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Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel International GCSE (9–1)

Centre Number | Candidate Number

Thursday 14 May 2020

Morning (Time: 2 hours) | Paper Reference **4CH1/1C 4SD0/1C**

Chemistry

Unit: 4CH1
Science (Double Award) 4SD0
Paper: 1C

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.
- 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 ▶

P62045A

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P 6 2 0 4 5 A 0 1 3 6

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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.

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Answer ALL questions.

1 This question is about chemical elements.

Use the Periodic Table to help you answer this question.

(a) (i) Identify the element with atomic number 5

(1)

.....

(ii) Give the symbol of a metallic element in Period 3

(1)

.....

(iii) Identify the element whose atoms contain 14 protons.

(1)

.....

(iv) Identify the element whose atoms have the electronic configuration 2.5

(1)

.....

(v) Give the name of the compound formed between oxygen and the element with atomic number 13

(1)

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(b) The position of an element in the Periodic Table can be used to predict its properties.

(i) Which group contains elements that are all unreactive?

(1)

- ☒ **A** Group 2
- ☒ **B** Group 5
- ☒ **C** Group 6
- ☒ **D** Group 0

(ii) Which of these is the least reactive element in Group 1?

(1)

- ☒ **A** caesium
- ☒ **B** lithium
- ☒ **C** potassium
- ☒ **D** sodium

(Total for Question 1 = 7 marks)

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2 (a) The boxes list changes that may happen in a laboratory and the names of some changes.

Draw one straight line from each change to its correct name.

(3)

Change	Name of change
ice turns into water	diffusion
solid carbon dioxide turns directly into a gas	dissolving
a solute is stirred into a solvent	evaporation
	freezing
	melting
	sublimation

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(b) A student has two solids, X and Y.

One of these solids is a pure substance and the other is a mixture.

Describe how the student could identify which solid is pure and which is a mixture by measuring a physical property of each solid.

(3)

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(Total for Question 2 = 6 marks)

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3 This question is about metals.

(a) Metals can be arranged in a reactivity series based on their reactions with water and their reactions with dilute hydrochloric acid.

The table shows how four metals, P, Q, R and S, react with water and with dilute hydrochloric acid.

Metal	Reaction with water	Reaction with dilute hydrochloric acid
P	no reaction	hydrogen gas forms very slowly
Q	no reaction	no reaction
R	hydrogen gas forms very quickly	not done
S	hydrogen gas forms quickly	hydrogen gas forms very quickly

(i) Identify which of the metals P, Q, R or S could be gold.

(1)

.....

(ii) Suggest why the reaction between metal R and dilute hydrochloric acid was not done.

(1)

.....

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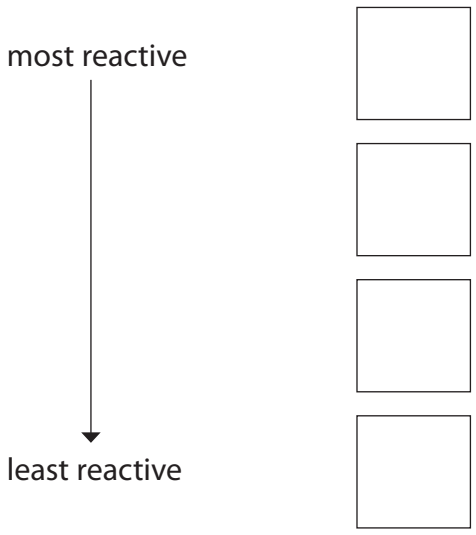
(iii) Use the information in the table to place the metals in order of reactivity from most reactive to least reactive.

(1)

most reactive



least reactive

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(b) Zinc is used to coat iron gates to prevent the iron from rusting.

(i) State the name of this method of preventing iron from rusting.

(1)

.....

(ii) State another method of preventing iron from rusting.

(1)

.....

(c) A mixture of zinc powder and copper(II) oxide is heated.

The chemical equation for the reaction that takes place is

$$Zn + CuO \rightarrow ZnO + Cu$$

(i) State how the reaction shows that zinc is more reactive than copper.

(1)

.....

.....

(ii) Explain which substance is the oxidising agent.

(2)

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(Total for Question 3 = 8 marks)

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4 Sodium hydroxide dissolves in water, forming a strongly alkaline solution.

Ammonia dissolves in water, forming a slightly less alkaline solution.

(a) (i) Identify the ion that makes the sodium hydroxide solution alkaline.

(1)

.....

(ii) What is a possible pH of ammonia solution?

(1)

☒ **A** 3

☒ **B** 6

☒ **C** 11

☒ **D** 14

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(b) When ammonia solution reacts with sulfuric acid, a neutralisation reaction occurs and ammonium sulfate forms.

(i) How does the sulfuric acid act in this reaction?

(1)

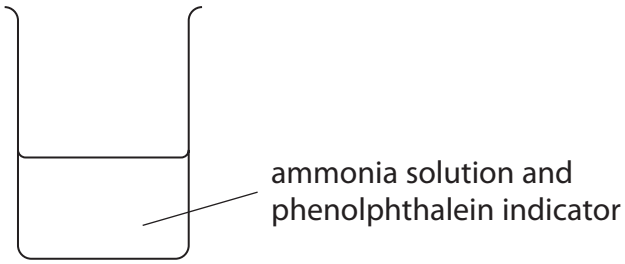
☒ **A** as a neutron donor

☒ **B** as a neutron acceptor

☒ **C** as a proton donor

☒ **D** as a proton acceptor

(ii) The diagram shows a beaker containing some ammonia solution and a few drops of phenolphthalein indicator.



Dilute sulfuric acid is added to the beaker until it is in excess.

What are the colours of the phenolphthalein indicator before and after adding excess sulfuric acid?

(1)

	Before	After
☒ **A**	orange	red
☒ **B**	yellow	red
☒ **C**	pink	colourless
☒ **D**	colourless	pink

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(c) Ammonium sulfate is used by gardeners as a fertiliser because it contains nitrogen.

(i) Explain why the chemical formula of ammonium sulfate is $(NH_4)_2SO_4$

Refer to the charges on the ions in your answer.

(2)

.....

.....

.....

.....

(ii) Calculate the relative formula mass of ammonium sulfate, $(NH_4)_2SO_4$

(1)

relative formula mass = ...

(iii) Calculate the mass, in grams, of nitrogen in 1.0 kg of ammonium sulfate.

(3)

mass = ... g

(Total for Question 4 = 10 marks)

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5 (a) Chlorine, bromine and iodine are elements in the Periodic Table.

Explain how the position of these elements in the Periodic Table depends on their electronic configurations.

(2)

.....

.....

.....

.....

(b) Chlorine reacts with methane to form CH_3Cl and HCl

(i) State the condition necessary for this reaction.

(1)

.....

(ii) Give the equation for this reaction.

(1)

.....

(iii) The bonds in a molecule of CH_3Cl are covalent.

Explain, in terms of electrostatic attractions, what is meant by a covalent bond.

(2)

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(iv) Draw a dot-and-cross diagram for a molecule of CH_3Cl

Show only the outer electrons of the atoms.

(2)

H

H C Cl

H

(v) CH_3Cl has a simple molecular structure.

Explain why CH_3Cl has a low boiling point.

(2)

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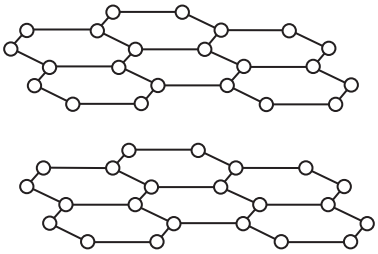
(c) Graphite is another substance that contains covalent bonds.

The diagram shows the structure of graphite.



Most covalent substances do not conduct electricity.

Explain why graphite is able to conduct electricity.

(2)

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(Total for Question 5 = 12 marks)

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6 The table shows the molecular formulae of six organic compounds, A, B, C, D, E and F.

A	B	C	D	E	F
C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4H_8	C_4H_{10}

(a) (i) Explain which homologous series compound B belongs to.

(2)

(ii) Give the letter of the compound that has the same empirical formula as its molecular formula.

(1)

(iii) Compound F exists as two isomers.

Explain what is meant by the term **isomers**.

Include the structures of the two isomers of compound F in your answer.

(3)

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(b) Describe how compound D can be obtained from crude oil using the industrial process of fractional distillation.

(4)

(c) Compound C can be used to make a polymer.

(i) State the type of polymer formed from compound C.

(1)

(ii) Name the polymer formed from compound C.

(1)

(iii) Draw the structure of this polymer.

Include the displayed formula of the repeat unit.

(2)

(Total for Question 6 = 14 marks)

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7 Dilute hydrochloric acid reacts with a solution of sodium thiosulfate ($Na_2S_2O_3$) to form a precipitate.

The equation for the reaction is

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + S(s) + H_2O(l) + SO_2(g)$$

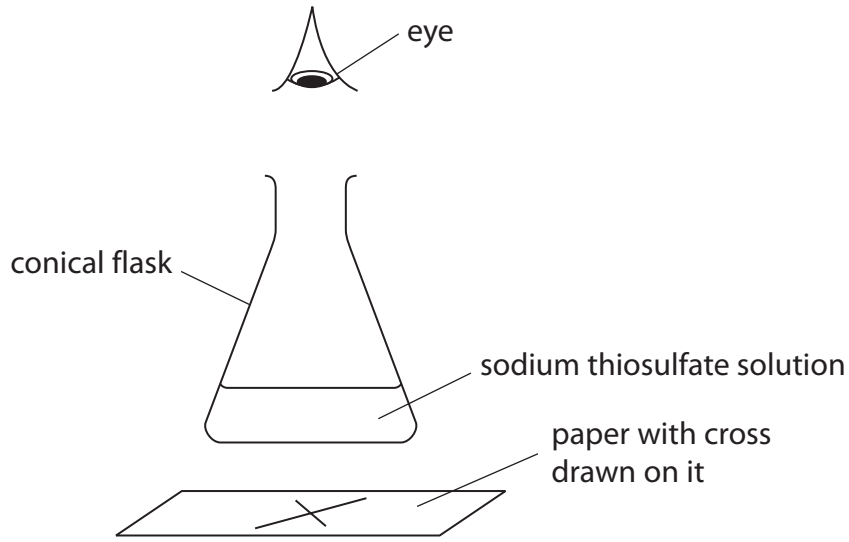
(a) State the name of the precipitate that forms.

(1)

.....

(b) The reaction is often used to investigate rates of reaction.

The diagram shows the apparatus a student uses to investigate the effect of temperature on the rate of the reaction.



This is the student's method.

- pour 50 cm^3 of cold sodium thiosulfate solution into a conical flask and heat it to 20 °C
- draw a cross (×) on a piece of paper and place it under the flask
- add 5 cm^3 of dilute hydrochloric acid to the flask
- look at the cross from above and record the time taken until the cross cannot be seen

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The student repeats the experiment four times, using sodium thiosulfate solution at a different temperature each time.

He keeps the volumes of sodium thiosulfate solution and hydrochloric acid constant in each experiment.

Give two other factors that the student should keep constant.

(2)

1 .....

.....

2 .....

.....

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

Temperature in °C	Time until cross cannot be seen in s
20	400
30	188
40	84
50	44
60	24

The highest temperature the student uses is 60 °C because he thinks the results might not be as accurate at temperatures higher than 60 °C.

Suggest a reason why the results might not be as accurate at temperatures higher than 60 °C.

(1)

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(d) The student wants to compare the rates of the reaction at the different temperatures.

He uses this formula to obtain a value for each rate of reaction

$$\text{rate} = \frac{1}{\text{time in s}}$$

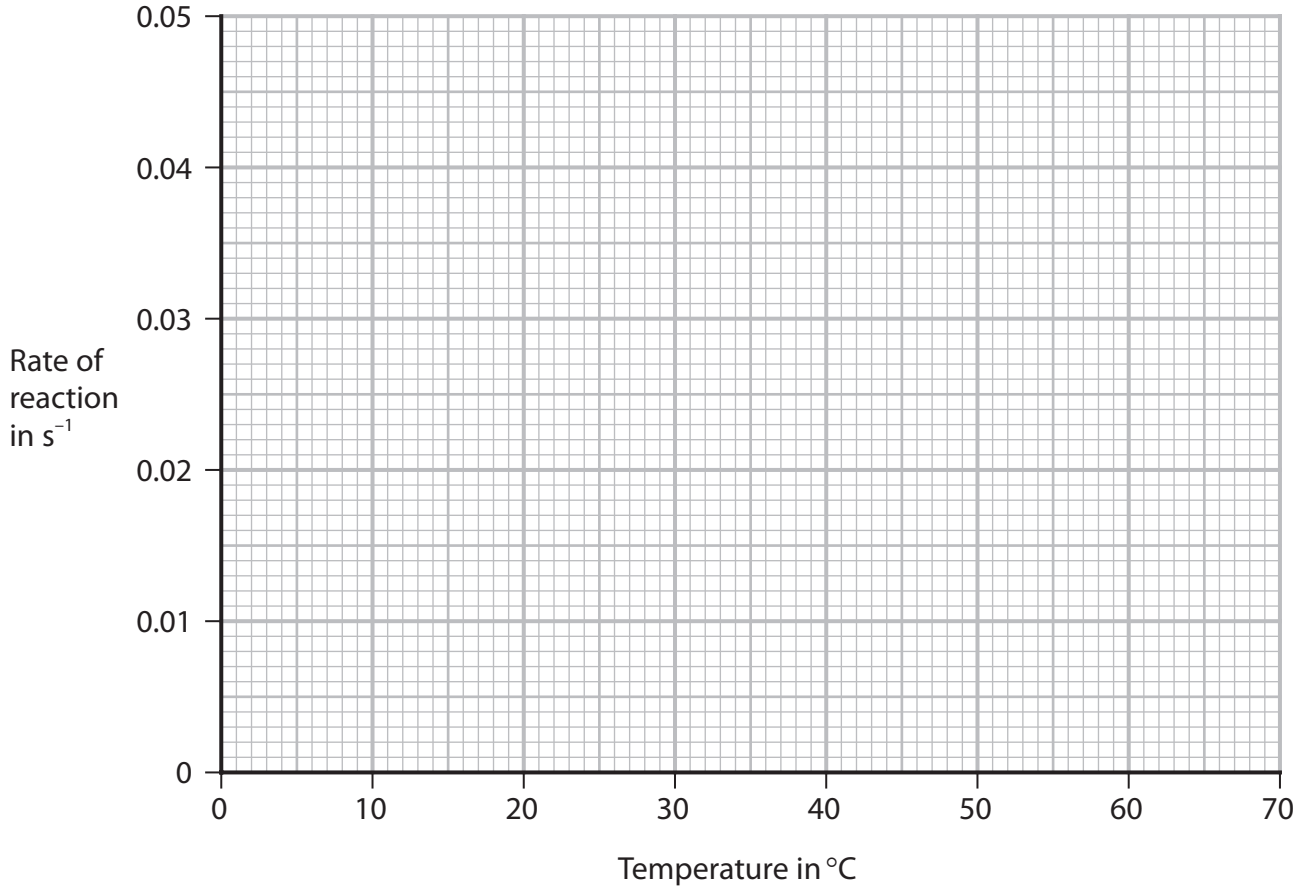
The table shows the value of the rate of reaction at each temperature.

Temperature in °C	Time until cross cannot be seen in s	Rate of reaction in s^{-1}
20	400	0.0025
30	188	0.0053
40	84	0.012
50	44	0.023
60	24	0.042

Plot the values of temperature and rate of reaction on the grid.

Draw a curve of best fit through the points.

(2)



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(e) (i) Use the graph to determine a value for the rate of the reaction at 45 °C.

Show on the graph how you obtained your answer.

(2)

rate of reaction = ... s^{-1}

(ii) Calculate the time that it would take for the cross not to be seen at 45 °C.

(2)

time = ... s

(iii) Describe the relationship between rate of reaction and temperature shown by the graph.

(1)

.....

.....

(f) Explain, in terms of particle collision theory, the effect that increasing the temperature has on the rate of a reaction.

(3)

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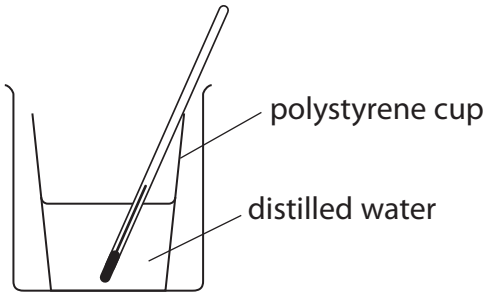
8 A student uses this apparatus to investigate the heat energy change when a salt dissolves in water to form a solution.



This is the student's method.

- add 50 cm^3 of distilled water to a polystyrene cup
- record the initial temperature of the water
- add a known mass of solid anhydrous copper(II) sulfate to the polystyrene cup and stir the solution with the thermometer until all the solid has dissolved
- record the maximum temperature of the copper(II) sulfate solution

(a) (i) Name the piece of apparatus the student should use to add the distilled water to the polystyrene cup.

(1)

.....

(ii) The student stirs the solution to help the solid dissolve more quickly.

Suggest another reason why the student stirs the solution.

(1)

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.....

.....

(iii) State the colour of the copper(II) sulfate solution.

(1)

.....

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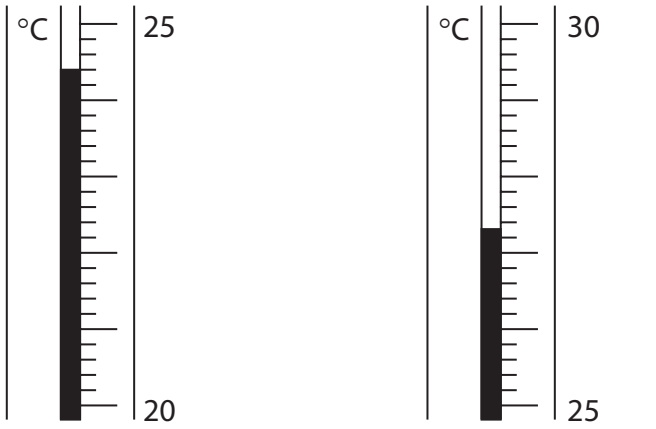
(b) The diagram shows the temperatures in one experiment.



initial temperature maximum temperature

Complete the table, giving all values to the nearest 0.1 °C.

(3)

maximum temperature in °C	
initial temperature in °C	
increase in temperature in °C	

(c) In a second experiment, when a student dissolves the anhydrous copper(II) sulfate in 50 cm^3 of distilled water, the increase in temperature is 3.3 °C.

(i) Show that the heat energy change (Q) in this second experiment is approximately 700 J.

[for water, c = 4.2 J/g/°C]

[mass of 1.0 cm^3 of water = 1.0 g]

(2)

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(ii) In this experiment the student uses 1.70 g of the anhydrous copper(II) sulfate.

Calculate the molar enthalpy change (ΔH) in kJ/mol.

Include a sign in your answer.

[M_r of $CuSO_4$ = 159.5]

(4)

ΔH = ... kJ/mol

(d) Another student does a similar experiment but uses hydrated copper(II) sulfate instead of anhydrous copper(II) sulfate.

The table shows his results.

initial temperature in °C	23.8
final temperature in °C when all solid dissolves	22.7

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

(2)

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.....

(Total for Question 8 = 14 marks)

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9 Sodium hydrogencarbonate ($NaHCO_3$) is also known as baking soda.

Baking soda can be used to make cakes increase in size in an oven.

This is the equation for the reaction that takes place when baking soda is heated.

$$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

(a) (i) What type of reaction is this?

(1)

- ☒ **A** combustion
- ☒ **B** decomposition
- ☒ **C** oxidation
- ☒ **D** reduction

(ii) Suggest why the reaction makes the cakes increase in size.

(1)

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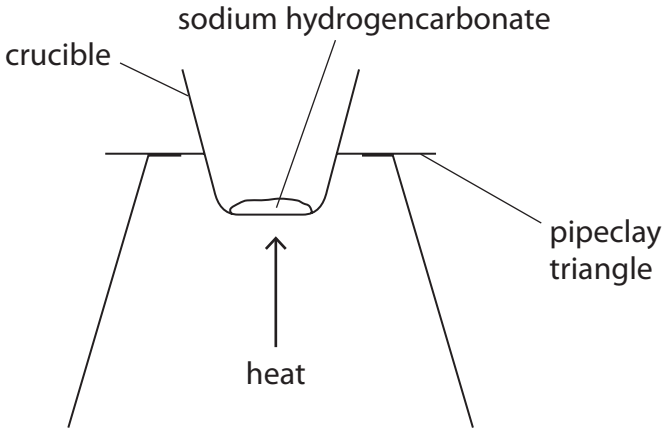
(b) A student uses this apparatus to investigate the reaction that takes place when sodium hydrogencarbonate is heated.



This is the student's method.

- weigh a crucible and record the mass
- add some sodium hydrogencarbonate to the crucible, reweigh it and record the mass
- heat the crucible and contents for five minutes, then allow to cool before weighing and recording the mass
- heat the crucible and contents again for a further three minutes, then allow to cool before weighing and recording the mass

(i) Give a reason why the crucible and contents are heated for a further three minutes.

(1)

.....

.....

.....

(ii) The student considered using a lid on the crucible in the experiment.

Suggest an advantage and a disadvantage of using a lid on the crucible.

(2)

advantage .....

.....

.....

disadvantage .....

.....

.....

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(c) The table shows some of the student's results.

mass of crucible and sodium hydrogencarbonate in g	29.75
mass of empty crucible in g	26.50

(i) Calculate the mass of sodium hydrogencarbonate that the student uses.

(1)

mass = ... g

(ii) Using this equation, calculate the maximum mass of sodium carbonate (Na_2CO_3) that could form in the student's reaction.

$$2NaHCO_3(s) \longrightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

[M_r of $NaHCO_3 = 84$ M_r of $Na_2CO_3 = 106$]

(3)

maximum mass = ... g

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(d) In a second experiment, the student uses a larger mass of sodium hydrogencarbonate.

She calculates that she should obtain 4.8 g of sodium carbonate.

She actually obtains 4.2 g of sodium carbonate.

(i) Calculate the percentage yield from the student's experiment.

(2)

percentage yield = ... %

(ii) Other than spillages, suggest a possible reason why the student's actual yield is less than expected.

(1)

.....

.....

.....

(Total for Question 9 = 12 marks)

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10 The table gives information about some lead compounds.

Compound	Formula	Appearance	Solubility in water
lead(II) oxide	PbO	yellow solid	insoluble
lead(IV) oxide	PbO_2	brown solid	insoluble
red lead oxide	Pb_3O_4	red solid	insoluble
lead(II) nitrate	$Pb(NO_3)_2$	white solid	soluble

(a) When a sample of red lead oxide is heated, it changes into a yellow solid and a gas forms that relights a glowing splint.

Complete the word equation for this reaction.

(2)

red lead oxide → ..... + ...

(b) A sample of one of the oxides of lead contains 86.6% lead and 13.4% oxygen by mass.

Show by calculation that the sample is lead(IV) oxide, PbO_2

[A_r of Pb = 207 A_r of O = 16]

(3)

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(c) Red lead oxide reacts with warm dilute nitric acid.

(i) Complete the chemical equation for the reaction.

Pb_3O_4(.....) + $4HNO_3$(.....) → .....$Pb(NO_3)_2$(aq) + PbO_2(s) + ...H_2O(l)

(2)

(ii) A student is given a sample of solid red lead oxide and some dilute nitric acid.

Describe how the student could obtain a pure dry sample of lead(II) nitrate crystals.

(6)

(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 110 MARKS

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