Model Answers

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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P 6 6 0 5 8 R A 0 1 4 0

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.

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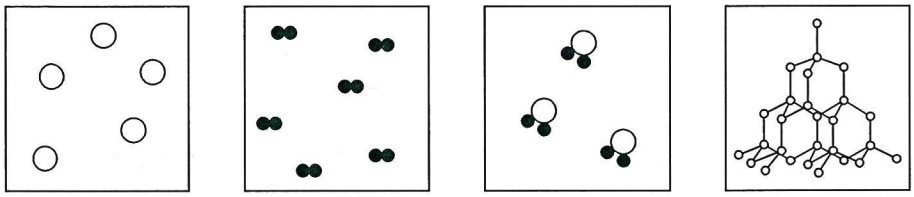
Answer ALL questions.

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)

- [x] **A**
- [ ] **B**
- [ ] **C**
- [ ] **D**

(ii) Which substance is a compound?

(1)

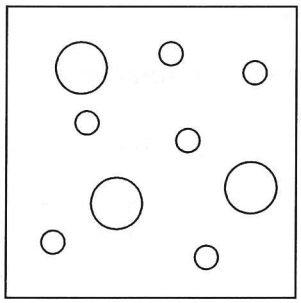
- [ ] **A**
- [ ] **B**
- [x] **C**
- [ ] **D**

(iii) Which substance could have the formula H_2?

(1)

- [ ] **A**
- [x] **B**
- [ ] **C**
- [ ] **D**

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



E

Give two reasons why substance E is a mixture.

(2)

1 two different elements

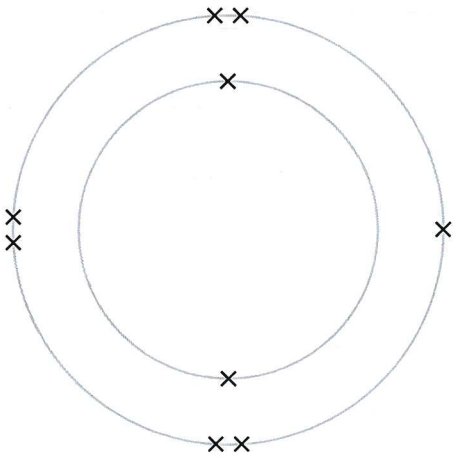
2 not chemically joined

(Total for Question 1 = 5 marks)

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)

has the fewest number of shells

(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	• does not need heating • reacts very quickly
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)

as the atoms get bigger

the reactivity decreases

(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)

Oxygen

(ii) Give the chemical name for rust.

(1)

iron(III) oxide

(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)

plastic acts as a barrier

therefore stops oxygen getting to the Iron

(ii) Give the name of method B.

(1)

galvanising

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

(2)

zinc is more reactive than Iron

therefore reacts in preference

(Total for Question 3 = 7 marks)

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)

14

(ii) Give the electronic configuration of G.

(1)

2,5

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

Refer to subatomic particles in your answer.

(2)

Same number of protons

different number of protons

(iv) Explain why H is a negative ion.

Refer to subatomic particles and their charges in your answer.

(2)

more electrons than protons

electrons have negative charge and protons have a positive charge

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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)

$$\frac{(98.930 \times 12) + (1.070 \times 13)}{100}$$

relative atomic mass = 12.01

(Total for Question 4 = 8 marks)

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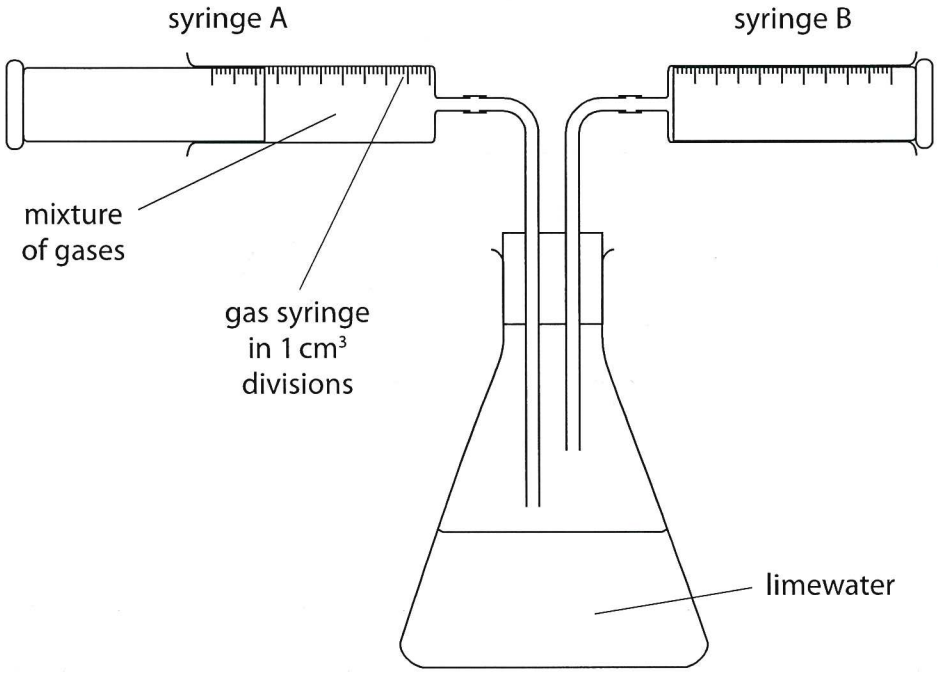
5 Two experiments are done to determine the percentage composition by volume of a mixture of three gases, carbon dioxide, oxygen and argon.

(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)

add more lime water to cover tube on the left

(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)

$\frac{10}{76} \times 100 = 13.2\%$

$76 - 66 =$ volume of CO_2

$= 10 cm^3$

percentage of carbon dioxide = 13.2 %

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

(1)

limewater turns from colourless to cloudy

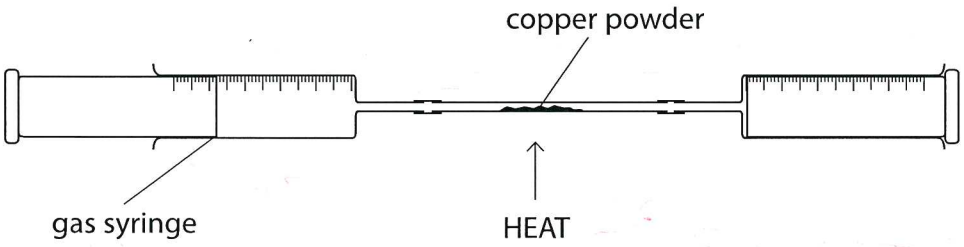
(iii) Explain why the gas syringes in experiment 1 cannot be used to find the percentage of carbon dioxide in a typical sample of air.

(2)

the amount of carbon dioxide in the air is too small therefore the reading would be less then 1 cm^3

(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)

copper(II) oxide

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

(1)

the powder has a greater surface area

(iii) Explain why argon is extremely unreactive.

(2)

argon has a full outer shell of electrons

therefore does not lose or gain electrons

(Total for Question 5 = 10 marks)

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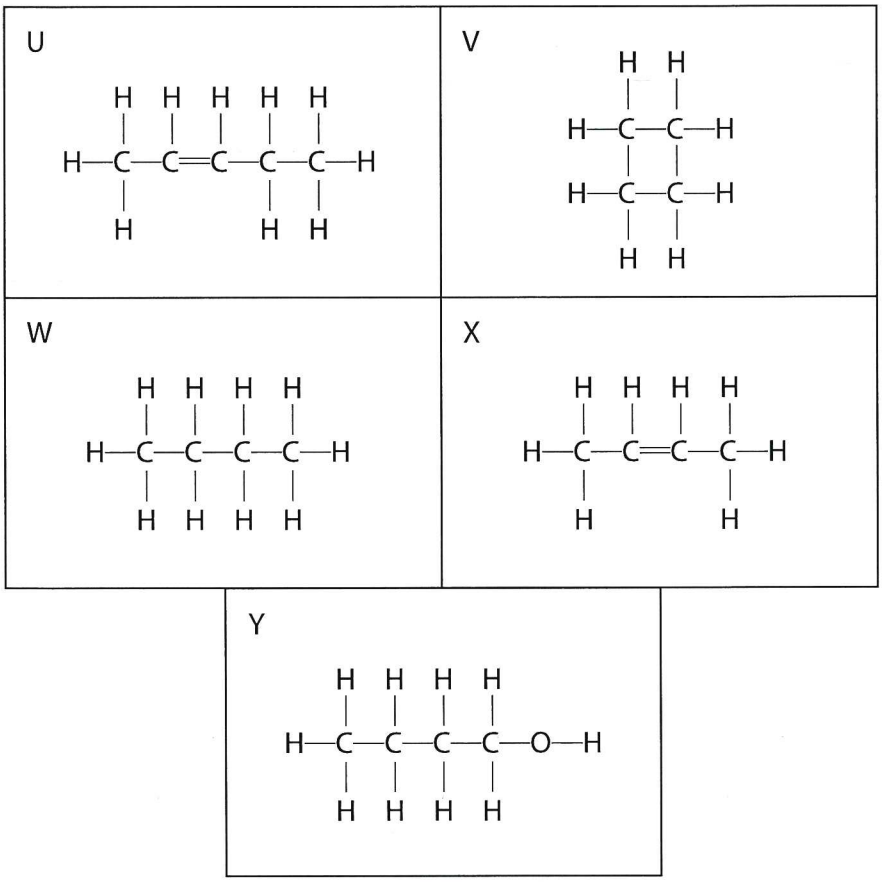
6 This question is about organic compounds.

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



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

(1)

Y

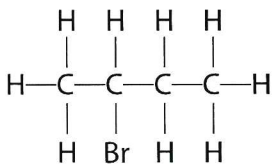
(ii) Give the letter of the compound that is a saturated hydrocarbon with the empirical formula CH_2

(1)

V

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

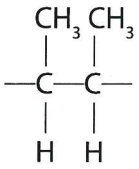
(1)



W

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

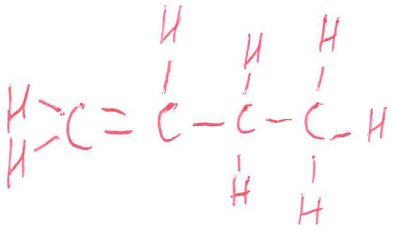
(1)



X

(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 Same general formula

2 Similar chemical properties

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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)

$\frac{38.7}{12}$ $\frac{9.7}{1}$ $\frac{51.6}{16}$

$\frac{3.225}{3.225}$ $\frac{9.7}{3.225}$ $\frac{3.225}{3.225}$ CH_3O

1 3 1

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

Deduce the molecular formula of compound Z.

(2)

$CH_3O = 31$

$\frac{62}{31} = 2$

Therefore $C_2H_6O_2$

molecular formula = $C_2H_6O_2$

(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)

$N_2 + O_2 \rightarrow 2NO$

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

(1)

the reaction has a high activation number

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

(1)

acid rain

(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)

Catalyst provides an alternative pathway with lower activation energy

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

(3)

particles are closer together

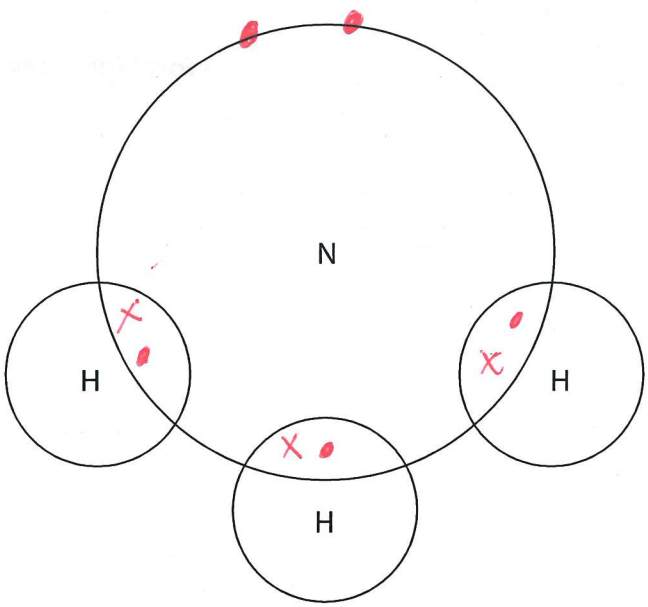
therefore more collisions

per unit time

(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)

attraction between nuclei and shared pair of electrons

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

(2)

force between molecules are weak

therefore requires little energy to overcome

(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)

add barium carbonate to the acid

until barium carbonate is in excess

filter off the excess barium carbonate

heat solution to evaporate some of the water

cool to crystallise

filter the crystals

leave crystals in a warm place to dry

(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)

add dilute acid then add barium chloride white precipitate

(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.

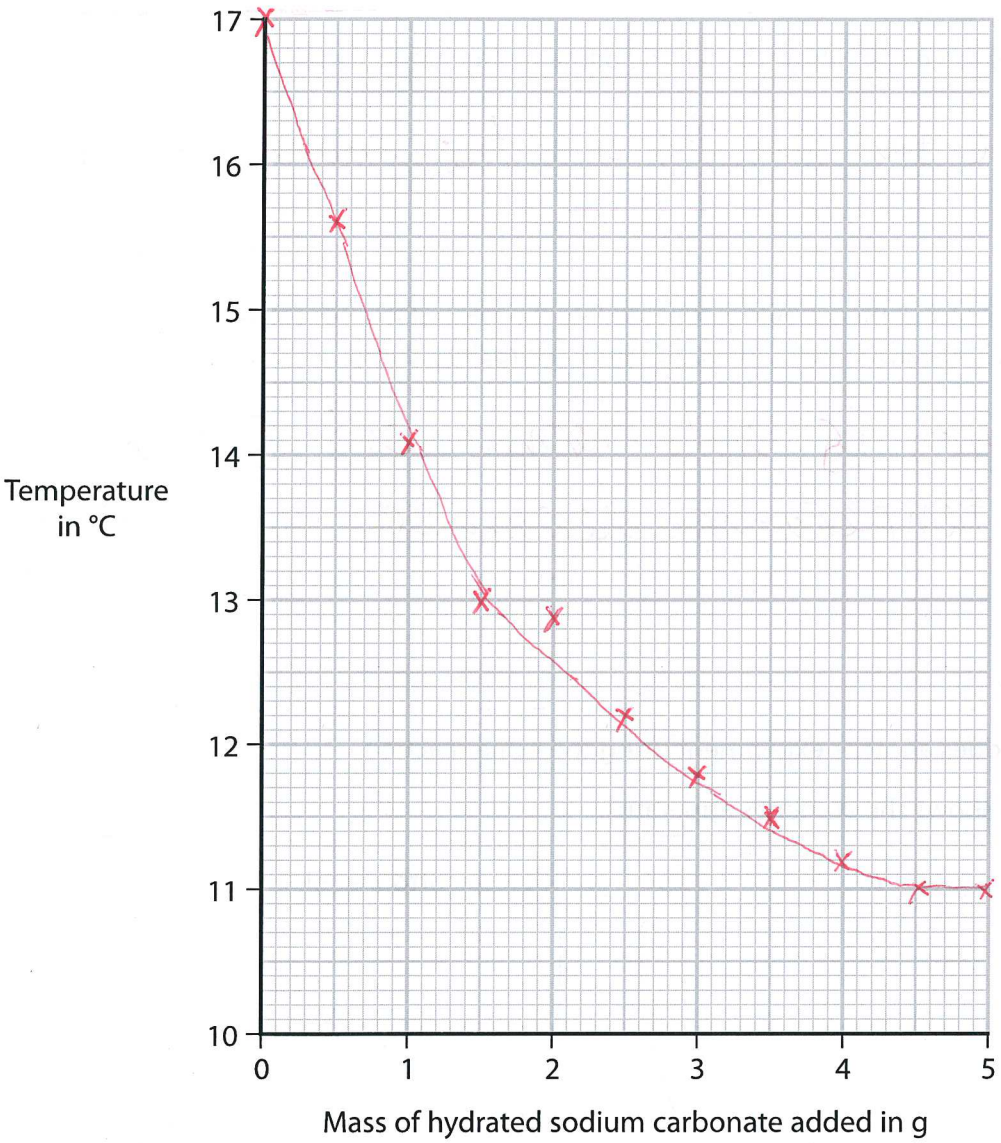
Mass of sodium carbonate added in g	Temperature in °C
0.0	17.0
0.5	15.6
1.0	14.1
1.5	13.0
2.0	12.9
2.5	12.2
3.0	11.8
3.5	11.5
4.0	11.2
4.5	11.0
5.0	11.0

(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)

polystyrene is an insulator reduces thermal energy from the surroundings therefore temperature decrease will be closer to true value

(iv) Suggest a reason for the anomalous result.

(1)

the Student forgot to stir the mixture

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

(1)

as the two results at the end are the same

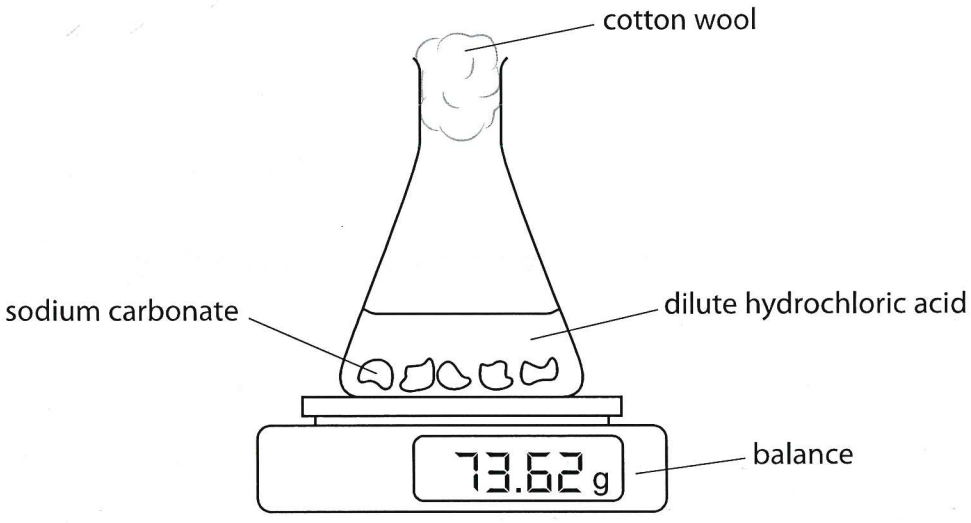
(vi) Use the results of the experiment to explain the type of reaction that occurs when sodium carbonate is added to dilute hydrochloric acid.

(2)

the reaction is endothermic as shown by the temperature decrease

(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.

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

(1)

to prevent acid splashing out

(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)

$mr(Na_2CO_3) = 106$

$mol = \frac{mass}{mr} = \frac{2.12}{106} = 0.02$

mass of $CO_2 = 0.02 \times 44 = 0.88$

mass = 0.88 g

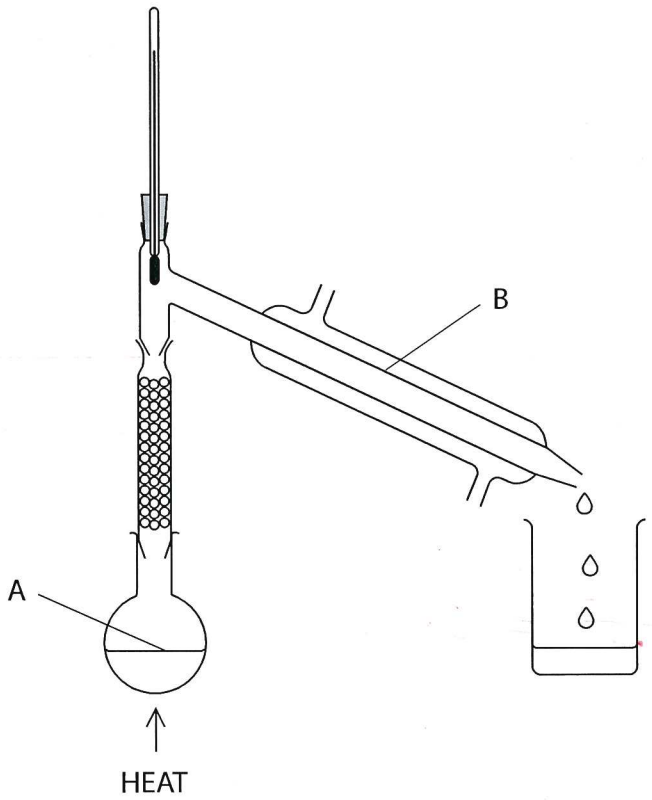
(iii) Suggest why the mass of carbon dioxide produced is less than the calculated maximum mass.

(1)

Sodium carbonate is impure

(Total for Question 9 = 14 marks)

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



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

(1)

fractional distillation

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

(1)

evaporation

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

(1)

condensation

(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)

$15.5 \times 0.79 = 12.245$ g of ethanol

$\frac{12.245}{46} = 0.266$ mol

amount = 0.266 mol

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

(1)

$0.266 \times 6.02 \times 10^{23} = 1.60 \times 10^{23}$

number of molecules = 1.60×10^{23}

(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)

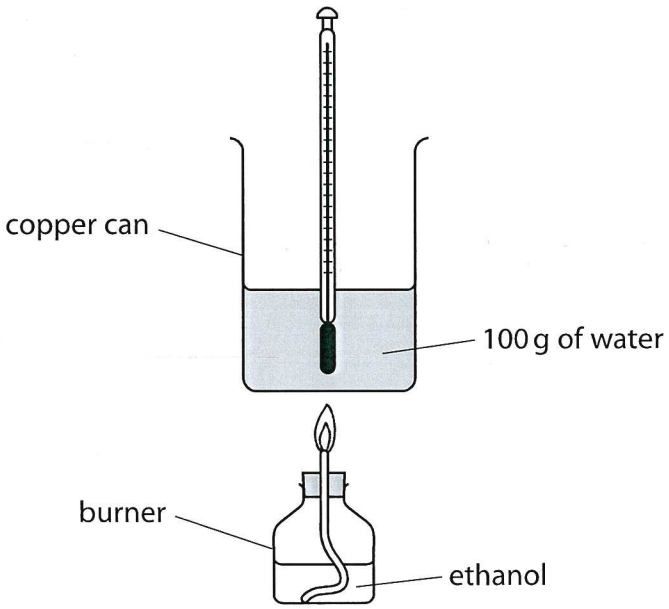
add anhydrous copper sulfate which in the presence of water turns blue

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

(2)

measure boiling point which is 100°C

(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)

$70.5 - 21.0 = 49.5 = \Delta T$

$Q = mc\Delta T = 100 \times 4.2 \times 49.5 = 20790\,J$

$= 20.790\,kJ$

$Q =$ 20790 J

(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)

20.790 kJ

$\frac{20.790}{0.0200} = -1039.5$ kJ/mol

$\Delta H =$ -1039.5 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)

displacement

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

(1)

most reactive

↓

least reactive

manganese

chromium

cadmium

Tin

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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 no colour change as copper is less reactive than magnesium

zinc added to iron sulfate solution zinc turns dark grey solution turns colourless as zinc is more reactive than iron

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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 concentration of dilute Sulfuric acid

2 temperature

(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)

Calcium Sulfate forms a layer ~~and~~ around the calcium metal

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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)

mol of Al = $\frac{1}{27} = 0.037$ mol

mol of H_2SO_4 = $\frac{0.037 \times 3}{2} = 0.0556$ mol

therefore H_2SO_4 is in excess

(Total for Question 11 = 12 marks)

TOTAL FOR PAPER = 110 MARKS

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