

Please check the examination details below before entering your candidate information

Candidate surname					Other names				
Centre Number					Candidate Number				

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**.

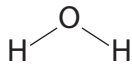
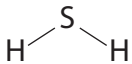
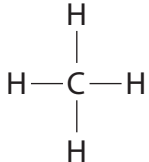
compound A	compound B	compound C	compound D
	$\text{O}=\text{C}=\text{O}$		

Figure 1

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

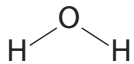
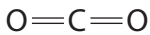
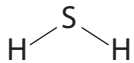
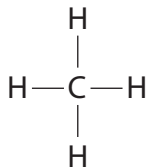
Give the formula of a molecule of compound **D**.

(1)

- (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	
	



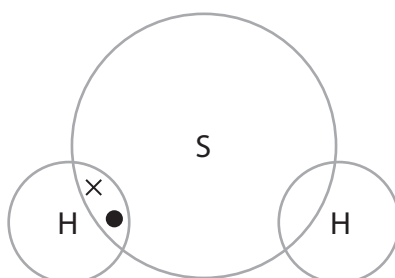
- (c) Figure 2 shows information about the number of electrons in the outer shell of each of the different atoms in a molecule of compound **C**.

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 =

number of neutrons =

number of electrons =

(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.

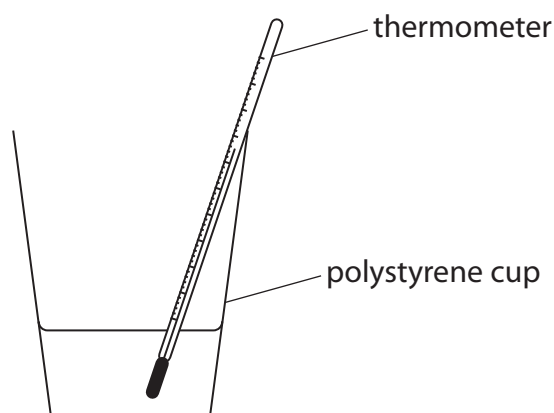


Figure 3

- (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)

mass of salt = 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)

temperature change = °C

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

(2)

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

(2)

(Total for Question 2 = 7 marks)



P 7 2 6 3 2 A 0 5 3 2

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

.....

.....

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)

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

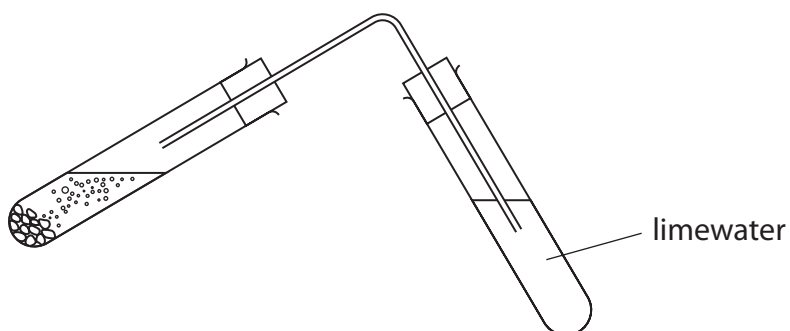


Figure 6

This apparatus will not work.

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

(1)

(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)

(Total for Question 3 = 9 marks)



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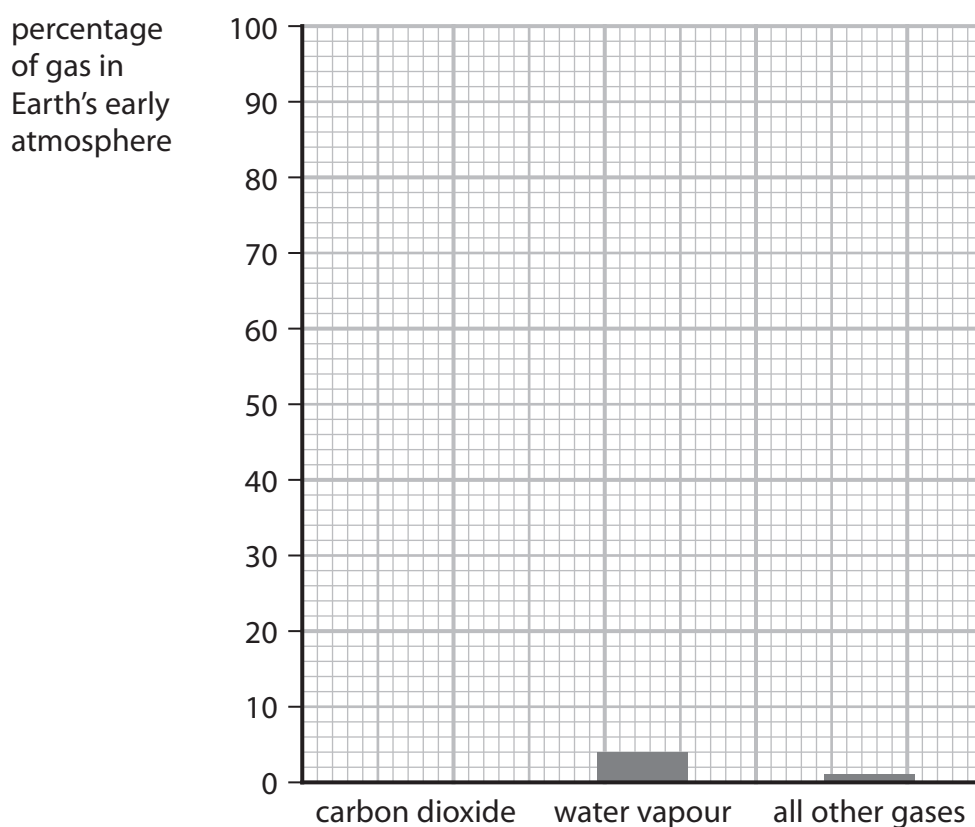
- 4 A scientist produced the information in Figure 7 about the Earth's atmosphere and the Earth's average surface temperature.

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

.....

(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)

.....
.....
.....
.....

(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)

.....

(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)

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)

(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.

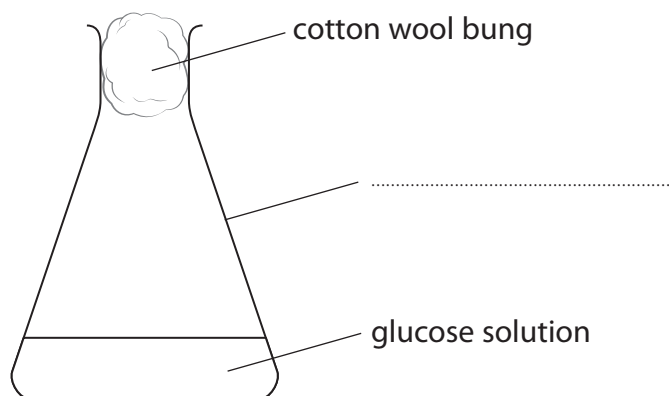


Figure 9

(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)

concentration of glucose solution = g dm⁻³

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

(1)

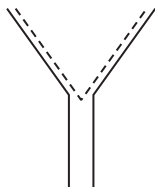
(d) After a few days, a dilute solution of ethanol is formed.

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

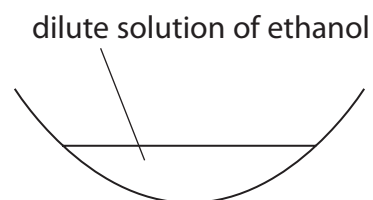
(1)



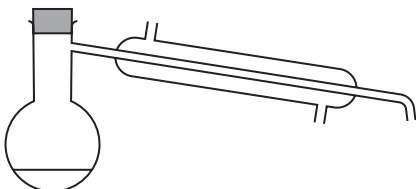
A



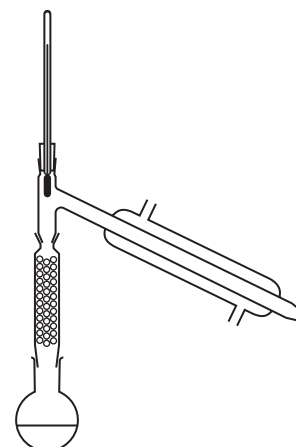
C



B



D



(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)

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.....

.....

maximum mass of ethanol = g

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

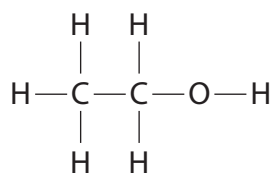
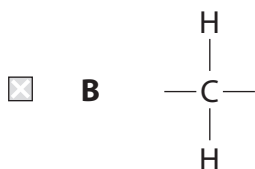
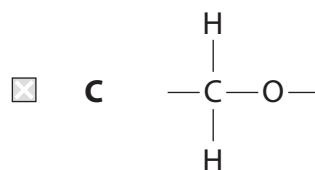
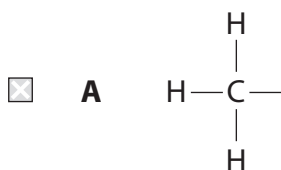


Figure 10

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)

(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)

..... →

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

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

(2)

.....
.....
.....
.....

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

Explain how sodium conducts electricity.

(2)

.....
.....
.....
.....

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

Use this information to state the formula of sodium chloride.

(1)

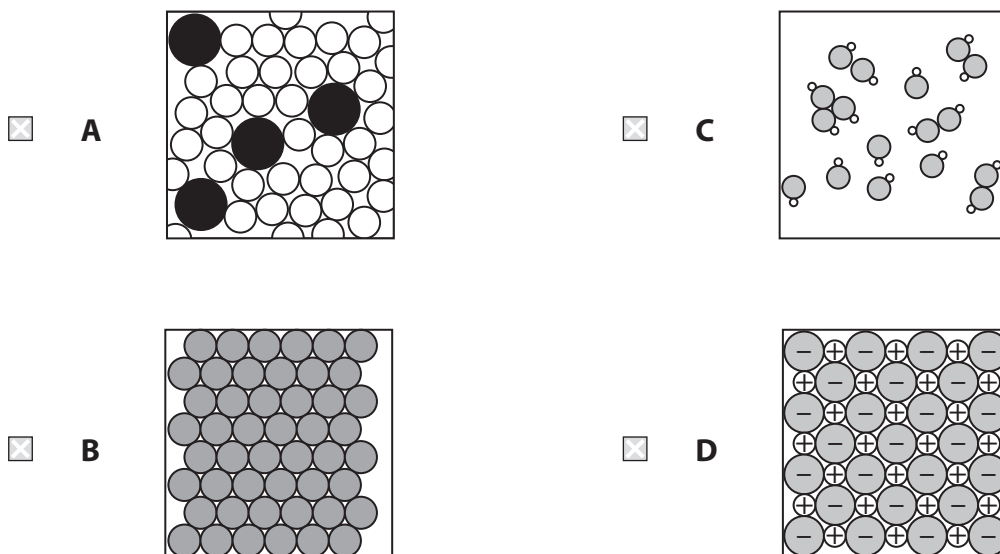
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(v) Sodium chloride is made of a giant structure of ions.

Which diagram shows the arrangement of particles in sodium chloride?

(1)



(vi) Sodium chloride solution conducts electricity.

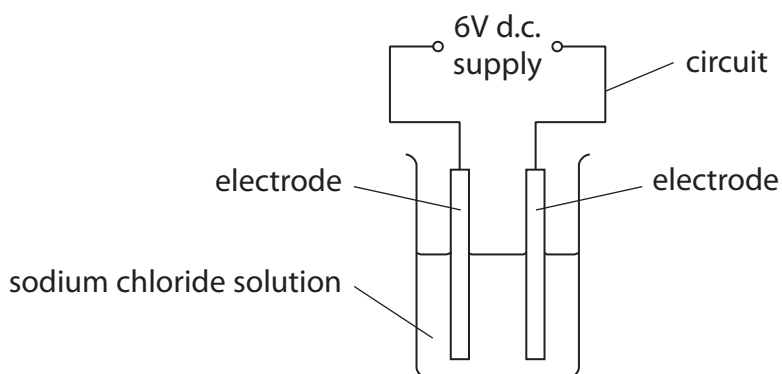


Figure 11

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

(1)

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- (1)

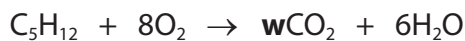


(Total for Question 6 = 12 marks)

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	
butane		<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)

.....

*(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.

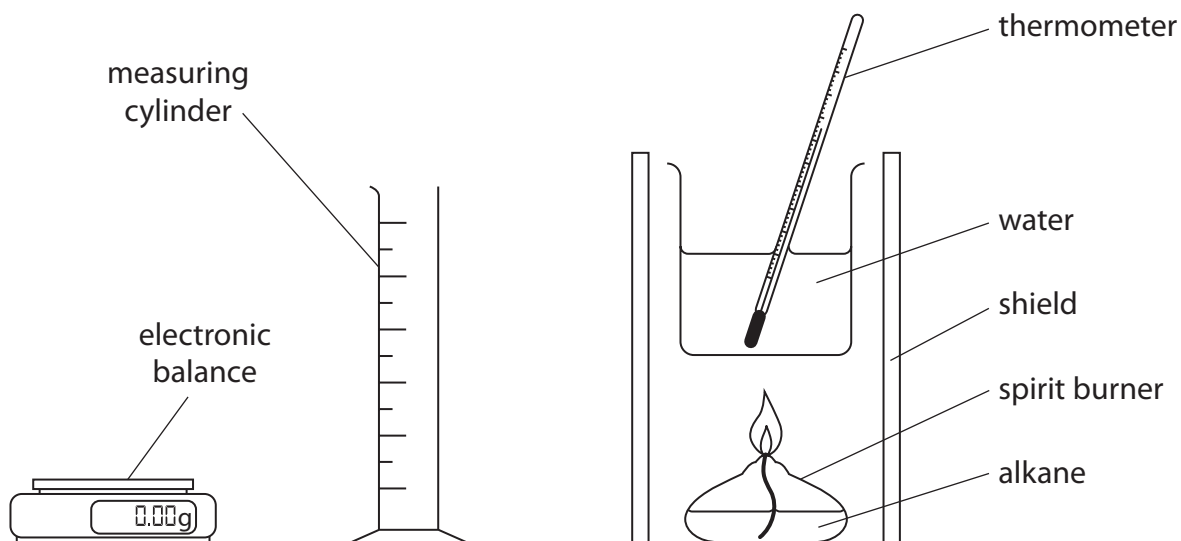


Figure 14

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)

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(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.

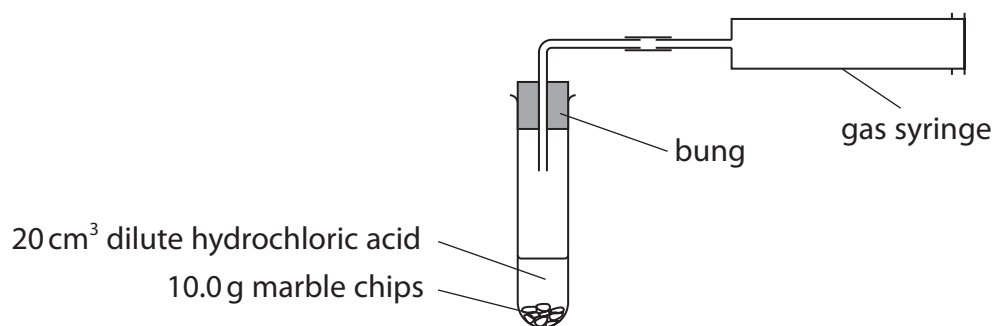


Figure 15

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

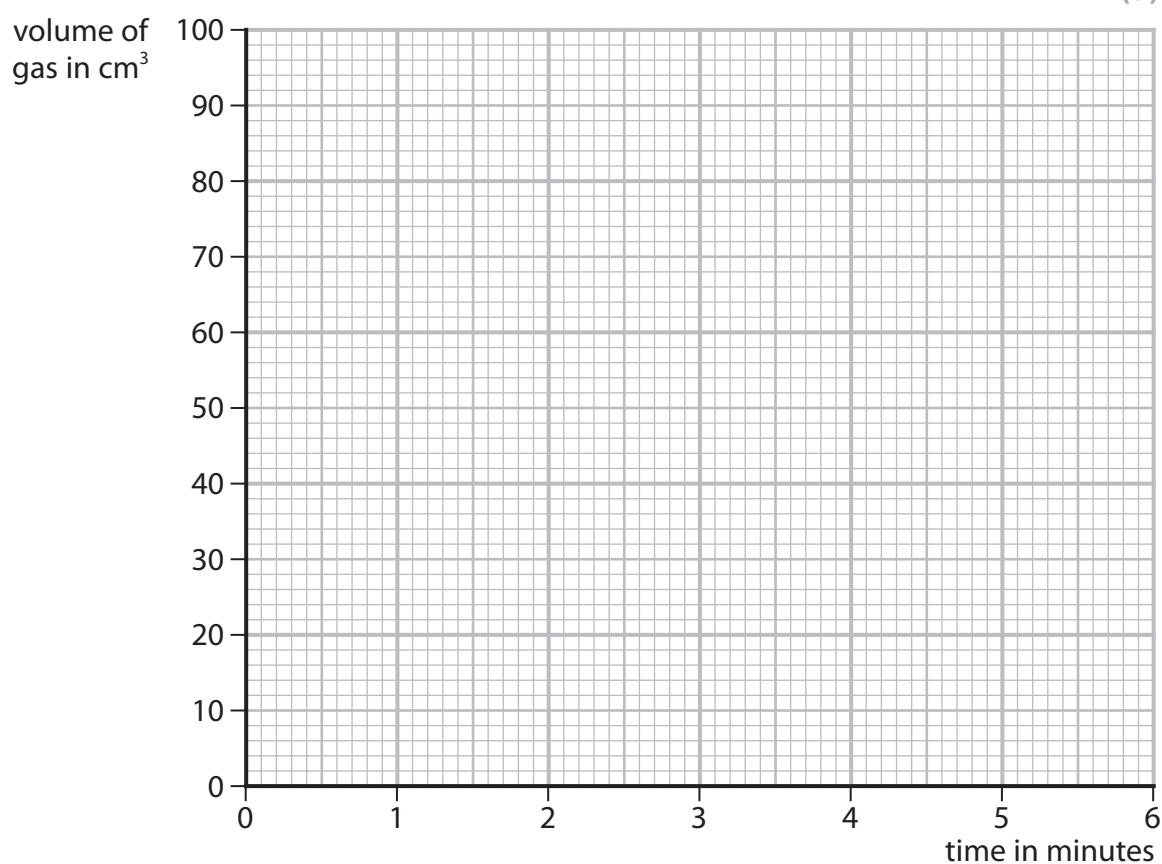
time in minutes	0	1	2	3	4	5	6
volume of gas in cm ³	0	52	78	91	97	100	100

Figure 16

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

Draw a curve of best fit.

(3)



(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 = $\text{cm}^3 \text{ min}^{-1}$

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

(3)

(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'.

(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)

(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)

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.....

.....

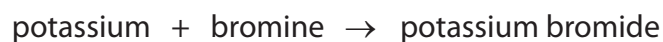
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(b) Which row shows two correct properties of group 1 metals?

(1)

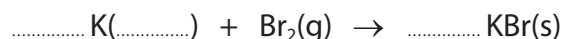
properties of group 1 metals		
☐ A	compounds are white in colour	high density
☐ B	low melting points	compounds are blue in colour
☐ C	soft enough to be cut by a knife	low melting points
☐ D	high density	conduct electricity

- (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)

.....

.....

.....

.....

- *(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.

(6)

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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

↓

largest

.....

.....

.....

.....

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

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

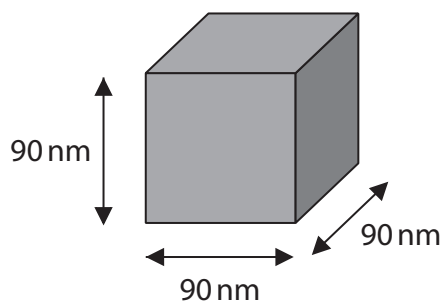


Figure 19

(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)

.....

.....

.....

.....

surface area to volume ratio = 1 :



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

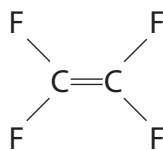


Figure 20

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

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

(2)

- (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

explanation

(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	12	14	16	19	20						
23	Na sodium 11	24	Mg magnesium 12											27	28	31	32	35.5	40						
39	K potassium 19	40	Ca calcium 20	45	48	51	52	55	56	59	59	63.5	65	70	73	75	79	80	84						
85	Rb rubidium 37	88	Sr strontium 38	89	91	93	96	[98]	101	103	106	108	112	115	119	122	128	127	131						
133	Cs caesium 55	137	Ba barium 56	139	178	181	184	186	190	192	195	197	201	204	207	209	[209]	[210]	[222]						

* 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.

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Mark Scheme (Results)

Summer 2023

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In Chemistry (1CH0)
Paper 2F

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Mark schemes have been developed so that the rubrics of each mark scheme reflects the characteristics of the skills within the AO being targeted and the requirements of the command word. So for example the command word 'Explain' requires an identification of a point and then reasoning/justification of the point.

Explain questions can be asked across all AOs. The distinction comes whether the identification is via a judgment made to reach a conclusion, or, making a point through application of knowledge to reason/justify the point made through application of understanding. It is the combination and linkage of the marking points that is needed to gain full marks.

When marking questions with a 'describe' or 'explain' command word, the detailed marking guidance below should be consulted to ensure consistency of marking.

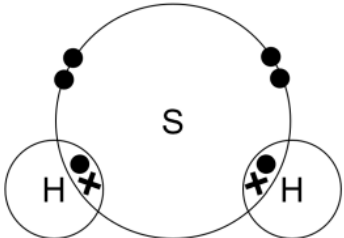
Assessment Objective		Command Word	
Strand	Element	Describe	Explain
AO1*		An answer that combines the marking points to provide a logical description	An explanation that links identification of a point with reasoning/justification(s) as required
AO2		An answer that combines the marking points to provide a logical description, showing application of knowledge and understanding	An explanation that links identification of a point (by applying knowledge) with reasoning/justification (application of understanding)
AO3	1a and 1b	An answer that combines points of interpretation/evaluation to provide a logical description	
AO3	2a and 2b		An explanation that combines identification via a judgment to reach a conclusion via justification/reasoning
AO3	3a	An answer that combines the marking points to provide a logical description of the plan/method/experiment	
AO3	3b		An explanation that combines identifying an improvement of the experimental procedure with a linked justification/reasoning

*there will be situations where an AO1 question will include elements of recall of knowledge directly from the specification (up to a maximum of 15%). These will be identified by an asterisk in the mark scheme.

Paper 2F Foundation Tier

Question number	Answer	Additional guidance	Mark
1(a)	CH ₄	allow H ₄ C / C ₁ H ₄ reject CH ₄ / H ₄ C / CH ⁴ / Ch ₄ / ch ₄	(1) AO3-1

Question number	Answer	Additional guidance	Mark
1(b)	name of compound carbon dioxide methane structure of molecule one mark for each line	do not award mark if more than one line join a left hand box with those on the right	(2) AO1-1

Question number	Answer	Additional guidance	Mark
1(c)	 shared pair (1) rest of molecule correct (1)	allow all dots or all crosses or a mixture of both allow remaining electrons not shown as pairs MP2 depends on MP1	(2) AO2-1

Question number	Answer	Additional guidance	Mark
1(d)	protons – 15 (1) neutrons – 16 (1) electrons – 15 (1)	accept ONLY whole numbers if no marks scored then maximum 1 mark for number of electrons = number of protons OR $p + n = 31$	(3) AO1-1

Total for Question 1 = 8 marks

Question number	Answer	Mark
2(a)	$24.16 - 22.52 = 1.64 \text{ (g)}$	(1) AO2-2

Question number	Answer	Additional guidance	Mark
2(b)(i)	+ (1) 8.7 (1) (°C) sign (1) value (1)	Allow answer to be shown on the table mark independently	(2) AO2-2

Question number	Answer	Additional guidance	Mark
2(b)(ii)	An explanation linking - salt with larger positive temperature rise in part (i) (1) - shows the {largest/highest} temperature rise (1)	allow ecf from Q02b(i) +8.7 °C in part(i) gives salt C in Q02b(ii) MP2 depends on MP1 allow gives out most heat / loses most energy / heats up the most / biggest temperature change ignore just quoting numbers ignore biggest exothermic change / because it's getting hotter reject B for both marking points	(2) AO2-1

Question number	Answer	Additional guidance	Mark
2(c)	An explanation linking - polystyrene is an insulator / poor conductor (of heat) (1) - reduces {heat/energy} {loss/transfer} (1)	allow RA for glass allow polystyrene has a higher specific heat capacity than glass allow (polystyrene) {keeps heat in / doesn't absorb heat} allow holds {warmth/heat} better (than glass) ignore temperature stays in the cup ignore loss of heat through the top	(2) A03-3

Total for Question 2 = 7 marks

Question number	Answer	Additional guidance	Mark
3(a)(i)	{dip/put} flame test wire into dilute hydrochloric acid, (1) then into {substance / ion} (1)	allow dip wire into water mark independently ignore metal in place of substance ignore use of spatula OR make solution of substance (1) dip {wire / splint} into solution (1)	(2) AO1-2

Question number	Answer	Additional guidance	Mark
3(a)(ii)	metal ion flame colour one mark for each line	do not award mark if more than one line join a left hand box with those on the right	(3) AO1-1

Question number	Answer	Mark
3(b)	C red-brown precipitate is the only correct answer. A, B and D are incorrect results for this test	(1) AO1-2

Question number	Answer	Additional guidance	Mark
3(c)(i)	carbon dioxide	allow CO ₂ do not accept CO ²	(1) AO1-2

Question number	Answer	Additional guidance	Mark
3(c)(ii)	{remove / loosen / slacken} {bung / stopper/lid} of right-hand test tube	allow any change that allows gas to bubble through the limewater	(1) AO3-3

Question number	Answer	Additional guidance	Mark
3(d)	ammonia	allow NH ₃ / NH ₃ reject ammonium / NH ³	(1) AO1-2

Total for Question 3 = 9 marks

Question number	Answer	Additional guidance	Mark
4(a)	bar on bar chart for carbon dioxide to 95 %	allow $\pm\frac{1}{2}$ small square ignore width of bar	(1) AO2-1

Question number	Answer	Additional guidance	Mark
4(b)(i)	over the past 3 billion years the average surface temperature of the Earth has decreased.		(1) AO2-1

Question number	Answer	Additional guidance	Mark
4(b)(ii)	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)	allow surface temperature has decreased allow lakes	(2) AO2-1

Question number	Answer	Mark
4(c)(i)	photosynthesis	(1) AO1-1

Question number	Answer	Mark
4(c)(ii)	B put a glowing splint into the gas and it relights A, C and D are incorrect tests for oxygen	(1) AO1-2

Question number	Answer	Additional guidance	Mark
4(d)(i)	(416.56 – 371.17 =) 45.39 (1) = 45 (1) (to nearest whole number)	answer of 45 alone with or without working scores (2) 1 mark for correct rounding (has to use only the numbers 416.56 and 371.17 in any calculation)	(2) AO2-1

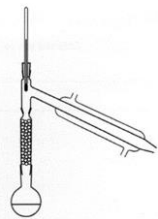
Question number	Answer	Additional guidance	Mark
4(d)(ii)	eg global warming / {ice caps/glaciers} melting / changing habitats / rising sea levels	allow { enhanced/increased } greenhouse effect / increased global temperatures / climate change / allow effects of climate change eg <u>more</u> extreme weather allow more photosynthesis ignore references to pollution / less oxygen in the air reject references to ozone layer / deforestation / acid rain	(1) AO1-1

Total for Question 4 = 9 marks

Question number	Answer	Additional guidance	Mark
5(a)(i)	(conical) flask	ignore volumetric flask	(1) AO2-2

Question number	Answer	Additional guidance	Mark
5(b)	$\frac{45}{150} = 0.3 \text{ (1)}$ $0.3 \times 1000 \text{ (1)} = 300 \text{ (g dm}^{-3}\text{)}$ OR $\frac{150}{1000} = 0.15 \text{ (dm}^3\text{)} \text{ (1)}$ $\frac{45}{0.15} = 300 \text{ (g dm}^{-3}\text{)} \text{ (1)}$	answer of 300 (g dm⁻³) alone scores (2) allow ecf from MP1 on both methods $\frac{150}{45} = 3.333 \text{ (0)}$ $3.333 \times 1000 = 3333 \text{ (1)}$	(2) AO2-1

Question number	Answer	Additional guidance	Mark
5(c)	yeast / zymase	allow enzyme / biological catalyst	(1) AO2-2

Question number	Answer	Mark
5(d)	D is the only correct answer  A is filtration B is simple distillation, C is evaporation / crystallisation	(1) AO1-1

Question number	Answer	Additional guidance	Mark
5(e)	$\frac{92}{180} = 0.5111111 \quad (1)$ $0.51111111 \times 45 = 23 \text{ (g)} \quad (1)$ OR $\frac{180}{92} = 1.956 \quad (1)$ $\frac{45}{1.956} = 23 \quad (1)$ OR $\frac{180}{45} = 4 \quad (1)$ $\frac{92}{4} = 23 \quad (1)$ OR $\frac{45}{180} = 0.25 \quad (1)$ $92 \times 0.25 = 23 \quad (1)$ OR $92 \times 45 = 4140 \quad (1)$ $\frac{4140}{180} = 23 \quad (1)$	answer of 23 (g) alone scores (2) allow any number of sig figs on step 1 except 1 for any method calculation, allow ecf from MP1 to MP2	(2) AO2-1

Question number	Answer	Mark
5(f)	D -O-H is the only correct answer A, B and C are not correct functional groups of an alcohol	(1) AO1-1

Question number	Answer	Additional guidance	Mark
5(g)	turns {orange /red / yellow}	allow combinations of red, orange & yellow ignore 'changes colour'	(1) AO2-2

Total for Question 5 = 9 marks

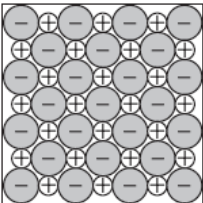
Question number	Answer	Mark
6(a)	B halogens A, C and D are names for other groups in the periodic table	(1) AO1-1

Question number	Answer	Additional guidance	Mark
6(b)(i)	Left side: sodium + chlorine (1) Right side: sodium chloride (1)	reactants in either order reject chloride on left hand side reject sodium chlorine on right hand side reject if other substances on right side use of formulae to produce a correctly balanced equation: $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$ (2)	(2) AO2-1

Question number	Answer	Additional guidance	Mark
6(b)(ii)	A description to include (two or more) atoms joined together (1) - by a {covalent bond / shared pair of electrons} (1)	allow made up of more than one atom / group of atoms ignore 'compound atoms' MP2 depends on MP1 allow {(chemically) bonded / chemically joined} together reject references to ionic bonding for MP2 if no other mark scored, allow 'particles joined by a {covalent bond / shared pair of electrons} (1)	(2) AO1-1

Question number	Answer	Additional guidance	Mark
6(b)(iii)	An explanation linking - electrons (1) (electrons) {can move / are delocalised / can pass through / can flow} (1)	reject ions MP2 depends on MP1 allow charged particles can move / are delocalised (1) ignore 'free' alone allow free-moving electrons / delocalised electrons / free flowing electrons (2)	(2) AO2-1

Question number	Answer	Additional guidance	Mark
6(b)(iv)	NaCl / Na ⁺ Cl ⁻	allow ClNa ignore upper case A, upper case L, lower case n ignore numbers in front of formula reject Na⁺ + Cl⁻ as final answer / Na⁻Cl⁺	(1) AO3-1

Question number	Answer	Mark
6(b)(v)	D  is the only correct answer A, B and C represent different structure types	(1) AO2-1

Question number	Answer	Additional guidance	Mark
6(b)(vi)	ammeter / (light) bulb / lamp	allow buzzer / multimeter allow correct symbol (on diagram) ignore voltmeter / data logger (alone) ignore 'add arrows'	(2) AO3-3

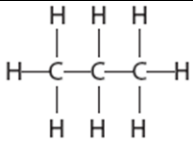
Question number	Answer	Additional guidance	Mark
6(c)(i)	$\text{H}_2 + \text{Cl}_2 \rightarrow 2 \text{HCl}$	allow multiples	(1) AO2-1

Question number	Answer	Additional guidance	Mark
6(c)(ii)	{dissolve in / add} water	allow {make aqueous / dissolve into a solution} allow bubble through water / mix with water ignore dilute / make it a liquid reject other substances	(1) AO1-1

Total for Question 6 = 12 marks

Question number	Answer	Mark
7(a)(i)	B 5 A , C and D are not correct because the equation would not balance	(1) AO2-1

Question number	Answer	Mark
7(a)(ii)	C pentane is oxidised A , B and D are not correct as these are different processes	(1) AO1-1

Question number	Answer	Additional guidance	Mark
7(b)(i)	 (1) C_4H_{10} (1)	allow lower case h allow non-linear structures allow non subscript numbers reject C^4H^{10}	(2) AO1-1

Question number	Answer	Additional guidance	Mark
7(b)(ii)	C_3H_7 (1)	allow non subscript numbers <u>but</u> reject C^3H^7 ignore 2 in front of correct empirical formula	(1) AO3-1

Question number	Indicative content	Mark
*7(b)(iii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. A02-2 (3 marks) and A03-3a (3 marks) 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	(6) A02-2 A03-3

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• The plan attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2) • Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	• The plan is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5–6	• The plan is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provide logical connections between scientific concepts throughout. A well-developed plan that synthesises relevant understanding coherently. (AO3)

Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material / discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> One relevant instruction (1) One variable to be controlled (1) Two relevant instructions (but not linked in sequence) (2) Two or more variables to be controlled (2) (just a list variables limits answer to level 1)	<u>Possible candidate response</u> (all examples, not a definitive list) • put hexane (or alkane) into burner (1) • same volume of water (being heated) (1) • measure known volume of water AND light the burner (2) • same volume of water being heated AND same temperature rise (2)
Level 2	3–4	<u>Additional Guidance</u> At least three relevant instructions (but not linked) (3) Two relevant instructions that are linked in sequence (3) At least three relevant instructions (but not linked) AND a relevant variable to be controlled (4) A part method (4)	<u>Possible candidate response</u> (all examples, not a definitive list) • measure known volume of water, find mass of burner + hexane, extinguish flame (3) • put hexane into spirit burner , find mass of burner + hexane (3) • measure known volume of water, find mass of burner + hexane, extinguish flame; use same volume of water for both alkanes (4) • measure known volume of water, put into beaker, record temperature, alkane into burner, find mass, light the burner, heat the water (4)
Level 3	5–6	<u>Additional Guidance</u> Basic method <u>that would work</u> , but lacks detail AND repeated with other alkane AND at least one variable to be controlled Method described that has details about apparatus AND repeated with other alkane AND at least one variable to be controlled	<u>Possible candidate response</u> • measure known volume of water, put into beaker, record temperature, alkane into burner, find mass, light the burner, heat the water, after temp rise find new mass of burner + alkane, repeat with other alkane. Keep same volume of water being heated (5) • measure 100 cm³ of water, put into beaker, record temperature, hexane into burner, find mass of burner + hexane, light the burner, heat the water, after temp rise of 30°C, extinguish flame, find new mass of burner + hexane, repeat with octane. Keep same volume of water being heated, same temp rise (6)

Total for Question 7 = 11 marks

Question number	Answer	Additional guidance	Mark
8(a)	6 or 7 points plotted correctly (2) or 4 or 5 points plotted correctly (1) best fit curve starting at (0,0) (1)	allow +/- half a square. for MP3, curve must be a single smooth curved line going through most or all of THEIR plotted points (ecf allowed), or if the points are not visible, through most or all of the correct values. reject curves going above or below 100cm³ by more than half a square. reject straight line / dot to dot straight lines bar charts – max 2 marks for plotting points if time value is clear	(3) AO2-1

Question number	Answer	Additional guidance	Mark
8(b)(i)	13	answer may be given in table	(1) AO2-1

Question number	Answer	Additional guidance	Mark
8(b)(ii)	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)	Note: a comparison of the rate of marble chips with that of marble powder is ignored ignore anything about rate increasing at the beginning / starts fast allow (rate of) reaction slows down ignore references to volumes of gas produced ignore reaction stops allow {concentration/amount} of acid decreases / marble chips getting smaller allow {marble chips <u>have</u> / acid <u>has</u>} reacted allow less {reactants/ marble chips/ acid} available ignore limiting factor/ reaction is ending allow fewer (successful) collisions ignore less particles have less energy	(3) AO3-2

Question number	Answer	Additional guidance	Mark
8(c)	graph to show - initial line steeper and to the left (1) - line levelling off at 100 cm³ before 5 minutes (1)	there must be a line from part (a) to award these marks. if lines are not labelled, make a reasonable assumption about which is C. mark independently. line should start from start of original line all levelling off within half a square of original line	(2) AO3-2

Question number	Answer	Mark
8(d)	C use a more concentrated acid is the only correct answer A, B and D will have no effect on the speed of reaction	(1) AO1-2

Question number	Answer	Additional guidance	Mark
8(e)	stopwatch / clock	allow timer / time app on phone	(1) AO1-2

Total for Question 8 = 11 marks

Question number	Answer	Additional guidance	Mark
9(a)	An explanation linking 1 <u>electron</u> (1) - in outer shell(s) (1)	allow 1 is the last number of the electronic configuration (1) ignore electronic configurations written out reject incorrect number of electrons MP2 depends on MP1 for outer allow {highest energy / last} for shell allow ring, energy level, orbital allow: 1 outer electron (2) 1 valence electron (2) have to lose 1 electron to get full outer shell (2) same number of electrons in outer shell (1) forms a +1 ion by losing one electron (1)	(2) AO1-1

Question number	Answer	Mark
9(b)	C soft enough to be cut by a knife / low melting point is the only correct answer A and D are incorrect because alkali metals do not have a high density B is incorrect because alkali metal compounds are not blue in colour	(1) AO1-1

Question number	Answer	Additional Guidance	Mark
9(c)	$2 \text{ K(s)} + \text{Br}_2(\text{g}) \rightarrow 2 \text{ KBr(s)}$ balancing (1) state symbol s (1)	allow multiples ignore 'two' ignore 'solid'	(2) AO2-1

Question number	Answer	Additional guidance	Mark
9(d)	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 <u>number</u> / have 20, 21, 22 neutrons (1)	reject compound / molecule / ion / elements <u>s</u> once allow same protons ignore electrons reject different protons allow different / extra / more / fewer neutrons ignore different mass / relative atomic mass reject different electrons	(2) AO1-1

Question number	Indicative content	Mark
9(e)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. • lithium, sodium, potassium float on water • metals move around on the water • bubbles form / fizz / effervescence • hydrogen / gas produced • metal hydroxide solution formed • metal + water → 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	(6) AO1-1

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question.
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question.
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question.

Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> Correctly describes the trend in reactivity of group 1 metals down the group. Gives at least 1 observation for reaction of one alkali metal and water. Identifies at least 1 product formed when alkali metals react with water. Writes at least one correct word equation	<u>Possible candidate response</u> potassium is more reactive than sodium (1) the metals get more reactive down the group (1) water with universal indicator turns purple when lithium is added (1) when potassium is added to water it moves on the surface with a lilac flame (2) when lithium is added to water, bubbles of hydrogen are formed (2) sodium makes sodium hydroxide (1) sodium + water → sodium hydroxide + hydrogen (2)
Level 2	3–4	<u>Additional Guidance</u> Compares reactions of at least 2 alkali metals including at least 1 observation. Compares at least 2 alkali metals including identifying at least 1 product of reaction with water. Gives at least 1 observation about reaction of alkali metals and makes prediction for Rb / Cs.	<u>Possible candidate response</u> lithium and sodium both float on the water (3) lithium is the least reactive because it moves less than the others, with fewer bubbles (4) lithium is less reactive than sodium because it produces fewer bubbles of hydrogen (4) sodium makes sodium hydroxide, potassium makes potassium hydroxide (3) potassium burns with a flame, caesium would explode (3) rubidium would give off more bubbles than potassium, and would move faster in the water (4)
Level 3	5–6	<u>Additional Guidance</u> Compares reactions of at least 3 alkali metals including at least 2 observations for at least one metal AND identifies at least one product of reaction with water. Compares at least 3 alkali metals, including predictions for Cs / Rb AND identifies at least one product of reaction with water.	<u>Possible candidate response</u> potassium is more reactive than sodium, which is more reactive than lithium. When added to water they move around the surface and then disappear, with lithium moving the slowest. The metals react to form metal hydroxides and hydrogen (6) sodium + water → sodium hydroxide + hydrogen potassium + water → potassium hydroxide + hydrogen rubidium + water → rubidium hydroxide + hydrogen (5)

Total for Question 9 = 13 marks

Question number	Answer	Additional guidance	Mark
10(a)	proton atom molecule nanoparticle in the correct order (2)	allow proton molecule atom nanoparticle (1)	(2) AO1-1

Question number	Answer	Mark
10(b)(i)	C 9.0×10^{-8} is the only correct answer A is incorrect as it is 90000 nanometres B is incorrect as it is 9000 nanometres D is incorrect as it is 0.09 nanometres	(1) AO2-1

Question number	Answer	Additional guidance	Mark
10(b)(ii)	surface area = $90 \times 90 \times 6$ (1) = 48 600 volume = $90 \times 90 \times 90$ (1) = 729 000 $\frac{729\,000}{48\,600} = 15$ (1) answer = 1 : 15	correct answer of 1:15 without working 3 marks allow ecf <u>surface area calculated</u> correctly evaluated (1) volume calculated ratio 1:90 scores 2 $\frac{48600}{729000} = 0.066$ (2) $\frac{729000}{8100} = 90$ (2) $\frac{8100}{729000} = 0.011$ (1)	(3) AO3-2

Question number	Answer	Additional guidance	Mark
10(c)(i)	$\begin{array}{cc} \text{F} & \text{F} \\ & \\ -\text{C} & -\text{C}- \\ & \\ \text{F} & \text{F} \end{array}$ (2) OR repeat unit including: - no double bond (1) - rest of repeat unit with linking bonds (1)	allow lowercase f allow diagram to show 1, 2, 4 or 6 carbon atoms eg $\begin{array}{c} \text{F} \\ \\ -\text{C}- \\ \\ \text{F} \end{array}$ 2 marks ignore brackets around repeat unit and n	(2) AO2-1

Question number	Answer	Additional guidance	Mark
10(c)(ii)	Use (1) Property (1) Reason (1) (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) OR • clothing /carpets (1) • because it is non-stick (1) • easy to clean / will not stain (1) OR • bottom of skis (1) • because it is slippery (1) • less friction on snow (1)	USES allow: pans / frying pans / saucepans / tennis rackets / named kitchen equipment / piping / skis ignore: sports equipment (in general) / 'kitchenware' / windows / window ledge / toothpaste PROPERTIES allow: slippery / smooth / non-stick / unreactive / does not conduct electricity / non-toxic / high melting point ignore: strong / lightweight / high boiling point Other reasonable uses include: lubricants - reduces friction graft material in surgery – inert/non-reactive prevent insects from climbing surfaces - slippery insulation of wiring & electrical circuits – does not conduct electricity/high melting point plumbers' tape – flexible/waterproof bottles – inert/non-reactive raincoat / rainjacket – waterproof Goretex clothing - waterproof Umbrella – water repellant flame retardant material (2) – high melting point hair straighteners – non-stick/no hair damage Allow any reasonable use	(3) AO1-1

Total for Question 10 = 11 marks