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Candidate surname		Other names	
Centre Number		Candidate Number	
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Pearson Edexcel Level 1/Level 2 GCSE (9–1)

Tuesday 13 June 2023

Morning (Time: 1 hour 45 minutes)

Paper reference **1CH0/2F**

Chemistry

PAPER 2

Foundation Tier

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.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.
- There is a periodic table on the back cover of the paper.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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Answer ALL questions. Write your answers in the spaces provided.

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 Figure 1 shows the structure of a molecule of each of four compounds, **A**, **B**, **C** and **D**.

compound A	compound B	compound C	compound D
	$O=C=O$		

Figure 1

- (a) The formula of a molecule of compound **A** is H_2O .

Give the formula of a molecule of compound **D**.

(1)

CH₄

- (b) The names of two of the compounds in Figure 1 are shown below.

Draw one straight line from each name to the structure of a molecule of that compound.

(2)

name of compound	structure of molecule
carbon dioxide	
methane	

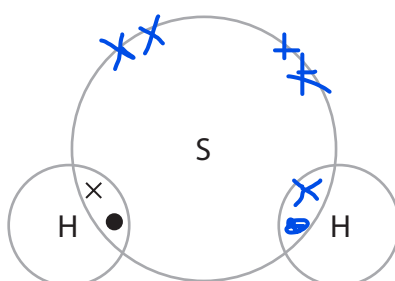
- (c) Figure 2 shows information about the number of electrons in the outer shell of each of the different atoms in a molecule of compound **C**.

symbol of element	number of electrons in outer shell of the atom
H	1
S	6

Figure 2

Use the information in Figure 2 to complete the dot and cross diagram for a molecule of compound **C**.

(2)



- (d) The atomic number of phosphorus, P, is 15.

One atom of phosphorus has a relative atomic mass of 31.

Give the number of protons, neutrons and electrons in this atom of phosphorus.

(3)

number of protons = 15 (1)

number of neutrons = 16 (1)

number of electrons = 15 (1)

(Total for Question 1 = 8 marks)



- 2 A student investigated the temperature change that took place when different salts were dissolved in water.

The student used the following method.

step 1 pour 50 cm^3 of water into a polystyrene cup and record the temperature of the water

step 2 find the mass of an empty boiling tube

step 3 add 2 spatula measures of a salt to the boiling tube and find its new mass

step 4 add the salt to the water

step 5 stir the mixture and record the temperature after 2 minutes.

Figure 3 shows the apparatus used.

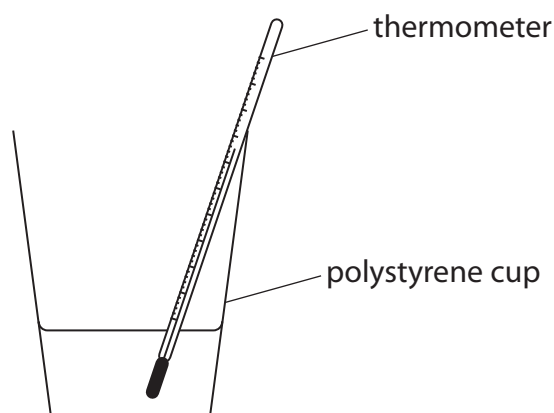


Figure 3

- (a) For steps 2 and 3, the student obtained the mass measurements shown in Figure 4 for the first salt.

mass of empty boiling tube in g	22.52
mass of boiling tube + 2 spatula measures of a salt in g	24.16

Figure 4

Use the mass measurements in Figure 4 to calculate the mass of salt, in grams, added to the water.

(1)

$$24.16 - 22.52 = 1.64 \text{ (g)}$$

mass of salt = 1.64 g



- (b) The student repeated the method for three different salts, **A**, **B** and **C**.

The same mass of each salt was used.

Figure 5 shows the temperature readings obtained for the three different salts.

salt	starting temperature of the water in °C	temperature of the mixture after 2 minutes in °C	temperature change in °C
A	20.5	25.6	+5.1
B	20.5	19.8	-0.7
C	20.5	29.2	

Figure 5

- (i) Calculate the temperature change for salt **C**.

Include a sign to show if the temperature change is an increase or a decrease.

(2)

+ (1) 8.7 (1) C
sign (1) value (1)

temperature change = °C

- (ii) Explain which salt produces the biggest exothermic change.

(2)

An explanation linking

- salt with larger positive temperature rise in part (i) (1)

- shows the {largest/highest} temperature rise (1)

- (c) Explain why a polystyrene cup is a better container to use for this investigation than a glass beaker.

(2)

An explanation linking

- polystyrene is an insulator / poor conductor (of heat) (1)
- reduces {heat/energy} {loss/transfer} (1)

(Total for Question 2 = 7 marks)



3 Chemical tests are used to identify unknown substances.

(a) A flame test can be used to identify metal ions in a substance.

(i) Complete step 2 of how to carry out a flame test.

(2)

step 1 dip a flame test wire in dilute hydrochloric acid and then hold the wire in a roaring Bunsen flame until the flame is colourless

step 2 {dip/put} flame test wire into dilute hydrochloric acid, (1)
then into {substance / ion} (1)

step 3 hold the wire with the substance in a roaring Bunsen burner flame.

(ii) Many metal ions produce a coloured flame in a flame test.

Draw one straight line from each metal ion to its flame colour in a flame test.

(3)

metal ion		flame colour
		blue-green
copper ion		lilac
potassium ion		orange-red
sodium ion		red
		yellow



- (b) Some metal ions can be identified using sodium hydroxide solution.

Drops of sodium hydroxide solution were added to a solution containing iron(III) ions, Fe^{3+} .

What would be seen?

(1)

- ☐ A blue solution
- ☐ B green liquid
- ☒ C red-brown precipitate
- ☐ D yellow gas

- (c) In the test for carbonate ions, dilute hydrochloric acid is added to the solid carbonate in a test tube.

A gas is given off.

- (i) Give the name of this gas.

(1)

carbon dioxide

- (ii) Figure 6 shows the apparatus that a student set up to test for this gas.

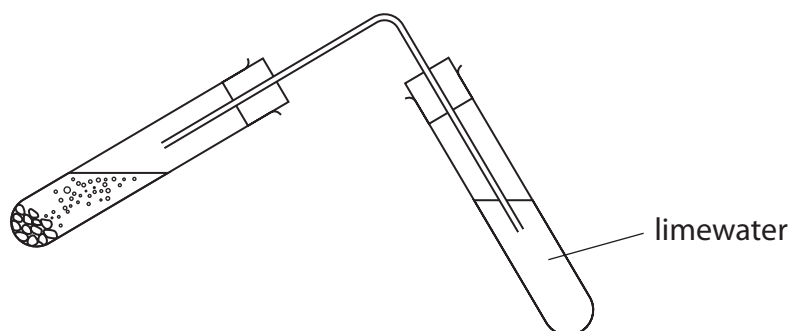


Figure 6

This apparatus will not work.

State what change is needed so that bubbles of the gas can pass through the limewater.

(1)

{remove / loosen / slacken} {bung / stopper/lid}
of right-hand test tube

(d) A compound that contained ammonium ions was dissolved in water.

A solution was formed.

Sodium hydroxide solution was added, and the mixture was heated.

A gas was given off.

This gas was tested with a piece of damp red litmus paper.

The litmus paper turned blue.

Name the gas that was given off.

(1)

ammonia

(Total for Question 3 = 9 marks)



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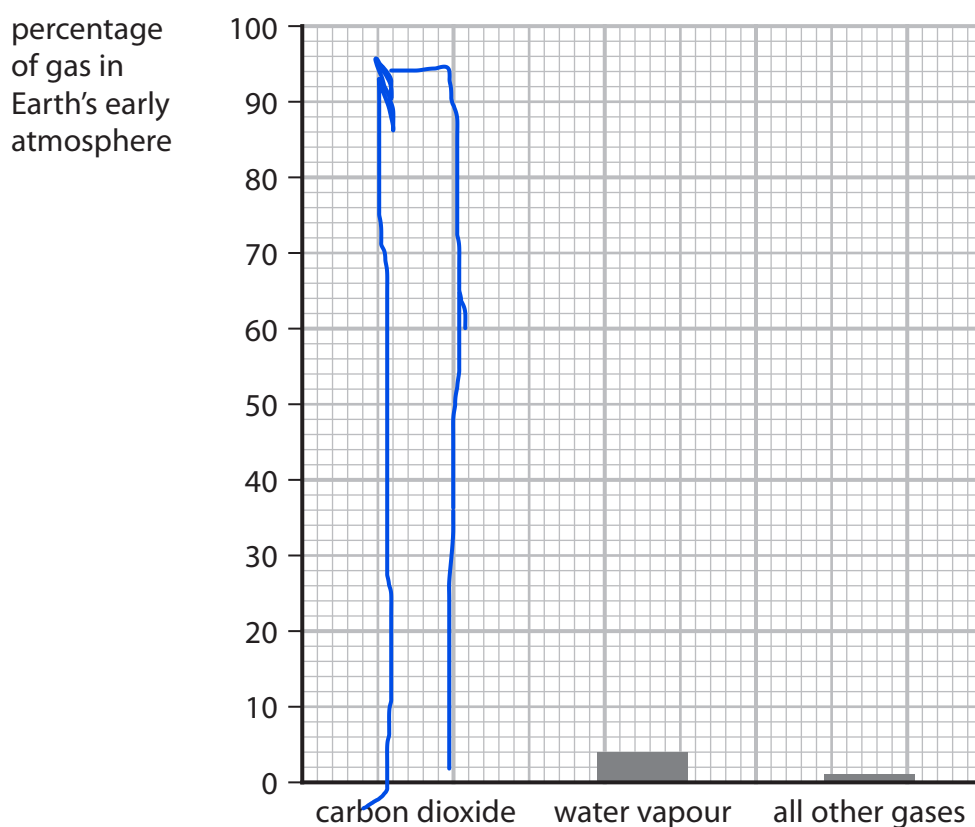
- 4 A scientist produced the information in Figure 7 about the Earth's atmosphere and the Earth's average surface temperature.

Earth's atmosphere 3 billion years ago		Earth's atmosphere today	
gas	%	gas	%
carbon dioxide	95	nitrogen	78.00
water vapour	4	oxygen	21.00
all other gases	1	carbon dioxide	0.04
		all other gases including water vapour	0.96
average surface temperature 3 billion years ago		average surface temperature today	
above 400 °C		20 °C	

Figure 7

- (a) Complete the bar chart showing the composition of the Earth's atmosphere 3 billion years ago by adding a bar to show the percentage of carbon dioxide.

(1)



(b) (i) Use words from the box to complete the following sentence.

(1)

has decreased

has increased

has stayed the same

Over the past 3 billion years the average surface temperature of the Earth

has decreased.

(ii) The Earth's atmosphere 3 billion years ago contained much more water vapour than today's atmosphere.

Explain what happened to the water vapour.

(2)

an explanation linking any two from

- {the Earth / atmosphere / water vapour} cooled (1)
- water vapour condensed / formed clouds (1)
- {(liquid) water / rain} formed (1)
- produced {oceans / seas / rivers / bodies of water} (1)

(c) Scientists think that the decrease in percentage of carbon dioxide was partly due to this gas being used in the growth of primitive plants.

(i) Carbon dioxide was used in the growth of primitive plants and produced oxygen.

Give the name of the process in plants that takes in carbon dioxide and produces oxygen.

(1)

photosynthesis

(ii) Which of the following tests would show that a gas is oxygen?

(1)

- ☐ A put a lighted splint into the gas and it burns with a pop
- ☒ B put a glowing splint into the gas and it relights
- ☐ C put a lighted splint into the gas and it relights
- ☐ D put a glowing splint into the gas and it burns with a pop

(d) Many people are concerned by the increasing amount of carbon dioxide in the atmosphere.

- (i) The amount of carbon dioxide in the atmosphere is measured in parts per million (ppm).

Figure 8 shows the amount of carbon dioxide in the atmosphere in June 2001 and in June 2021.

	amount of carbon dioxide in ppm
June 2001	371.17
June 2021	416.56

Figure 8

Calculate the increase in the amount of carbon dioxide, in ppm, from June 2001 to June 2021.

Give your answer to the nearest whole number.

(2)

$$(416.56 - 371.17 =) 45.39 \text{ (1)}$$

$$= 45 \text{ (1) (to nearest whole number)}$$

increase in amount of carbon dioxide = ppm

- (ii) State **one** possible effect that could be caused by the increasing amount of carbon dioxide in the atmosphere.

(1)

eg global warming / {ice caps/glaciers} melting
/ changing habitats / rising sea levels

(Total for Question 4 = 9 marks)



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5 Ethanol can be made by fermentation of a solution of glucose, a carbohydrate.

A student used the apparatus shown in Figure 9 for the fermentation reaction.

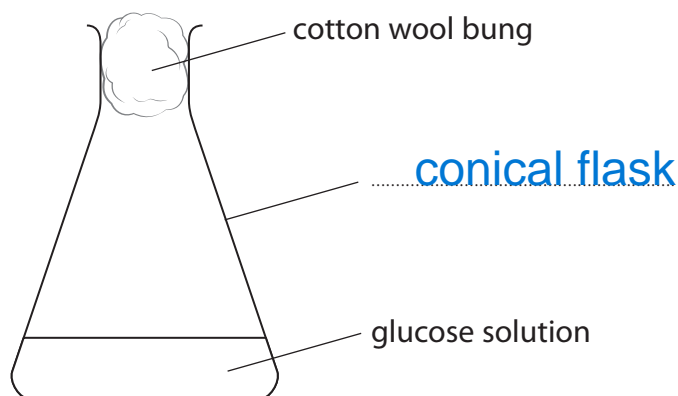


Figure 9

(a) Complete the missing label on Figure 9.

(1)

(b) The student dissolved 45 g of glucose in water to make 150 cm³ of glucose solution.

Calculate the concentration of this solution in g dm⁻³.

(2)

$$\frac{45}{150} = 0.3 \text{ (1)}$$

$$0.3 \times 1000 \text{ (1)} = 300 \text{ (g dm}^{-3}\text{) OR}$$

$$\frac{150}{1000} = 0.15 \text{ (dm}^3\text{) (1)}$$

$$45 = 300 \text{ (g dm}^{-3}\text{) (1)}$$

concentration of glucose solution = 0.15 g dm⁻³

(c) State what should be added to the glucose solution to cause the fermentation reaction.

(1)

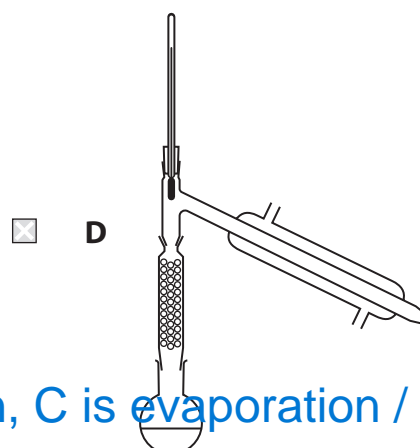
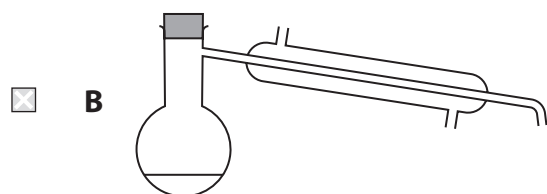
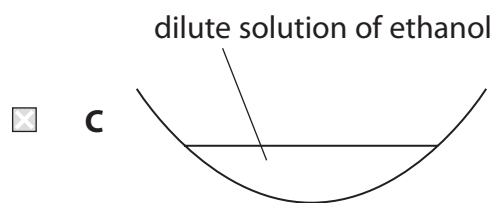
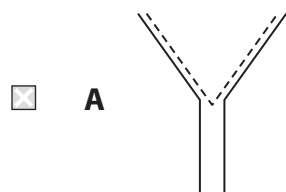
yeast / zymase



(d) After a few days, a dilute solution of ethanol is formed.

Which piece of apparatus should be used to produce a concentrated solution of ethanol from the dilute solution of ethanol by fractional distillation?

(1)



A is filtration B is simple distillation, C is evaporation / crystallisation

(e) The complete fermentation of 180 g of glucose produces 92 g of ethanol.

Calculate the maximum mass of ethanol, in g, produced from the complete fermentation of 45 g of glucose.

(2)

$$\frac{92}{180} = 0.5111111 \quad (1)$$

$$0.5111111 \times 45 = 23 \text{ (g)} \quad (1)$$

maximum mass of ethanol = 23 g

(f) The structure of a molecule of ethanol is shown in Figure 10.

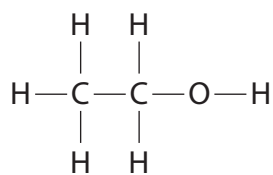
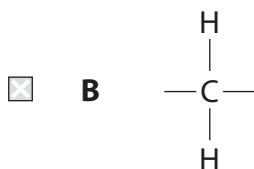
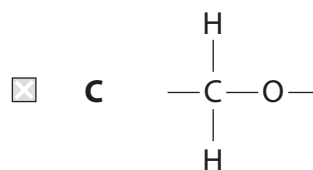
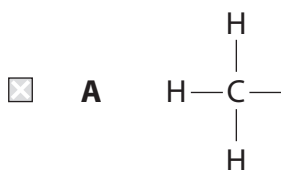


Figure 10

Ethanol is an example of an alcohol.

What is the functional group of an alcohol?

(1)



(g) Ethanol can be oxidised to form ethanoic acid.

State what is seen when a piece of universal indicator paper is placed in some dilute ethanoic acid.

(1)

turns {orange /red / yellow}

(Total for Question 5 = 9 marks)

6 Chlorine is an element in group 7 of the periodic table.

(a) What name is given to group 7 of the periodic table?

(1)

- ☐ A alkali metals
- ☒ B halogens
- ☐ C noble gases
- ☐ D transition metals

(b) Chlorine reacts with sodium to form sodium chloride.

(i) Write the word equation for this reaction.

(2)

sodium + chlorine (1) → sodium chloride (1)

(ii) Chlorine, Cl_2 , is made of simple molecules.

Describe what is meant by the term **molecule**.

(2)

A description to include

- (two or more) atoms joined together (1)
- by a {covalent bond / shared pair of electrons} (1)

(iii) Sodium, like all metals, conducts electricity.

Explain how sodium conducts electricity.

(2)

An explanation linking

- electrons (1)
- (electrons) {can move / are delocalised / can pass through / can flow} (1)

(iv) Sodium chloride contains sodium ions, Na^+ , and chloride ions, Cl^- .

Use this information to state the formula of sodium chloride.

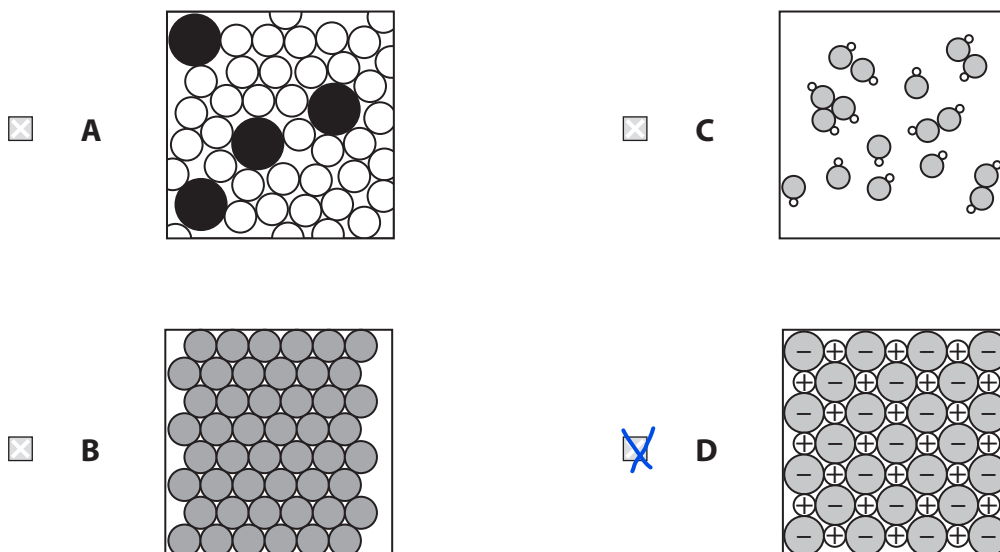
(1)

NaCl / Na+Cl-

(v) Sodium chloride is made of a giant structure of ions.

Which diagram shows the arrangement of particles in sodium chloride?

(1)



(vi) Sodium chloride solution conducts electricity.

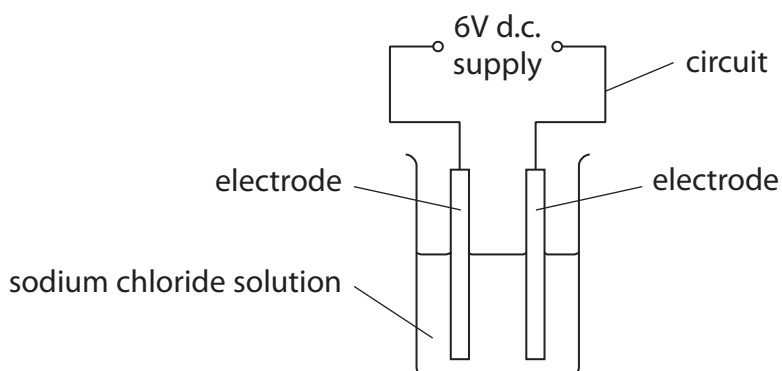


Figure 11

State what can be put into the circuit in Figure 11 to show that a current is flowing.

(1)

ammeter / (light) bulb / lamp

(c) Figure 12 shows a flow diagram of how hydrochloric acid can be made.

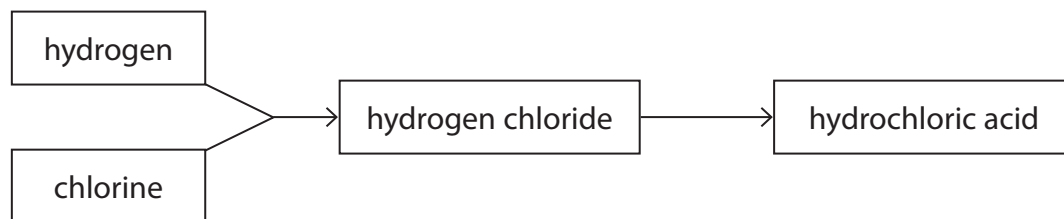


Figure 12

- (i) Balance the equation for the reaction between hydrogen and chlorine to form hydrogen chloride.

(1)



- (ii) State how hydrogen chloride can be converted into hydrochloric acid.

(1)

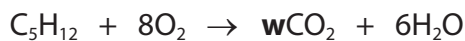
{dissolve in / add} water

(Total for Question 6 = 12 marks)

7 In the complete combustion of alkanes, the alkane reacts with oxygen to produce carbon dioxide and water only.

(a) Pentane, C_5H_{12} , is an alkane.

The equation for the complete combustion of pentane, C_5H_{12} , can be shown as



(i) What is the value of **w** needed to balance the equation for the reaction?

(1)

- ☐ **A** 2
- ☒ **B** 5
- ☐ **C** 8
- ☐ **D** 12

(ii) What happens to pentane in this reaction?

(1)

- ☐ **A** pentane is cracked
- ☐ **B** pentane is distilled
- ☒ **C** pentane is oxidised
- ☐ **D** pentane is reduced



(b) Figure 13 shows some information about four alkanes.

- (i) Complete Figure 13 to show the structure of one molecule of propane and the formula of butane.

(2)

alkane	formula	structure of one molecule
propane	C_3H_8	<pre> H H H H - C - C - C - H H H H </pre>
butane	C_4H_{10}	<pre> H H H H H - C - C - C - C - H H H H H </pre>
pentane	C_5H_{12}	<pre> H H H H H H - C - C - C - C - C - H H H H H H </pre>
hexane	C_6H_{14}	<pre> H H H H H H H - C - C - C - C - C - C - H H H H H H H </pre>

Figure 13

- (ii) Using the information in Figure 13, give the empirical formula of hexane.

(1)

C_3H_7

- *(iii) A student is asked to compare the amount of energy released during the combustion of two alkanes, hexane and octane.

The student is given the apparatus shown in Figure 14.

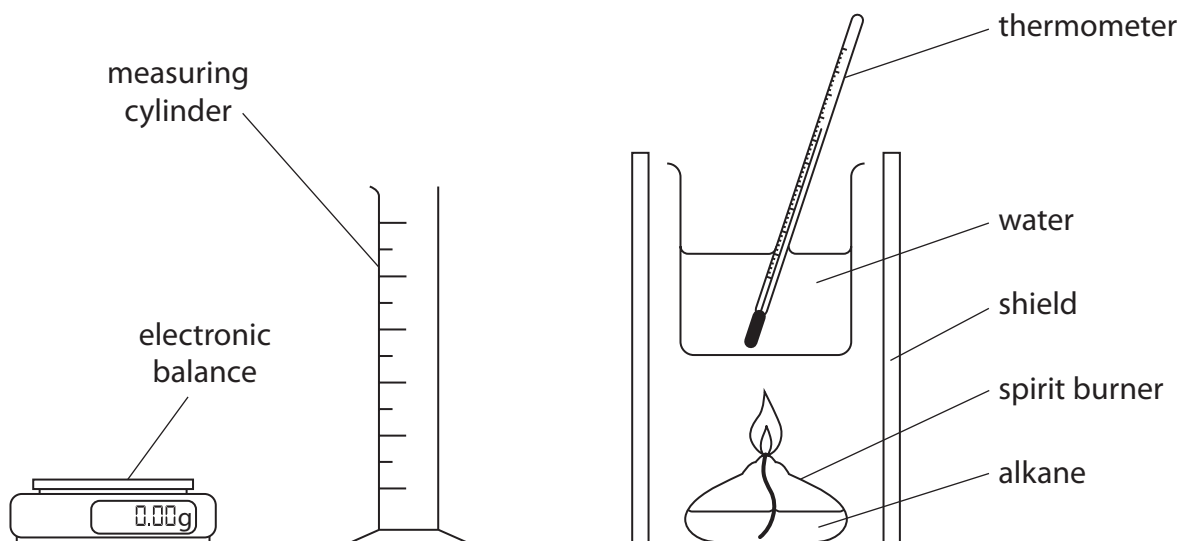


Figure 14

Using the apparatus shown, devise a plan for the student to compare the masses of hexane and octane required to raise the temperature of water by 30°C , describing how any variables in the experiment can be controlled to make a fair comparison.

(6)

plan (alkanes used could be in either order)

- measure known volume of water
- put into beaker
- put hexane into burner
- find mass of burner + hexane
- record temperature of water
- light the burner under the beaker of water
- put draft shield around apparatus
- stir water with thermometer
- heat water until temperature has risen by 30°C
- extinguish flame
- find new mass of burner + hexane
- replace with same volume of cold water
- repeat experiment with octane in burner

variables controlled

- same volume of water being heated

- same height of water above flame
- same temperature rise recorded
- shield prevents drafts
- same sized wick

(Total for Question 7 = 11 marks)

- 8 A student used the apparatus shown in Figure 15 to investigate the reaction between marble chips and dilute hydrochloric acid.

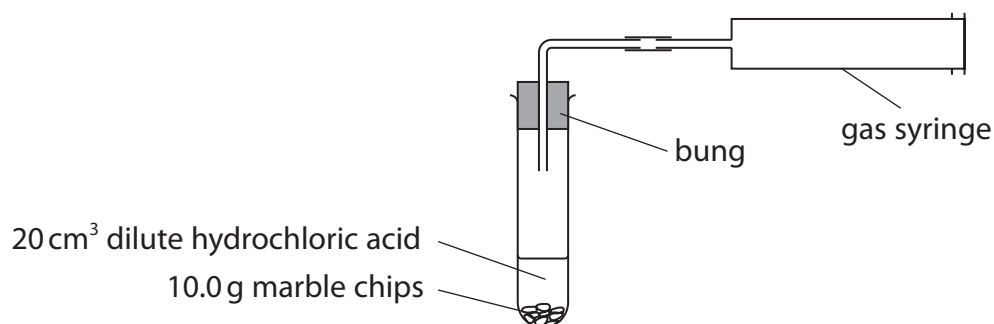


Figure 15

The student recorded the volume of gas every minute as shown in Figure 16.

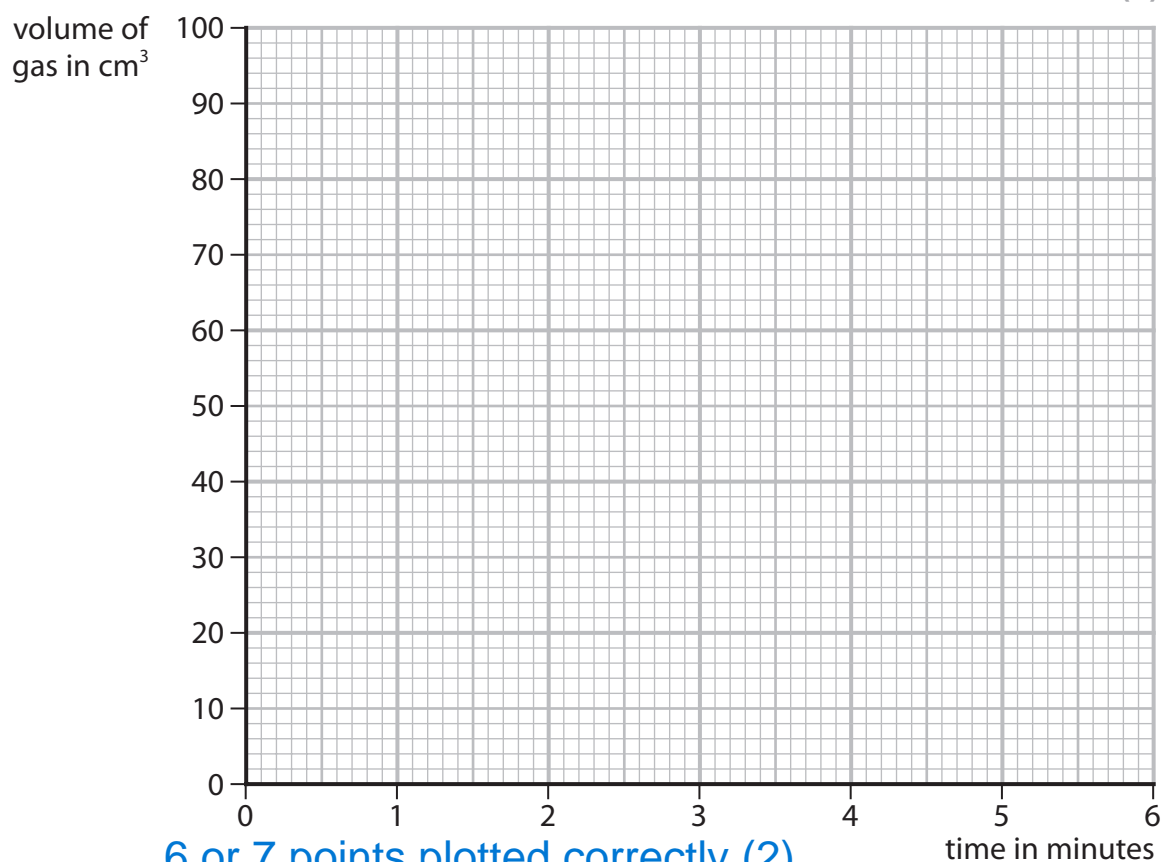
time in minutes	0	1	2	3	4	5	6
volume of gas in cm ³	0	52	78	91	97	100	100

Figure 16

- (a) On the grid, plot the results shown in Figure 16.

Draw a curve of best fit.

(3)



6 or 7 points plotted correctly (2)

or

4 or 5 points plotted correctly (1)

best fit curve starting at (0,0) (1)



(b) Rate of reaction can be calculated using

$$\text{rate of reaction} = \frac{\text{volume of gas produced in 1 minute}}{1 \text{ minute}}$$

Figure 17 shows the rates of reaction calculated from the results of this experiment.

The rate of reaction for the time interval 2 to 3 minutes is missing.

time interval	0 to 1 minute	1 to 2 minutes	2 to 3 minutes	3 to 4 minutes	4 to 5 minutes
rate of reaction in $\text{cm}^3 \text{ min}^{-1}$	52	26		6	3

Figure 17

(i) Calculate the rate of reaction for the time interval 2 to 3 minutes.

(1)

rate of reaction = 13 $\text{cm}^3 \text{ min}^{-1}$

(ii) State and explain what happens to the rate of reaction as the acid reacts with the marble chips in this experiment.

(3)

An explanation linking

- rate of reaction decreases / reaction is slower (1)
- as {reactants / acid/ marble chips} are used up (1)
- so less frequent collisions (1)

(c) The student repeated the experiment using the same volume of acid and the same mass of marble chips but used smaller marble chips.

All other conditions remained the same.

The student found that the reaction with the smaller marble chips was faster to start with but produced the same volume of gas.

Using this information, draw a line on the grid to show the results for the reaction with the smaller marble chips.

Label this line 'C'.

graph to show

- initial line steeper and to the left (1)
- line levelling off at 100 cm^3 before 5 minutes (1)

(2)

(d) Which of the following changes would make the reaction faster?

(1)

- ☐ **A** use a larger boiling tube
- ☐ **B** use a larger volume of the dilute acid
- ☒ **C** use a more concentrated acid
- ☐ **D** use a smaller boiling tube

(e) State what could be used to measure time in the investigation.

(1)

stopwatch / clock

(Total for Question 8 = 11 marks)



- 9 Figure 18 shows some information about some group 1 metals.

group 1 metal	atomic number	relative atomic mass
lithium	3	7
sodium	11	23
potassium	19	39
rubidium	37	85
caesium	55	133

Figure 18

- (a) Explain, in terms of their electronic configurations, why these metals are placed in group 1 of the periodic table.

(2)

An explanation linking

• 1 electron (1)

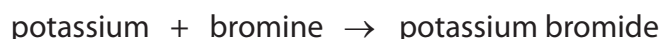
• in outer shell(s) (1)

- (b) Which row shows two correct properties of group 1 metals?

(1)

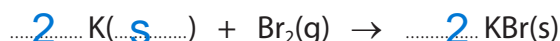
properties of group 1 metals		
<input type="checkbox"/> A	compounds are white in colour	high density
<input type="checkbox"/> B	low melting points	compounds are blue in colour
<input checked="" type="checkbox"/> C	soft enough to be cut by a knife	low melting points
<input type="checkbox"/> D	high density	conduct electricity

(c) The word equation for the reaction of potassium with bromine is



Add the missing state symbol and balance the equation for this reaction.

(2)



(d) A sample of potassium contains three isotopes, potassium-39, potassium-40 and potassium-41.

Explain the meaning of the term **isotopes**.

(2)

An explanation linking

- (atoms) {of same element / with same number of protons} / all contain 19 protons / same atomic number (1)
- different number of neutrons / different mass number / have 20, 21, 22 neutrons (1)

*(e) The reactivity of the group 1 metals increases from lithium to caesium.

Often, teachers demonstrate the reactions of lithium, sodium and potassium with water.

These reactions can be used to predict the behaviour and reactions of rubidium and caesium with water.

Describe the reactions of each of the group 1 metals with water including the predicted behaviour and reactions of rubidium and caesium.

You may use word equations in your answer.

lithium, sodium, potassium float on water

(6)

- metals move around on the water
- bubbles form / fizz / effervescence
- hydrogen / gas produced
- metal hydroxide solution formed
- metal + water \rightarrow metal hydroxide + hydrogen
- purple solution formed if universal indicator present in the water
- lithium slowly disappears
- sodium forms a ball / melts
- sodium disappears quickly
- potassium burns with a lilac flame
- potassium disappears very quickly
- rubidium much more reactive (than potassium)
- rubidium burns with coloured flame
- caesium explosive / more reactive than rubidium



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(Total for Question 9 = 13 marks)



10 (a) Atoms, molecules, nanoparticles and protons are types of particle.

List these four types of particle in order of size from smallest to largest.

(2)

smallest	proton
↓	atom
	molecule
↓	nanoparticle
largest	

(b) Nanoparticles have a large surface area to volume ratio.

Figure 19 shows a cube-shaped nanoparticle with sides of 90 nm.

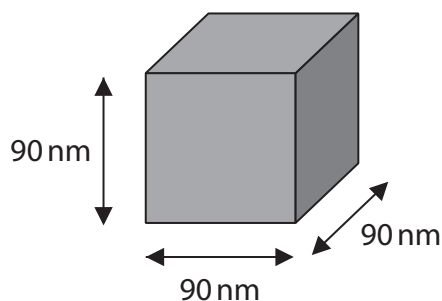


Figure 19

(i) What is 90 nm in metres?

(1)

- ☐ A 9.0×10^{-5}
- ☐ B 9.0×10^{-6}
- ☒ C 9.0×10^{-8}
- ☐ D 9.0×10^{-11}

(ii) Calculate the simplest surface area to volume ratio for the nanoparticle in Figure 19.

Show your working.

(3)

$$\text{surface area} = 90 \times 90 \times 6 \text{ (1)} = 48\,600$$

$$\text{volume} = 90 \times 90 \times 90 \text{ (1)} = 729\,000$$

$$\frac{729\,000}{48\,600} = 15 \text{ (1)}$$

$$\text{answer} = 1 : 15$$

surface area to volume ratio = 1 :

(c) Figure 20 shows the structure of a molecule of tetrafluoroethene.

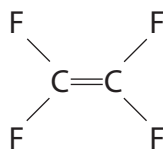


Figure 20

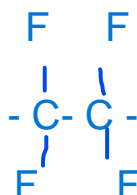
(i) Tetrafluoroethene can form the polymer poly(tetrafluoroethene).

Draw a diagram to show the structure of the repeating unit of this polymer.

(2)

repeat unit including:

- no double bond (1)
- rest of repeat unit with linking bonds (1)



(ii) Poly(tetrafluoroethene) is also known as TeflonTM.

State one use of poly(tetrafluoroethene) and explain how one of its properties makes it suitable for that use.

(3)

use

Property (1)

explanation

(Property & reason MUST depend on use)

Examples:

- for coating (frying) pans (1)
- because it is {slippery/non stick} (1)
- food will not stick to the (frying) pan (1)

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS

The periodic table of the elements

1		2		Key										3		4		5		6		7		0	
				relative atomic mass atomic symbol name atomic (proton) number																					
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								

* The elements with atomic numbers from 58 to 71 are omitted from this part of the periodic table.

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

