Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE (9–1)

Time 2 hours

Paper reference 4CH1/1CR 4SD0/1CR

Chemistry

UNIT: 4CH1

Science (Double Award) 4SD0

PAPER: 1CR

You must have:
Calculator, ruler

January 2023

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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.

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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P 7 1 8 9 3 A 0 1 3 2

Pearson

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										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
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **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	178 **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	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[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	Elements with atomic numbers 112–116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

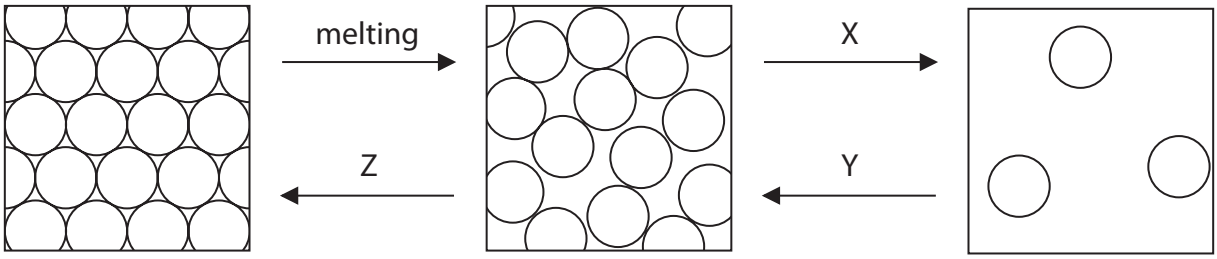
**** The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have been omitted.***

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

Answer ALL questions.

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 ☒.

1 The diagram shows how the particles are arranged in the three states of matter.



(a) Use words from the box to identify the changes of state X, Y and Z.

condensing	cooling	crystallising	diffusing
evaporating	freezing	heating	

(3)

X .....

Y .....

Z .....

(b) Describe the differences in the movement of particles in solids and gases.

(2)

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.....

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.....

.....

.....

(Total for Question 1 = 5 marks)

2 This question is about gases in the atmosphere.

(a) (i) Name the most abundant gas in the atmosphere.

(1)

.....

(ii) Name the noble gas that makes up about 1% of the atmosphere.

(1)

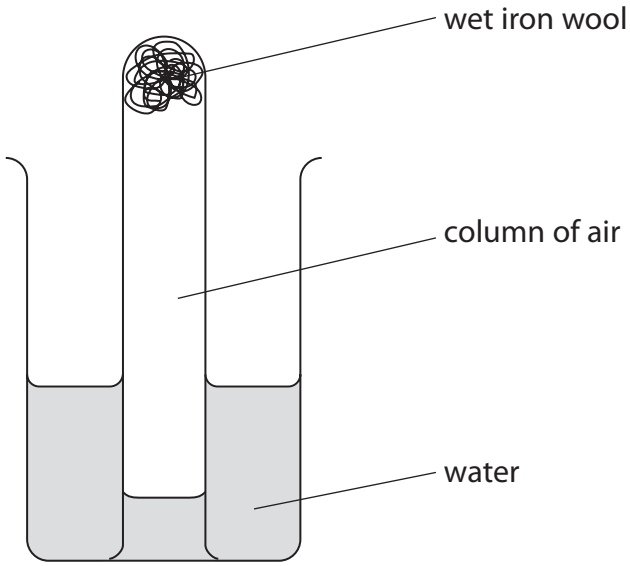
.....

(iii) Name a greenhouse gas in the atmosphere.

(1)

.....

(b) A student uses this apparatus to determine the percentage of oxygen in a sample of air.



This is the student's method.

- measure the initial length of the column of air in the tube
- leave the apparatus for one week
- measure the final length of the column of air

The table shows the student's results.

initial length of column of air in mm	84
final length of column of air in mm	69

(i) State the appearance of the iron wool after one week.

(1)

.....

(ii) Use the student's results to show that the percentage of oxygen in the sample of air is approximately 18%.

(2)

(iii) The actual percentage of oxygen in air is approximately 21%.

Give a reason why the percentage of air calculated from the student's results is less than 21%.

(1)

.....

.....

.....

(Total for Question 2 = 7 marks)

3 This question is about alkanes.

(a) An alkane has the structural formula $CH_3CH_2CH_2CH_3$

Give the missing information for this alkane.

(4)

structural formula	$CH_3CH_2CH_2CH_3$
name	
	C_4H_{10}
empirical formula	
	C_nH_{2n+2}

(b) There are two isomers of C_4H_{10}

(i) State what is meant by the term **isomers**.

(2)

.....

.....

.....

.....

(ii) Draw the displayed formula of each isomer of C_4H_{10}

(2)

Isomer 1	Isomer 2

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(c) Methane reacts with bromine to form bromomethane and one other product.

(i) Give the formula of the other product.

(1)

.....

(ii) What is the name of this type of reaction?

(1)

- ☒ **A** addition
- ☒ **B** decomposition
- ☒ **C** neutralisation
- ☒ **D** substitution

(iii) State the condition needed for this reaction to occur.

(1)

.....

(d) When ethane (C_2H_6) burns in a plentiful supply of air, carbon dioxide and water are formed.

(i) Give a chemical equation for this reaction.

(2)

.....

(ii) When the air supply is limited, incomplete combustion occurs.

Explain why a gas formed by incomplete combustion can cause a problem for humans.

(2)

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.....

.....

(Total for Question 3 = 15 marks)

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4 A student investigates the effect of temperature on the rate of reaction between two solutions, A and B. When the reaction occurs, the mixture turns from colourless to blue.

This is the student's method.

- pour 25 cm^3 of solution A into a conical flask
- add solution B and measure the temperature of the mixture
- record the time taken for the mixture to turn blue

The student repeats this method at different temperatures.

(a) Give two variables that the student needs to keep constant in this investigation.

(2)

1 .....

2 .....

(b) The table shows the student's results.

Temperature in °C	15	20	25	35	45	65
Time taken in seconds	178	156	132	130	122	113

(i) Plot the student's results on the grid.

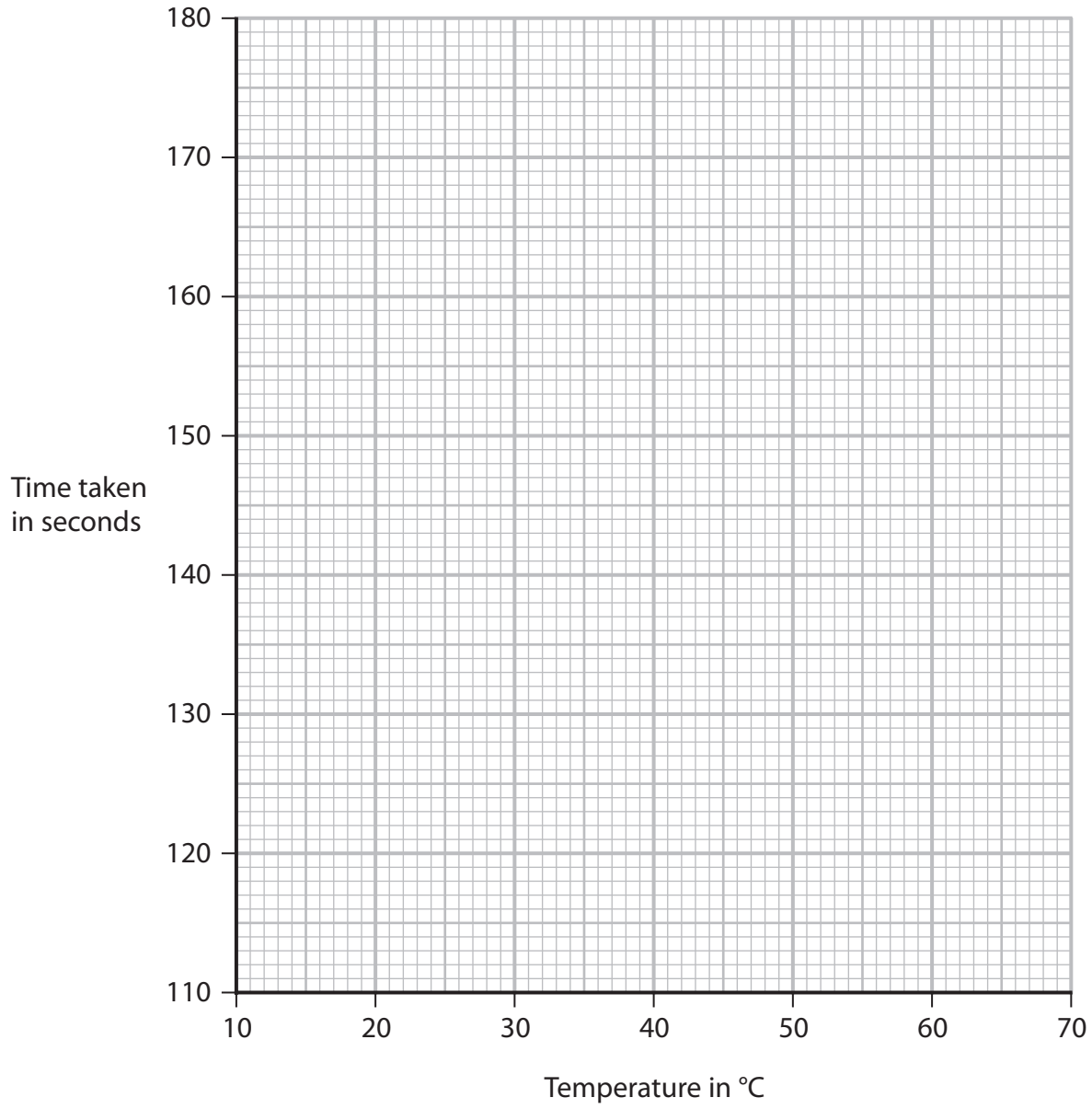
(1)

(ii) Draw a circle around the anomalous result.

(1)

(iii) Draw a curve of best fit.

(1)



(iv) Give a reason for the anomalous result.

(1)

.....

.....

(v) Use your graph to determine the time taken for the mixture to turn blue at 55 °C.

Show your working on the graph.

(2)

time taken = ... s

(c) Use information from the table to calculate the mean rate of reaction at 20 °C.

Use the expression

$$\text{mean rate} = \frac{1}{\text{time in seconds}}$$

Give your answer in standard form.

(2)

mean rate = ... s^{-1}

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(d) Explain how increasing the temperature affects the rate of a reaction.

Refer to particle collision theory in your answer.

(3)

(Total for Question 4 = 13 marks)

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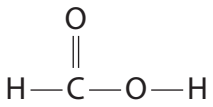
5 This question is about organic compounds.

(a) The diagram shows the displayed formula of methanoic acid.



(i) Give the total number of atoms in one molecule of methanoic acid.

(1)

.....

(ii) Determine the relative molecular mass (M_r) of methanoic acid.

(1)

M_r = ...

(iii) Explain why methanoic acid is not a hydrocarbon.

(2)

.....

.....

.....

.....

(b) The atoms in methanoic acid are held together by covalent bonds.

(i) State, in terms of electrostatic attractions, what is meant by the term **covalent bond**.

(2)

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(ii) Draw a dot-and-cross diagram to show the bonding in a molecule of methanoic acid.

Show only the outer electrons of each atom.

(3)

(c) Calculate the empirical formula of the organic compound with this composition by mass.

C = 52.2% H = 13.0% O = 34.8%

(3)

empirical formula = ...

(Total for Question 5 = 12 marks)

6 This question is about elements in Group 7 of the Periodic Table.

(a) (i) Which element is a liquid at room temperature?

(1)

- ☒ **A** astatine
- ☒ **B** bromine
- ☒ **C** chlorine
- ☒ **D** fluorine

(ii) What colour is solid iodine?

(1)

- ☒ **A** black
- ☒ **B** dark brown
- ☒ **C** dark grey
- ☒ **D** purple

(iii) Describe a test for chlorine gas.

(2)

.....

.....

.....

.....

(b) A sample of chlorine, containing two isotopes, has this percentage composition by mass.

chlorine-35 71.2% chlorine-37 28.8%

Calculate the relative atomic mass of this sample of chlorine.

Give your answer to one decimal place.

(3)

relative atomic mass = ...

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(c) A student is given an aqueous solution of chlorine and an aqueous solution of sodium iodide.

Explain how the student can use these solutions to compare the reactivity of chlorine with the reactivity of iodine.

(4)

(Total for Question 6 = 11 marks)

7 (a) A teacher ignites a piece of magnesium ribbon and places it in a gas jar of oxygen.

This is the equation for the reaction.

$$2Mg + O_2 \rightarrow 2MgO$$

Give two observations that would be made during this reaction.

(2)

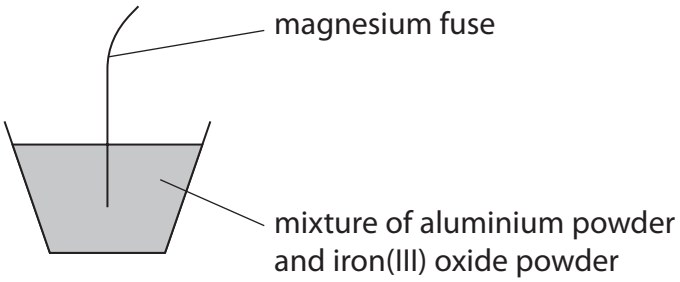
1 .....

.....

2 .....

.....

(b) The teacher demonstrates the reaction between aluminium and iron(III) oxide.



The teacher ignites the magnesium fuse. A very exothermic reaction then occurs between aluminium powder and iron(III) oxide.

The products of the reaction are iron and aluminium oxide.

(i) State what is meant by the term **exothermic**.

(1)

.....

.....

(ii) Give a chemical equation for the reaction between aluminium and iron(III) oxide.

(1)

.....

(iii) Explain why this reaction is a redox reaction.

(2)

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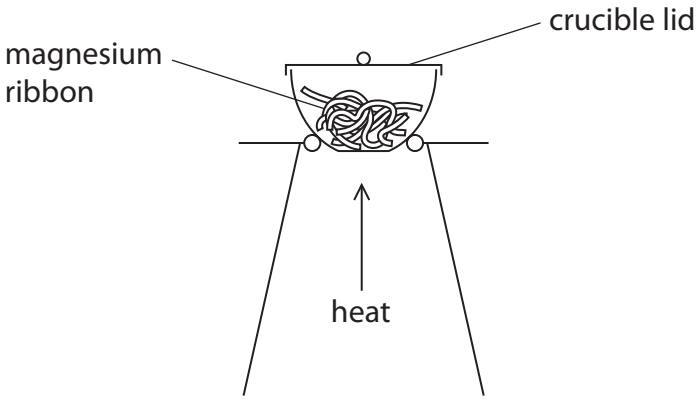
(c) A student uses this apparatus to determine the formula of magnesium oxide.



This is the student's method.

- find mass of empty crucible and lid
- place some magnesium ribbon in crucible
- find mass of crucible, lid and magnesium ribbon
- heat crucible, lifting lid occasionally
- after five minutes, find mass of crucible, lid and magnesium oxide

(i) Explain why the student lifts the lid.

(2)

(ii) The mass of magnesium oxide formed is less than expected.

Describe what the student should do next to obtain a more accurate value for the mass of magnesium oxide.

(2)

.....

.....

.....

.....

(Total for Question 7 = 10 marks)

8 This question is about the oxides of some elements in Group 4 of the Periodic Table.

(a) When 5.34 g of lead(II) carbonate are heated, lead(II) oxide and carbon dioxide are formed.

This is the equation for the reaction.

$$PbCO_3(s) \rightarrow PbO(s) + CO_2(g)$$

(i) Give the name for this type of reaction.

(1)

.....

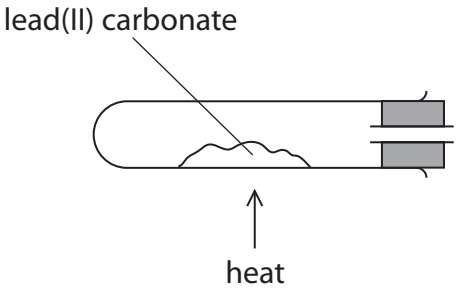
(ii) Calculate the maximum mass of lead(II) oxide that can be formed from 5.34 g of lead(II) carbonate.

[for $PbCO_3$, $M_r = 267$ for PbO, $M_r = 223$]

(2)

maximum mass = ... g

(b) The diagram shows apparatus used to heat lead(II) carbonate.



(i) Complete the diagram to show what needs to be added to the apparatus to test that the gas released is carbon dioxide.

(2)

(ii) Give the result of the test.

(1)

.....

.....

(c) Silicon dioxide (SiO_2) and carbon dioxide both contain covalent bonds.

Silicon dioxide is a solid with a high melting point. Carbon dioxide is a gas at room temperature.

Explain why silicon dioxide has a much higher melting point than carbon dioxide.

Refer to structure and bonding in your answer.

(6)

(Total for Question 8 = 12 marks)

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9 A student uses the reaction between zinc powder and dilute nitric acid to prepare some zinc nitrate crystals.

(a) (i) Complete the equation for the reaction by adding the state symbols.

(1)

$$Zn\ (\ldots\ldots) + 2HNO_3\ (\ldots\ldots) \rightarrow Zn(NO_3)_2\ (\ldots\ldots) + H_2\ (\ldots\ldots)$$

(ii) State what the student would observe during this reaction.

(1)

.....

.....

(b) In the preparation, the student adds an excess of zinc powder to some dilute nitric acid.

(i) State why the student uses an excess of zinc powder.

(1)

.....

.....

(ii) Describe what the student should do next to obtain pure, dry crystals of zinc nitrate.

(5)

(c) The formula for the zinc nitrate crystals is $Zn(NO_3)_2.6H_2O$

When zinc nitrate crystals are heated, the products are zinc oxide, nitrogen dioxide (NO_2), oxygen and water.

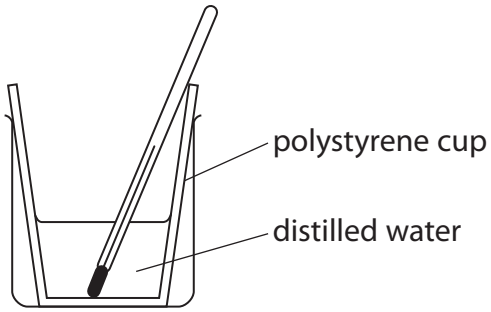
Complete the equation for this reaction.

(2)

$2Zn(NO_3)_2.6H_2O \rightarrow$ ..... + ... + ... + ...

(Total for Question 9 = 10 marks)

10 A student uses this apparatus to find the heat energy change when ammonium nitrate dissolves in water to form a solution.



This is the student's method.

- add 50 cm^3 of distilled water to the polystyrene cup and record the initial temperature of the water
- add a known mass of ammonium nitrate to the polystyrene cup and stir the mixture until all the solid dissolves
- record the minimum temperature of the ammonium nitrate solution

(a) Give two reasons why the student stirs the mixture.

(2)

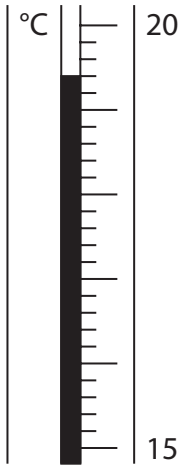
1 .....

.....

2 .....

.....

(b) The diagram shows the minimum temperature of the solution.



Complete the table by giving the missing information.

Give both values to the nearest 0.1 °C.

(2)

initial temperature of distilled water in °C	23.4
minimum temperature of solution in °C	
temperature change in °C	

(c) The student repeats the experiment, again using 50 cm^3 water, and finds that the temperature change is 3.9 °C.

(i) Show that the heat energy change, Q, in this experiment is about 800 J.

[c = 4.2 J / g / °C for the solution]

[mass = 1.0 g for 1.0 cm^3 of solution]

(2)

(ii) The student uses 2.8 g of ammonium nitrate in this experiment.

Calculate the enthalpy change, ΔH, in kJ / mol.

Include a sign in your answer.

[for NH_4NO_3, M_r = 80]

(4)

ΔH = ... kJ / mol

(d) Describe a test to show that the ammonium nitrate solution contains ammonium ions.

(3)

(e) In another experiment the student adds anhydrous copper(II) sulfate to distilled water.

The table shows the student's results.

initial temperature of water in °C	23.2
maximum temperature of solution in °C	28.5

Explain what the results show about the type of energy change that occurs when anhydrous copper(II) sulfate dissolves in water.

(2)

(Total for Question 10 = 15 marks)

TOTAL FOR PAPER = 110 MARKS

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