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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

Time 2 hours

Paper reference **4CH1/1C 4SD0/1C**

Chemistry

Science (Double Award) 4SD0
PAPER: 1C

November 2021

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.
- Good luck with your examination.

Turn over ▶

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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.

P 6 6 0 5 8 R A 0 2 4 0

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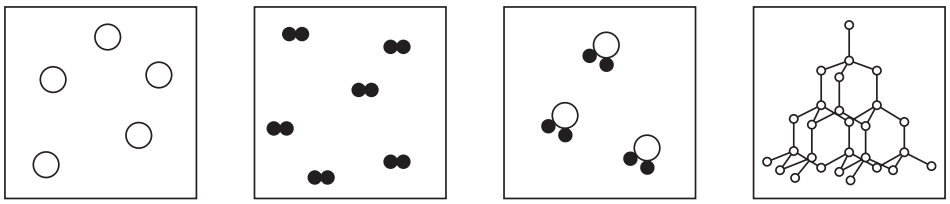
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Answer ALL questions.

1 (a) The diagram shows the particles in four substances, A, B, C and D.



A **B** **C** **D**

(i) Which substance contains single atoms of one element?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(ii) Which substance is a compound?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(iii) Which substance could have the formula H_2?

(1)

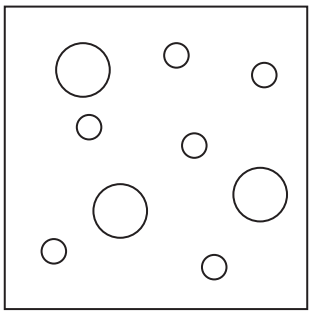
- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

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(b) The diagram shows the particles in substance E.



E

Give two reasons why substance E is a mixture.

(2)

1 .....

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2 .....

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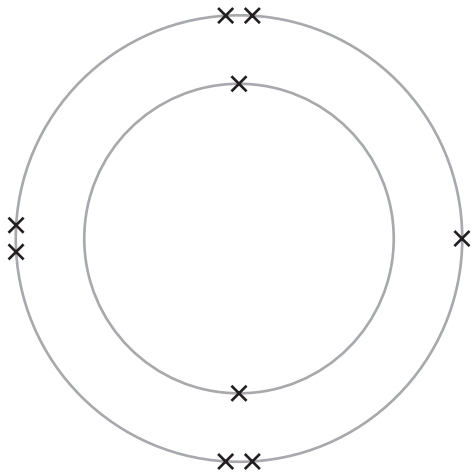
(Total for Question 1 = 5 marks)

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2 This question is about Group 7 elements and their reactions.

(a) Fluorine has the smallest atoms in Group 7.

The diagram shows the electronic configuration of a fluorine atom.



(i) State why fluorine has the smallest atoms in Group 7.

(1)

.....

.....

(ii) Which row gives the correct number of occupied electron shells and the correct number of outer shell electrons in an atom of iodine?

Use the Periodic Table on page 2 to help you.

(1)

		Number of occupied electron shells	Number of outer shell electrons
☒	**A**	4	5
☒	**B**	5	6
☒	**C**	5	7
☒	**D**	7	5

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(b) (i) The table gives descriptions of the reactions of some Group 7 elements with iron wool.

Complete the table by giving a description of the reaction of fluorine with iron wool.

(2)

Element	Description of reaction with iron wool
fluorine	
chlorine	• does not need heating • reacts quickly
bromine	• needs heating • reacts slowly
iodine	• needs heating • reacts very slowly

(ii) State the relationship between the reactivity of the Group 7 elements and the size of their atoms.

(2)

.....

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.....

.....

(Total for Question 2 = 6 marks)

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3 This question is about the rusting of iron.

(a) Water is needed for iron to rust.

(i) Name one other substance needed for iron to rust.

(1)

.....

(ii) Give the chemical name for rust.

(1)

.....

(b) The diagram shows two methods used to prevent iron from rusting.



Method A Method B

Method A will only work if the plastic coating is not damaged.

Method B will work even when the zinc coating is damaged.

(i) Explain how method A prevents iron from rusting.

(2)

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(ii) Give the name of method B.

(1)

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(iii) Explain how method B prevents iron from rusting even when the zinc coating is damaged.

(2)

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(Total for Question 3 = 7 marks)

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4 (a) The table shows the number of protons, neutrons and electrons in species F, G and H.

	Species F	Species G	Species H
number of protons	7	7	7
number of neutrons	7	8	7
number of electrons	7	7	10

(i) Give the mass number of F.

(1)

(ii) Give the electronic configuration of G.

(1)

(iii) Explain why F and G are isotopes of the same element.

Refer to subatomic particles in your answer.

(2)

(iv) Explain why H is a negative ion.

Refer to subatomic particles and their charges in your answer.

(2)

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(b) A sample of carbon contains atoms of mass number 12 and 13

The table shows the percentages of these atoms in the sample.

Mass number	Percentage (%)
12	98.930
13	1.070

Calculate the relative atomic mass (A_r) of this sample of carbon.

Give your answer to two decimal places.

(2)

relative atomic mass = ...

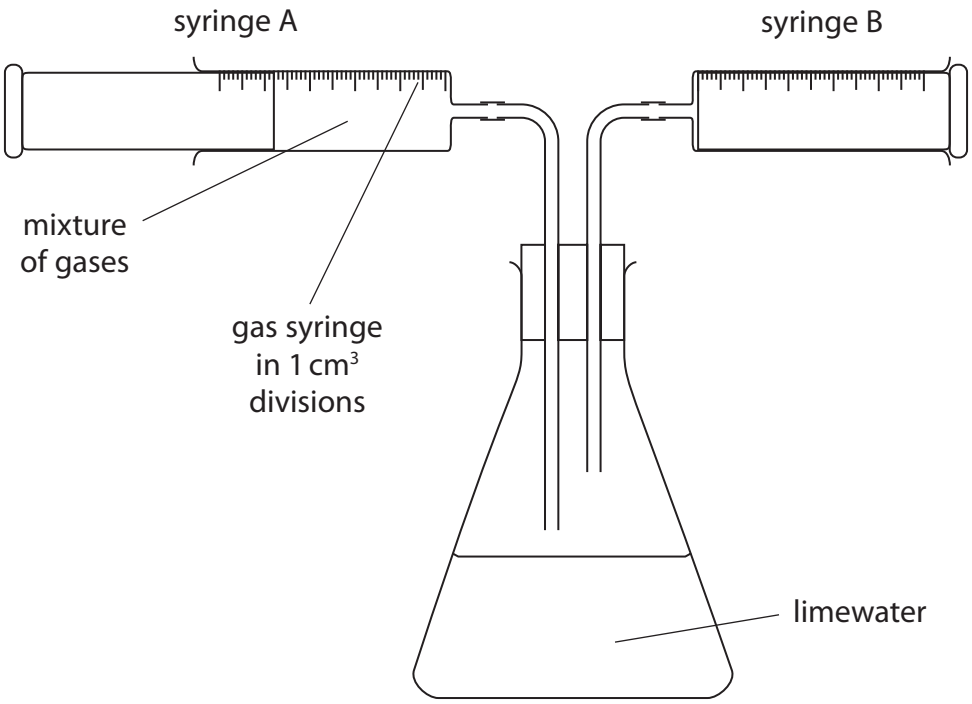
(Total for Question 4 = 8 marks)

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5 Two experiments are done to determine the percentage composition by volume of a mixture of three gases, carbon dioxide, oxygen and argon.

(a) In experiment 1, a student bubbles the mixture of gases through limewater. Carbon dioxide reacts with limewater.

The diagram shows the apparatus the student uses.



The student pushes the mixture of gases out of syringe A, but no gas bubbles appear in the limewater.

Give one change the student needs to make to the apparatus for gas bubbles to appear in the limewater.

(1)

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(b) When the apparatus in experiment 1 is set up correctly, the mixture of gases is bubbled gently through the limewater so that all the carbon dioxide is removed.

The volume of the mixture of gases in syringe A at the start is 76 cm^3.

The volume of the mixture of gases in syringe B at the end is 66 cm^3.

(i) Calculate the percentage by volume of carbon dioxide in the mixture of gases in syringe A.

(2)

percentage of carbon dioxide = ... %

(ii) Give the change in the appearance of the limewater.

(1)

.....

.....

(iii) Explain why the gas syringes in experiment 1 cannot be used to find the percentage of carbon dioxide in a typical sample of air.

(2)

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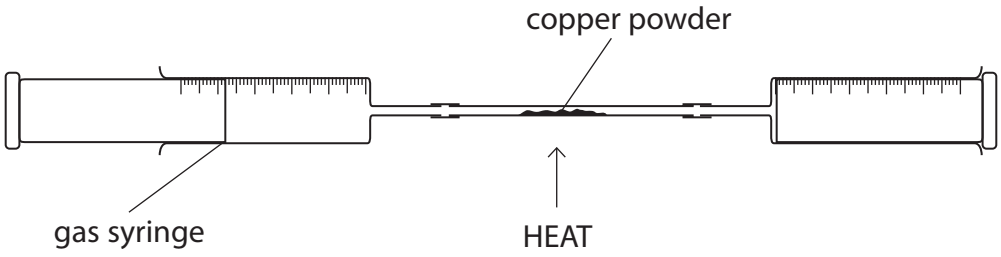
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(c) In experiment 2, a teacher pushes the remaining gases over hot copper powder.

The diagram shows the apparatus the teacher uses.



The copper powder turns black as it reacts with oxygen.

Argon is extremely unreactive, so it does not react with copper.

(i) Name the black substance that forms on the copper powder.

(1)

.....

(ii) Suggest why the teacher uses copper powder instead of the same mass of large pieces of copper.

(1)

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(iii) Explain why argon is extremely unreactive.

(2)

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(Total for Question 5 = 10 marks)

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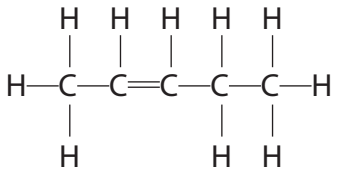
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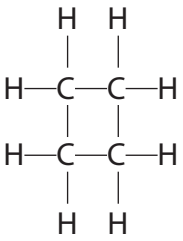
6 This question is about organic compounds.

(a) The diagram shows the displayed formulae of five compounds, U, V, W, X and Y.

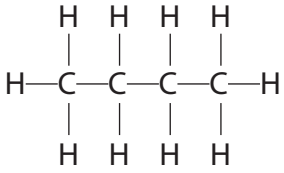
U



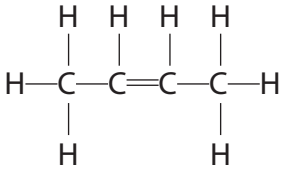
V



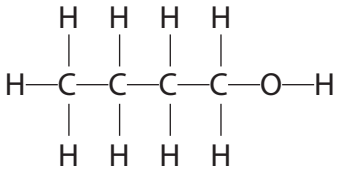
W



X



Y



(i) Give the letter of the compound that is not a hydrocarbon.

(1)

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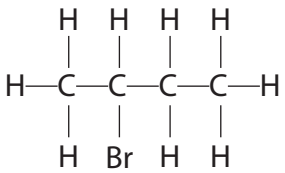
(ii) Give the letter of the compound that is a saturated hydrocarbon with the empirical formula CH_2

(1)

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(iii) Give the letter of the compound that reacts with bromine in the presence of ultraviolet radiation to form this structure.

(1)



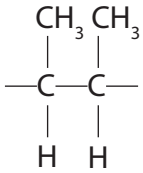
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(iv) Give the letter of the compound that forms an addition polymer with this repeat unit.

(1)



(v) Give the displayed formula of an alkene that is an isomer of compound X.

(1)

(vi) Compounds U and X are members of the same homologous series.

Members of the same homologous series have the same functional group.

Give two other characteristics of compounds in the same homologous series.

(2)

1 .....

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2 .....

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(b) Compound Z contains 38.7% carbon, 9.7% hydrogen and 51.6% oxygen by mass.

(i) Show by calculation that the empirical formula of compound Z is CH_3O

(2)

(ii) The relative formula mass (M_r) of compound Z is 62

Deduce the molecular formula of compound Z.

(2)

molecular formula = ...

(Total for Question 6 = 11 marks)

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7 This question is about nitrogen and some of its compounds.

(a) Nitrogen and oxygen do not react together at room temperature.

At the high temperatures in a car engine, nitrogen and oxygen react to form nitrogen monoxide, NO

(i) Give a chemical equation for this reaction.

(1)

.....

(ii) Give a reason why this reaction only occurs at high temperatures.

(1)

.....

.....

(iii) State why it is important that oxides of nitrogen are not released into the atmosphere.

(1)

.....

.....

(b) Nitrogen monoxide gas can be removed from car exhaust fumes when it reacts with carbon monoxide gas.

(i) The rate of the reaction is increased by passing the gases over a catalyst.

Explain how a catalyst increases the rate of a reaction.

(2)

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(ii) Explain how increasing the pressure of gases increases the rate of reaction.

(3)

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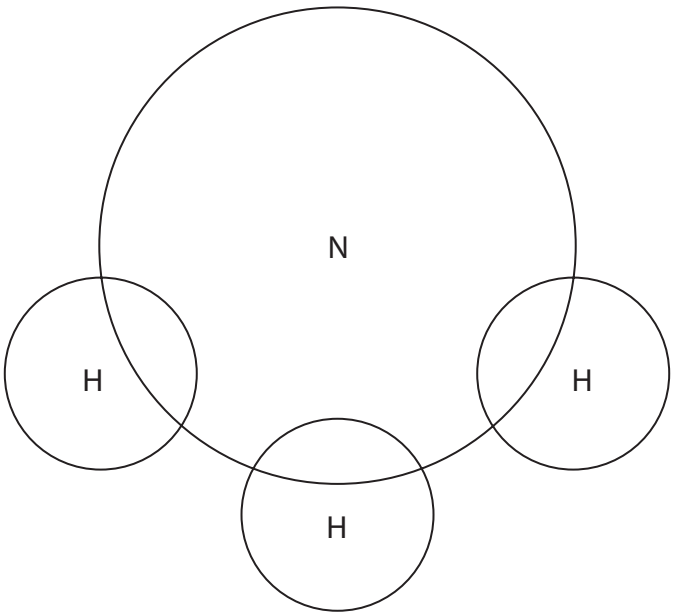
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(c) Ammonia is a simple molecule with the formula NH_3

(i) Complete the diagram to show the outer shell electrons in ammonia.

(2)



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(ii) The bonds in ammonia are covalent.

Describe the forces of attraction in a covalent bond.

(2)

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(iii) Explain why ammonia has a low boiling point.

(2)

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(Total for Question 7 = 14 marks)

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8 This question is about barium chloride.

(a) Barium chloride can be made by reacting barium carbonate with dilute hydrochloric acid.

The chemical equation for the reaction is

$$BaCO_3(s) + 2HCl(aq) \rightarrow BaCl_2(aq) + H_2O(l) + CO_2(g)$$

Describe a method to produce dry crystals of hydrated barium chloride, starting with barium carbonate powder and dilute hydrochloric acid.

(6)

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(b) A colourless solution contains sodium carbonate and sodium sulfate.

Describe a test using barium chloride to show that the colourless solution contains sulfate ions.

(2)

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(Total for Question 8 = 8 marks)

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9 A student investigates the reaction between solid hydrated sodium carbonate and dilute hydrochloric acid.

(a) She uses this method to investigate the temperature change during the reaction.

Step 1 pour 25.0 cm^3 of dilute hydrochloric acid into a polystyrene cup

Step 2 record the temperature of the dilute hydrochloric acid

Step 3 add 0.5 g of sodium carbonate and stir the mixture

Step 4 record the lowest temperature of the mixture

Step 5 add further 0.5 g portions of sodium carbonate, one portion at a time, stir the mixture and record the lowest temperature each time

The table shows the student's results.

Mass of sodium carbonate added in g	Temperature in °C
0.0	17.0
0.5	15.6
1.0	14.1
1.5	13.0
2.0	12.9
2.5	12.2
3.0	11.8
3.5	11.5
4.0	11.2
4.5	11.0
5.0	11.0

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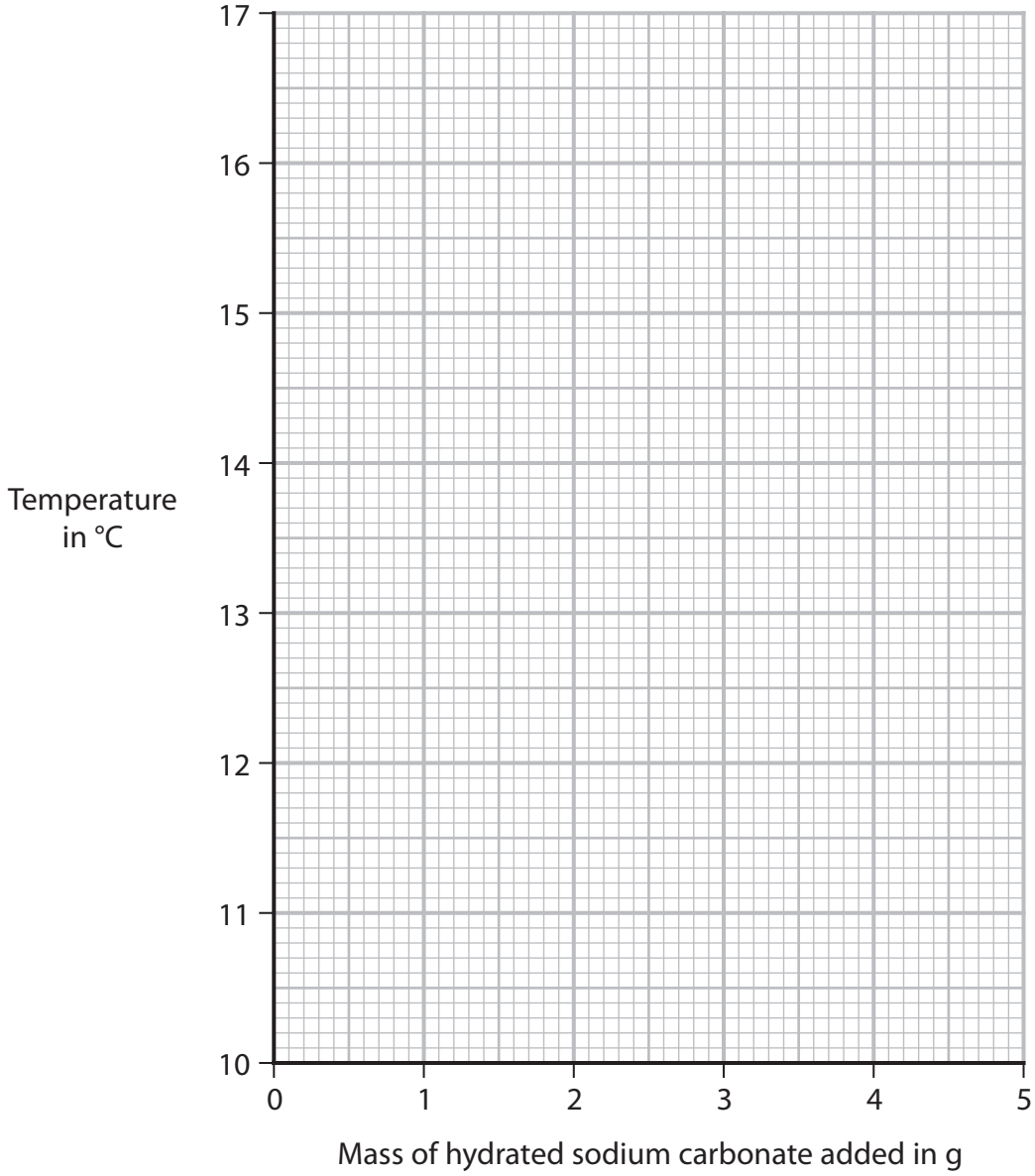
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(i) Plot the student's results on the grid.

(2)

(ii) Draw a curve of best fit, ignoring the anomalous result.

(1)



(iii) Explain why it is better to use a polystyrene cup instead of a glass beaker in this experiment.

(2)

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.....

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(iv) Suggest a reason for the anomalous result.

(1)

.....

.....

(v) State how the results show that all the dilute hydrochloric acid has reacted.

(1)

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(vi) Use the results of the experiment to explain the type of reaction that occurs when sodium carbonate is added to dilute hydrochloric acid.

(2)

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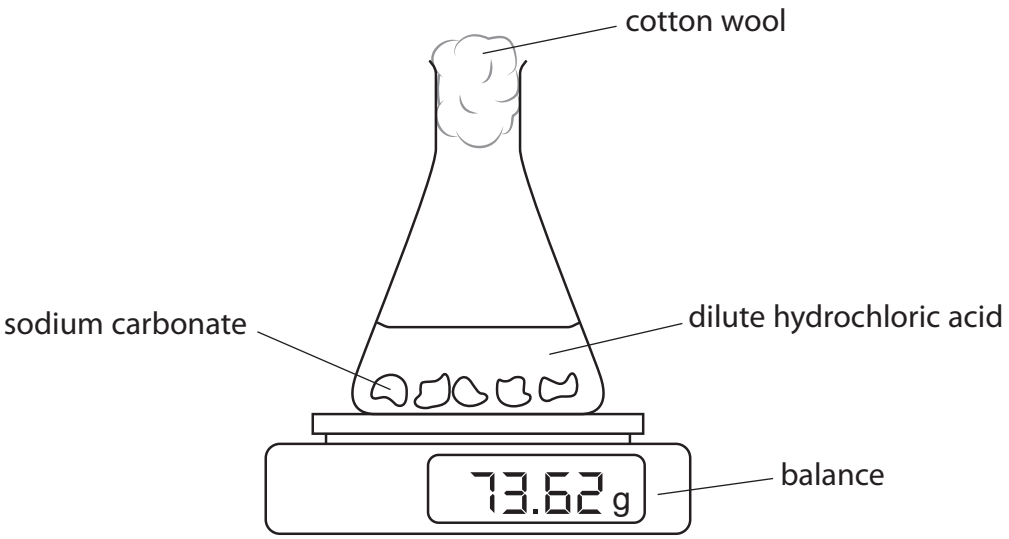
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(b) The student does another experiment using the same reaction.

The diagram shows the student's apparatus.



The mass on the balance decreases as carbon dioxide gas escapes.

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(i) Give a reason for the cotton wool plug in the conical flask.

(1)

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.....

(ii) The student adds 2.12 g of sodium carbonate to an excess of dilute hydrochloric acid.

The chemical equation for the reaction is

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

Calculate the maximum mass, in g, of carbon dioxide formed in the reaction.

(3)

mass = ... g

(iii) Suggest why the mass of carbon dioxide produced is less than the calculated maximum mass.

(1)

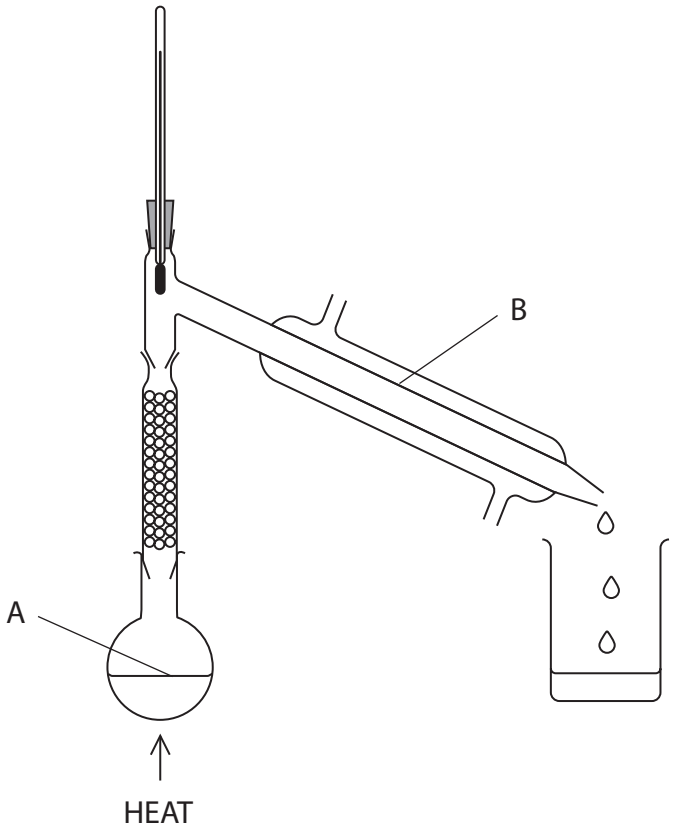
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(Total for Question 9 = 14 marks)

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10 A teacher uses this apparatus to separate a mixture of ethanol and water.



(a) (i) Name this method of separation.

(1)

.....

(ii) Name the change of state taking place at A.

(1)

.....

(iii) Name the change of state taking place at B.

(1)

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(b) The mixture contains 15.5 cm^3 of ethanol.

1.0 cm^3 of ethanol has a mass of 0.79 g.

One mole of ethanol contains 6.00×10^{23} molecules.

[M_r of ethanol = 46]

(i) Calculate the amount, in moles, of ethanol in 15.5 cm^3 of ethanol.

(2)

amount = ... mol

(ii) Calculate the number of molecules of ethanol in 15.5 cm^3 of ethanol.

(1)

number of molecules = ...

(c) After five minutes, the teacher collects a sample of colourless liquid in a new beaker.

(i) Describe a chemical test to show that the colourless liquid contains water.

(2)

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(ii) Describe a physical test to show if the colourless liquid is pure water.

(2)

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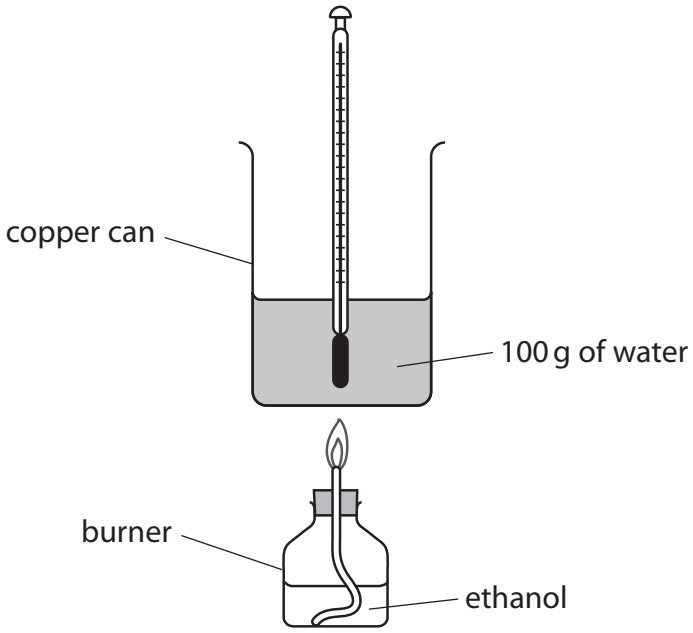
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(d) The teacher uses this apparatus to heat 100 g of water.



He records the temperature of the water before and after heating.

temperature of water before heating = 21.0 °C

temperature of water after heating = 70.5 °C

(i) Calculate the heat energy change (*Q*) in joules.

[specific heat capacity of water is 4.2 J/g/°C]

(3)

Q = ... J

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(ii) The student burns 0.0200 mol of ethanol.

Use this information and your value for *Q* to calculate the molar enthalpy change (ΔH), in kJ/mol, for the combustion of ethanol.

Include a sign in your answer.

(2)

ΔH = ... kJ/mol

(Total for Question 10 = 15 marks)

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11 This question is about the reactivity of metals.

(a) Table 1 shows whether a reaction occurs between a metal and an aqueous solution of a metal sulfate.

Metal	Metal sulfate	Does a reaction occur?
manganese	chromium sulfate	yes
tin	cadmium sulfate	no
chromium	cadmium sulfate	yes

Table 1

(i) Name the type of reaction that occurs between manganese and chromium sulfate.

(1)

.....

(ii) Use the information in Table 1 to complete the order of reactivity.

(1)

most reactive



least reactive

manganese

.....

.....

.....

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(b) Table 2 shows the colours of four metals and the colours of their metal sulfate solutions.

Metal	Colour of metal	Colour of metal sulfate solution
copper	brown	blue
iron	dark grey	green
magnesium	silvery	colourless
zinc	light grey	colourless

Table 2

When a metal is added to a metal sulfate solution there may be a colour change on the surface of the metal and in the solution.

Use the information in Table 2 and your knowledge of the reactivity series to explain any colour changes in these two experiments.

(5)

copper added to magnesium sulfate solution.....

.....

.....

.....

.....

zinc added to iron sulfate solution.....

.....

.....

.....

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(c) A different experiment can be used to place metals in order of reactivity.

This is the method.

Step 1 add 1 g of a metal to 25 cm^3 of dilute sulfuric acid

Step 2 measure the volume of gas produced in one minute

(i) Give two variables that should be controlled in this experiment.

(2)

1 .....

.....

2 .....

.....

(ii) A small piece of calcium is added to some dilute sulfuric acid in a beaker.

One of the products of the reaction, calcium sulfate, is insoluble in water.

Suggest why the reaction stops after a short time, even though the beaker still contains calcium and dilute sulfuric acid.

(1)

.....

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(d) 1.00 g of aluminium is added to 0.0600 mol of dilute sulfuric acid.

The equation for the reaction is

$$2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$$

Show by calculation that the sulfuric acid is in excess.

(2)

(Total for Question 11 = 12 marks)

TOTAL FOR PAPER = 110 MARKS

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