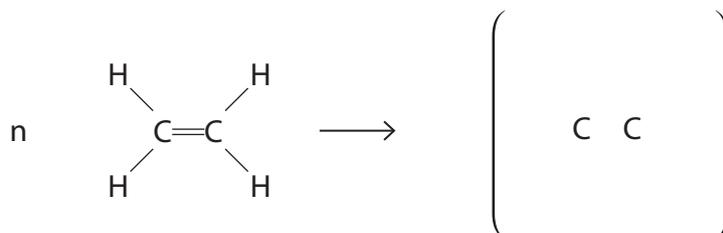
(b) Ethene is used to make poly(ethene).

(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)

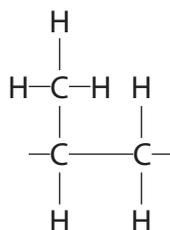
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(c) The diagram shows the repeat unit of another polymer.



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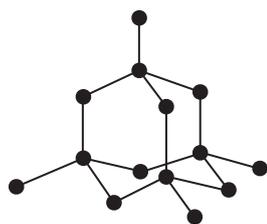
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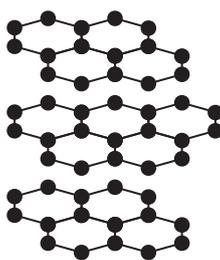
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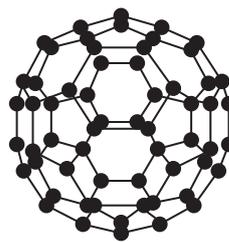
(b) The diagram shows three different structures of carbon.



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.

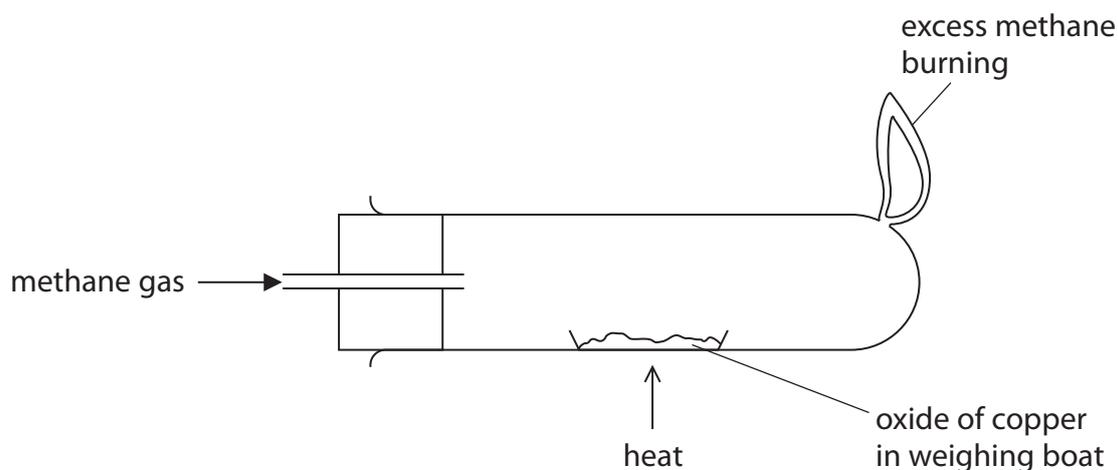
Complete the equation for the reaction between copper(II) oxide and methane.

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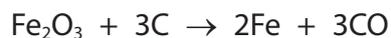
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(c) Iron forms when iron(III) oxide is heated with carbon.

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]

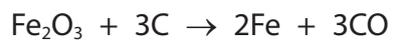
(4)

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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