Please check the examination details below before entering your candidate information

Candidate surname	Other names
ANSWERS	MODEL

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

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.

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
																	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

1 **H** 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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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 This question is about acids, alkalis and indicators.

(a) Which of these is the colour of litmus indicator in an acidic solution?

(1)

- ☐ **A** blue
- ☐ **B** orange
- ☒ **C** red
- ☐ **D** yellow

(b) Which of these is the pH value of a neutral solution?

(1)

- ☐ **A** 0
- ☐ **B** 4
- ☒ **C** 7
- ☐ **D** 14

(c) Which of these describes a solution with a pH value of 9?

(1)

- ☐ **A** strongly acidic
- ☐ **B** strongly alkaline
- ☐ **C** weakly acidic
- ☒ **D** weakly alkaline

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(d) Which of these is the chemical formula of an acid?

(1)

- [x] **A** HNO_3
- [ ] **B** H_2O
- [ ] **C** NaCl
- [ ] **D** NaOH

(e) Name the type of reaction that occurs when an acid reacts with an alkali.

(1)

Neutralisation.

(f) Name the two products of the reaction between hydrochloric acid and potassium hydroxide.

(2)

1 Water

2 Potassium Chloride

(Total for Question 1 = 7 marks)

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2 (a) (i) State the meaning of the term **solute**.

(1)

The Solid that dissolves in a Solvent

(ii) State the meaning of the term **solvent**.

(1)

The liquid that the Solute dissolves in.

(b) Explain what is meant by a saturated solution.

(2)

It Contains as much dissolved Solute as possible, at a part.cular temperature.

(c) A dark purple liquid is diluted by adding water.

The diluted liquid becomes a pale purple colour.

Explain the process that causes this change.

Refer to particles in your answer.

(2)

Diffusion - The part.cles Spread out evenly throughout the liquid.

(Total for Question 2 = 6 marks)

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3 This question is about chromatography.

Two students carry out separate chromatography experiments to find the R_f values for five different food dyes, A, B, C, D and E.

(a) State two things that should be the same in both experiments so that the students can compare their results fairly.

(2)

1 Same Solvent

2 Same type of Chromatography paper.

(b) After doing the experiments the students calculate the R_f value for each food dye.

The table shows their results.

Dye	Student 1 R_f value	Student 2 R_f value
A	0.45	0.45
B	0.63	0.64
C	0.00	0.00
D	0.83	1.20
E	0.30	0.30

(i) State what can be concluded about dye C.

(1)

C is insoluble in the Solvent.

(ii) Explain which R_f value cannot be correct.

(2)

Student 2, dye D as R_f Value must not be greater than 1.

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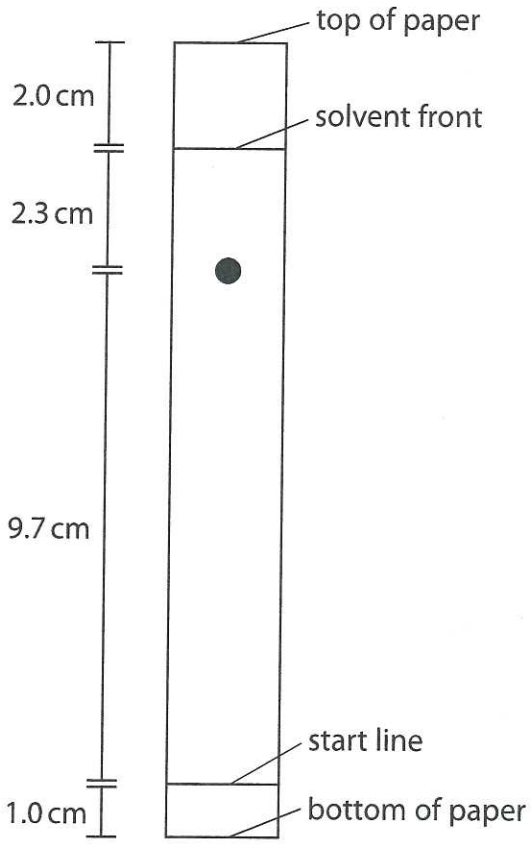
(c) The diagram shows a chromatogram for a different food dye.

Some distances are shown on the diagram.



Calculate the R_f value for this food dye.

Give your answer to two significant figures.

(3)

R_f = Distance travelled by Solute / Distance travelled by Solvent

= 9.7 / 9.7 + 2.3

= 0.81

R_f = 0.81 (2 s.f.)

(Total for Question 3 = 8 marks)

4 (a) State the meaning of the term **atomic number**.

(1)

The number of protons in the nucleus of the atom.

(b) An atom of element X contains 14 protons, 14 electrons and 15 neutrons.

(i) Which of these is the mass number of this atom?

(1)

- ☐ **A** 14
- ☐ **B** 15
- ☐ **C** 28
- ☒ **D** 29

(ii) Explain which group of the Periodic Table element X belongs to.

(2)

Group 4 because it has 4 electrons in its outer shell.

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(c) The table shows the composition of a sample of a different element, Y, containing three isotopes.

Mass number of isotope	Percentage of isotope in sample
32	95.0
33	0.75
34	4.25

Using information from the table, calculate the relative atomic mass (A_r) of this sample of element Y.

Give your answer to one decimal place.

(3)

$$\frac{32(95) + 33(0.75) + 34(4.25)}{100}$$

$$= 32.0925$$

A_r = ~~32.1~~ 32.1 (1 d.p.)

(Total for Question 4 = 7 marks)

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5 This is a question about metals and their compounds.

(a) State one property of metals.

(1)

Good Conductor of electricity / malleable.

(b) Mercury is the only metal that is liquid at room temperature.

Describe the difference in the movement of particles in liquid mercury and in a solid metal.

(2)

In liquid Mercury particles can move whereas in solid metal the particles are in fixed positions.

(c) Magnesium is a metal that burns in air.

(i) State one observation made during the combustion of magnesium metal.

(1)

Bright white flame.

(ii) State one chemical property of the product of combustion that can be used to classify magnesium as a metal.

(1)

Magnesium oxide is a base.

(d) In the absence of air, magnesium reacts with sulfur to form the ionic compound magnesium sulfide, MgS

(i) Give a reason why the reaction needs to be done in the absence of air.

(1)

Magnesium / Sulphur would react with oxygen.

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(ii) Describe, in terms of electrons, the formation of the ions in magnesium sulfide.

Give the charges on the ions.

(3)

A magnesium atom loses two electrons to form an Mg^{2+} ion.

A Sulphur atom gains two electrons to form an S^{2-} ion.

(iii) Explain why magnesium sulfide has a very high melting point.

(3)

The strong electrostatic attraction between the oppositely charged Mg^{2+} and S^{2-} ions require lots of energy and high temperatures to overcome.

(iv) Magnesium sulfide reacts with hydrochloric acid to form magnesium chloride and hydrogen sulfide gas, H_2S

Give the chemical equation for this reaction.

(2)

$MgS + 2HCl \rightarrow MgCl_2 + H_2S$

(Total for Question 5 = 14 marks)

6 Ocimene is an organic compound that gives some plants their particular smell.

The molecular formula of ocimene is $C_{10}H_{16}$

(a) Calculate the relative formula mass (M_r) of ocimene.

(1)

10(12) +16

M_r = 136

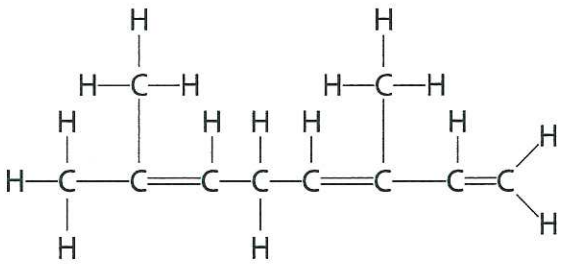
(b) Using ocimene as an example, explain what is meant by the term **empirical formula**.

(2)

It is the Simplest whole number ratio of atoms present in a Compound.

The empirical formula of Ocimene is C_5H_8.

(c) The displayed formula of ocimene is



Explain why ocimene is described as an unsaturated hydrocarbon.

(3)

It Contains C=C double bonds and Contains atoms of Carbon and hydrogen only.

(d) Ocimene is an alkene.

(i) Which of these types of reaction occurs between ocimene and bromine?

(1)

- [x] **A** addition
- [ ] **B** polymerisation
- [ ] **C** precipitation
- [ ] **D** substitution

(ii) Many alkenes have the general formula C_nH_{2n}

Suggest why ocimene does not have this general formula.

(1)

It Contains three double bonds - not the usual 1 for an alkene of general formula C_nH_{2n}

(e) Ocimene can take part in combustion reactions.

Complete the equation for the complete combustion of ocimene.

(2)

$C_{10}H_{16}$ + 14 O_2 → $10CO_2$ + $8H_2O$

(f) Two different products can form during the incomplete combustion of ocimene. One product is a solid and the other is a poisonous gas.

(i) Identify these two products.

(2)

Carbon

Carbon Monoxide.

(ii) State why the gas produced is poisonous.

(1)

Carbon monoxide reduces the capacity of blood to carry oxygen.

(Total for Question 6 = 13 marks)

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7 (a) Explain the meaning of the term **thermal decomposition**.

(2)

Breaking down a Substance by heating.

(b) The equation for the thermal decomposition of potassium hydrogencarbonate is

$$2KHCO_3 \rightarrow K_2CO_3 + H_2O + CO_2$$

Calculate the maximum mass of K_2CO_3 that could be produced from the thermal decomposition of 2.50 g of $KHCO_3$

(4)

$n(KHCO_3) = \frac{mass}{mr} = \frac{2.50}{39+1+12+3(16)}$

$= 0.025$ mol

Ratio $n(KHCO_3 : K_2CO_3) = 2:1$

$n(K_2CO_3) = \frac{0.025}{2} = 0.0125$ mol

$m(K_2CO_3) = mr \times mol$

$= (2(39)+12+3(16)) \times 0.0125$

$= 1.725$

maximum mass of K_2CO_3 = 1.725 g

(Total for Question 7 = 6 marks)

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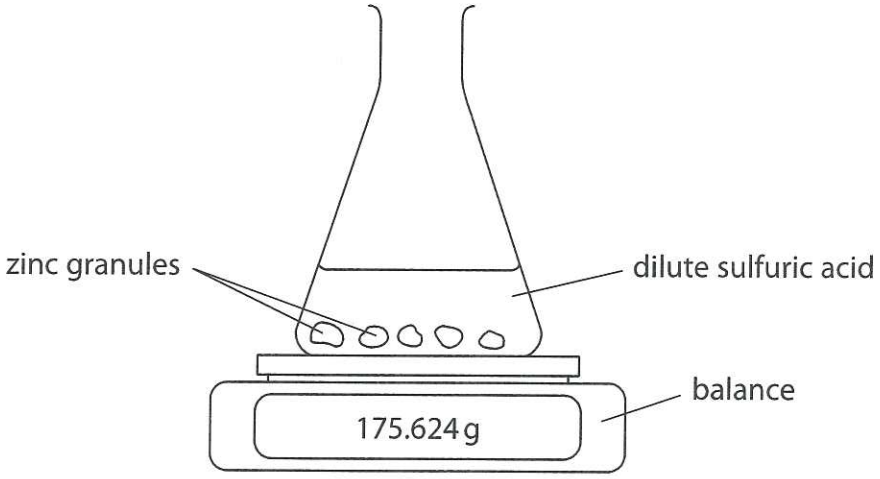
8 A student uses this apparatus in an experiment to study the rate of the reaction between zinc and dilute sulfuric acid.



This is the student's method.

- add a few zinc granules to a conical flask on a balance
- add 100 cm^3 of dilute sulfuric acid to the flask, start a timer and immediately record the mass of the flask and contents
- record the mass of the flask and contents every minute until the mass remains constant

The mass of the flask and contents decreases because hydrogen gas is produced and leaves the flask.

The student uses the mass readings to calculate the total mass of hydrogen produced.

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

(1)

$$Zn\,(\text{s}) + H_2SO_4\,(\text{aq}) \rightarrow ZnSO_4\,(\text{aq}) + H_2\,(\text{g})$$

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

Time in minutes	Total mass of hydrogen produced in mg
0	0
1	80
2	110
3	130
4	148
5	162
6	165
7	184
8	192
9	198
10	204
11	209
12	214
13	218
14	220
15	220

(i) Plot the student's results. The first three have been done for you.

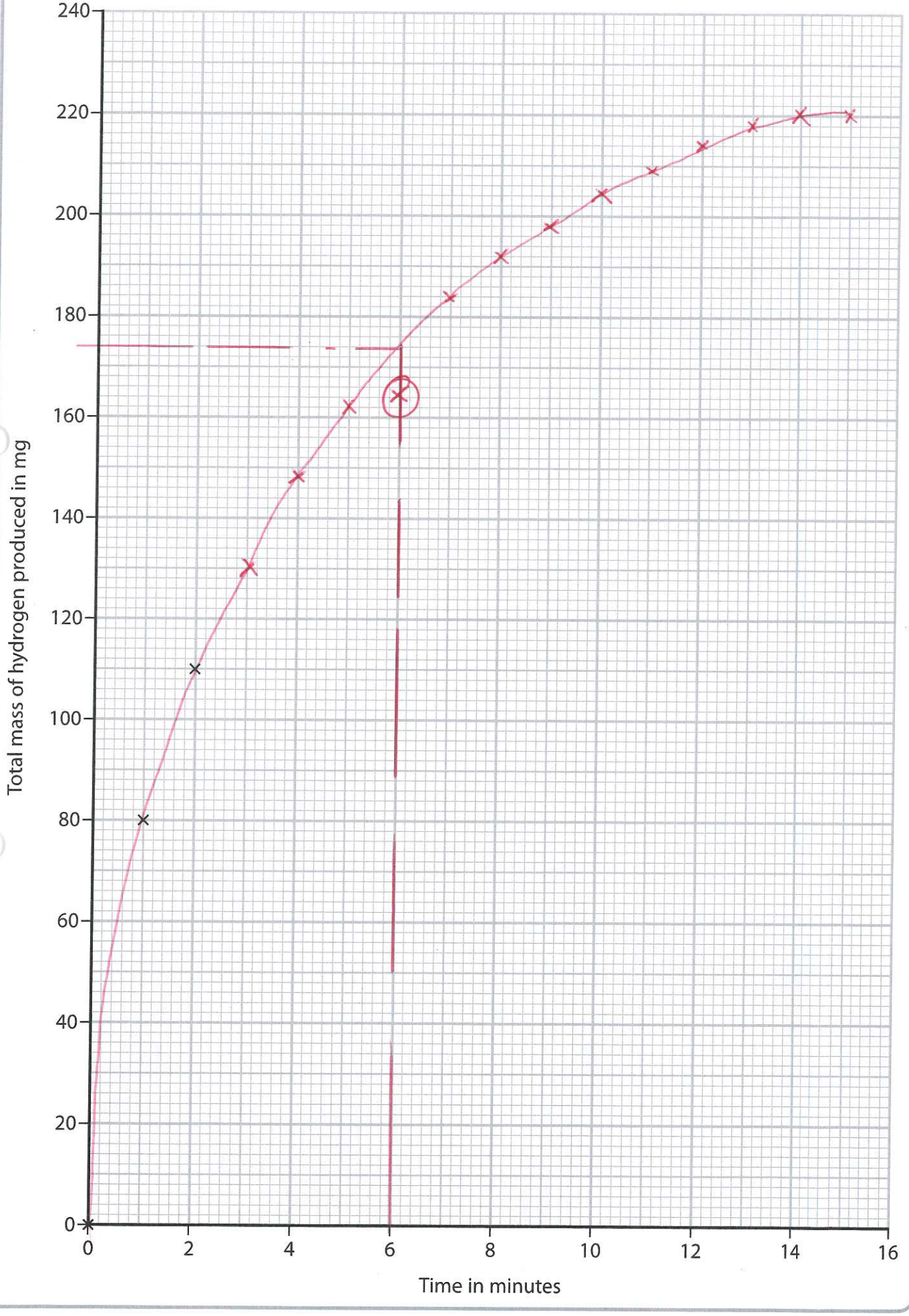
(1)

(ii) Draw a circle around the anomalous result.

(1)

(iii) Draw a curve of best fit.

(1)



(iv) Give a possible reason for the anomalous result.

(1)

The reading was taken before 6 minutes.

(v) Determine a more likely value for this result.

(1)

174g

(c) (i) Explain how the shape of the curve shows how the rate of the reaction changes as time increases.

(2)

As time increases the curve becomes less steep, showing the rate of reaction decreases.

(ii) At the end of the experiment there is no zinc left in the flask.

Give a conclusion the student could make from this observation.

(1)

The Sulphuric acid was in excess.

(d) The student does another experiment using

- the same amount of similarly sized magnesium granules instead of zinc
- the same volume of sulfuric acid, but of a lower concentration

Explain why it is difficult to predict how the rate of reaction in this experiment compares with the rate of reaction in the first experiment.

(3)

Magnesium is more reactive than Zinc so will increase the rate. Less Concentrated acid would decrease the rate. It is difficult to tell which of these changes will have the greater effect and hence whether the rate will increase or decrease.

(e) Explain, in terms of particle collision theory, how increasing the temperature affects the rate of a reaction.

(3)

At higher temperatures, the particles have more kinetic energy. Hence, there are more successful collisions per unit time and the rate of reaction increases.

(Total for Question 8 = 15 marks)

9 A student is given a mixture of two white solid compounds, and a colourless solution containing the same two compounds.

The student is told that one of the compounds is a halide and that the other compound is a carbonate.

(a) Give two reasons why the student should know, without doing any tests, that one of the compounds **cannot** be copper(II) carbonate.

(2)

1 Copper (II) Carbonate is green.

2 Copper (II) Carbonate is insoluble.

(b) Describe tests the student could do to show that the mixture contains potassium carbonate and potassium iodide.

(6)

To test for potassium ions:

- A flame test produces a lilac flame.

Test for Carbonate ions:

- Add acid to the mixture of solids
- Bubble the gas produced into lime water
- Lime water goes cloudy as CO_2 is produced due to the Carbonate ions.

Test for iodide ions:

- Add dilute nitric acid then Silver nitrate solution.
- The yellow precipitate that forms shows iodide ions are present.

(Total for Question 9 = 8 marks)

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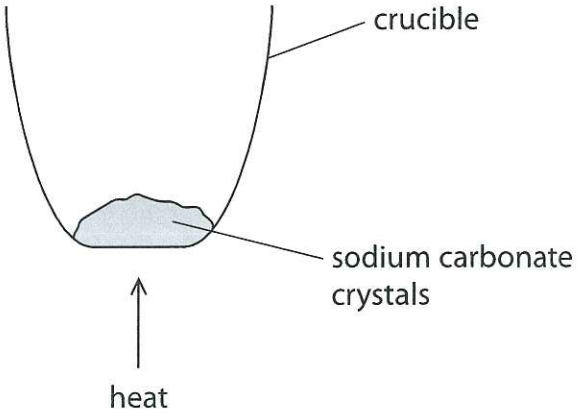
10 (a) A student is given a pure sample of sodium carbonate crystals and is told that the formula of the crystals is $Na_2CO_3.xH_2O$

State what xH_2O in the formula shows about the sodium carbonate crystals.

(1)

Contains Water of Crystallisation.

(b) The student uses this apparatus to find the value of x in $Na_2CO_3.xH_2O$



This is the student's method.

- find the mass of an empty crucible without a lid
- add some sodium carbonate crystals $Na_2CO_3.xH_2O$ to the crucible
- find the total mass of the crucible and sodium carbonate crystals
- heat the crucible to remove water from the crystals
- allow the crucible and contents to cool down
- find the mass of the cold crucible and contents

These are the student's results.

	Mass in grams
empty crucible	22.75
crucible and sodium carbonate crystals $Na_2CO_3.xH_2O$	29.71
cold crucible and contents	25.93

(i) Calculate the mass of sodium carbonate left after heating and cooling.

(1)

25.93 - 22.75

= 3.18g

mass of sodium carbonate = 3.18 g

(ii) Calculate the mass of H_2O lost from the sodium carbonate crystals during heating.

(1)

29.71 - 25.93

= 3.78

mass of H_2O = 3.78 g

(iii) Show that the student's results suggest that the formula of the sodium carbonate crystals is $Na_2CO_3.7H_2O$

[M_r of Na_2CO_3 = 106 M_r of H_2O = 18]

(3)

	Na_2CO_3		H_2O
mass	3.18		3.78
mr	106		18
=	0.03	:	0.21
Smallest	0.03		0.03
=	1	:	7

∴ The formula is $Na_2CO_3.7H_2O$

(c) The student's teacher says that the correct formula of the sodium carbonate crystals is $Na_2CO_3.10H_2O$

(i) The student did not make any mistakes in their measurements.

Explain what could have caused the student's value for *x* to be too low.

(2)

The Crystals weren't heated for long enough So not all of the water was removed.

(ii) Describe how the student could improve the method to obtain a more accurate value for *x*.

(2)

~~Repeat~~ Reheat and reweigh until a constant mass is reached

(Total for Question 10 = 10 marks)

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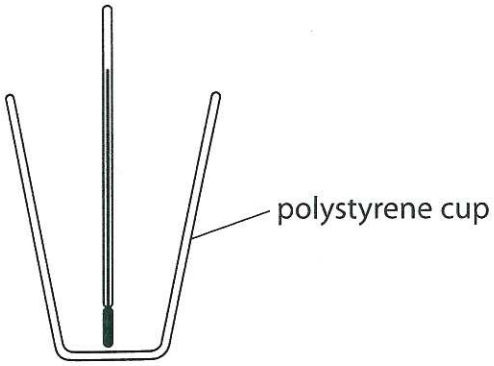
11 A student investigates the temperature change during the reaction between zinc metal and copper(II) sulfate solution.

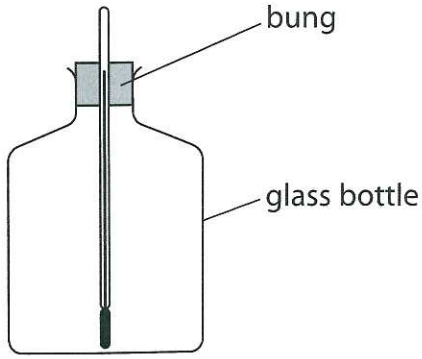
The student considers two different methods.

Method 1



- pour 50 cm^3 of copper(II) sulfate solution into the polystyrene cup
- record the temperature of the solution
- add 3 g of zinc powder
- stir using the thermometer and record the highest temperature reached

Method 2



- record the temperature of 50 cm^3 of copper(II) sulfate solution
- pour the 50 cm^3 of copper(II) sulfate solution into the glass bottle
- add 3 g of zinc powder
- push the bung and thermometer into the bottle and record the highest temperature reached

(a) Discuss the advantages and disadvantages of each method.

(6)

Using Polystyrene (an insulator) prevents heat loss to surrounding air in method 1 whereas the glass bottle in method 2 is a poor thermal insulator so thermal energy loss occurs.

Method 1 lacks a lid so heat will be lost to the surrounding air; whereas method 2 uses a bung, preventing heat loss to the surrounding air - the bung also prevents spillages.

Stirring in method 1 will ensure an even temperature whereas method 2 doesn't allow stirring so an even temperature isn't guaranteed.

(b) The equation for the reaction is

$$Zn\,(s) + CuSO_4\,(aq) \rightarrow ZnSO_4\,(aq) + Cu\,(s)$$

50 cm^3 of copper(II) sulfate solution contains 0.025 mol $CuSO_4$

A mass of 3 g of zinc is used.

Show that the zinc is in excess.

[A_r of zinc = 65]

(2)

$n(CuSO_4) = 0.025$ mol

Ratio $n(CuSO_4 : Zn) = 1:1$

$n(Zn)$ Required $= 0.025$ mol

$n(Zn)_{present} = \frac{3}{65} = 0.046$ mol

$0.046 > 0.025$

$\therefore$ Zn in excess

(c) The student reacts a solution containing 0.025 mol $CuSO_4$ with an excess of zinc.

These are the student's results.

temperature of 50 cm^3 of copper(II) sulfate solution = 21.1 °C

highest temperature reached = 40.6 °C

(i) Show that the energy change Q for this reaction is about 4000 J

[mass of 1 cm^3 of solution = 1.0 g]

[for the solution, c = 4.2 J / g / °C]

(3)

$Q = mc\Delta T$

$= 50 \times 4.2 \times (40.6 - 21.1)$

$= 4095$ J

(ii) Calculate the molar enthalpy change (ΔH), in kJ / mol, for the reaction.

(3)

$\Delta H = \frac{4095}{0.025}$

$= -163800$ J/mol

$= -163.8$ kJ/mol

$\Delta H =$ -163.8 kJ / mol

(d) The ionic equation for the reaction is

$$Zn\,(s) + Cu^{2+}\,(aq) \rightarrow Zn^{2+}\,(aq) + Cu\,(s)$$

Explain what is oxidised and what is reduced in this reaction.

(2)

Zinc is oxidised because it loses electrons.

Copper ions are reduced as they gain electrons.

(Total for Question 11 = 16 marks)

TOTAL FOR PAPER = 110 MARKS

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