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EDEXCEL GCSE CHEMISTRY: QUESTIONS BY TOPIC

Rates of Reaction and Energy Changes (7)

GCSE Chemistry (Higher) Topic 7

14 questions · 135 marks · Mark schemes included

Pearson Edexcel GCSE (9-1) Chemistry 1CH0, Higher Tier, June 2018 - June 2025

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HOW TO USE THIS BOOKLET

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any row below to jump straight to that question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

14 questions · 135 marks · lowest tariff first



6-MARK QUESTIONS

1 question in this booklet



1 Butanol is a liquid fuel.

A student investigated the mass of butanol needed to increase the temperature of 100 cm^3 of water by 1°C .

The student used the following method.

step 1 add 100 cm^3 of water to a beaker

step 2 measure the mass of a spirit burner containing butanol

step 3 measure the initial temperature of the water in the beaker

step 4 place the spirit burner containing butanol under the beaker of water

step 5 light the wick of the burner and start to stir the water with the thermometer

step 6 stop heating the water when the temperature of the water has increased by 30°C

step 7 remeasure the mass of the spirit burner containing butanol.

Figure 1 shows the apparatus used.

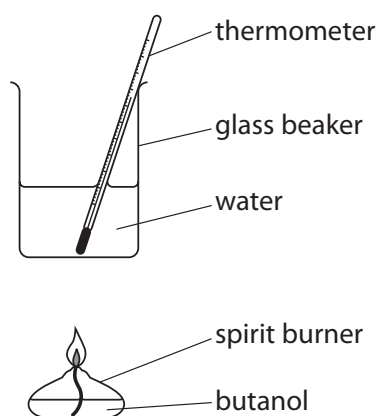


Figure 1

(a) Figure 2 shows the student's results.

mass of spirit burner at start in g	mass of spirit burner at end in g
134.67	133.59

Figure 2

In the student's investigation, the temperature of the 100 cm^3 water increased by 30°C .

Calculate the mass of butanol needed to increase the temperature of the 100 cm^3 water by 1°C .

(2)

mass of butanol = ... g

- (b) The student investigated the effect of changing the fuel on the mass of fuel needed to heat the water.

The student used an identical spirit burner filled with pentanol, another liquid fuel.

Give **two** variables that the student should keep the same in this investigation.

(2)

variable 1

variable 2

- (c) Suggest **two** improvements that the student could make to their apparatus so that more of the heat energy is transferred to the water.

(2)

improvement 1

improvement 2

(Total for Question 1 = 6 marks)



7-MARK QUESTIONS

1 question in this booklet



3 Calcium carbonate reacts with dilute hydrochloric acid to produce carbon dioxide gas.

The rate of reaction between calcium carbonate and dilute hydrochloric acid at room temperature was investigated.

(a) The investigation was carried out with different sized calcium carbonate pieces.

The mass of calcium carbonate and all other conditions were kept the same.

The results are shown in Figure 1.

size of calcium carbonate pieces used	volume of carbon dioxide gas produced in five minutes in cm^3
large	16
small	48
powder	90

Figure 1

State, using the information in Figure 1, the effect of the surface area of the calcium carbonate on the rate of this reaction.

(1)

.....

.....

.....

(b) The calcium carbonate powder produced 90 cm^3 of carbon dioxide in five minutes.

Calculate the average rate of reaction in $\text{cm}^3\text{ s}^{-1}$.

(3)

.....

.....

.....

.....

average rate of reaction = ... $\text{cm}^3\text{ s}^{-1}$



- (c) The experiments were repeated at a higher temperature.
The rate of reaction for each experiment increased.

Explain, in terms of particles, why the rate of reaction increased when the temperature was increased.

(3)

(Total for Question 3 = 7 marks)



9-MARK QUESTIONS

5 questions in this booklet



- 6 (a) Sodium thiosulfate solution, $\text{Na}_2\text{S}_2\text{O}_3$, reacts with dilute hydrochloric acid.



- (i) When dilute hydrochloric acid is mixed with sodium thiosulfate solution, the mixture turns cloudy.

Explain why the mixture turns cloudy.

(2)

.....

.....

.....

.....

- (ii) In an investigation, different concentrations of hydrochloric acid are reacted with sodium thiosulfate solution.
The mixture goes cloudy at different rates.

Describe how the rate at which the mixture goes cloudy can be measured.

(3)

.....

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.....

.....

- (iii) You are provided with some dilute hydrochloric acid which has a concentration of 50 g dm^{-3} .

For this experiment, dilute hydrochloric acid with a concentration of 20 g dm^{-3} is required.

How much water must be added to 100 cm^3 of 50 g dm^{-3} hydrochloric acid to make dilute hydrochloric acid with a concentration of 20 g dm^{-3} ?

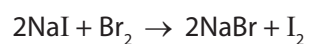
(1)

- ☐ A 200 cm^3
- ☐ B 150 cm^3
- ☐ C 100 cm^3
- ☐ D 50 cm^3



(b) Sodium iodide solution is colourless.

When a solution of bromine is added to sodium iodide solution, a reaction occurs.



(i) The mixture turns brown.

Give the name of the substance causing the brown colour.

(1)

(ii) Explain which substance has been reduced in this reaction.

(2)

(Total for Question 6 = 9 marks)



- 2 A student used the apparatus in Figure 3 to investigate the rate of the reaction between a metal and dilute hydrochloric acid.

Pieces of the metal were placed in dilute hydrochloric acid in the flask, and the total volume of gas produced was measured every minute.

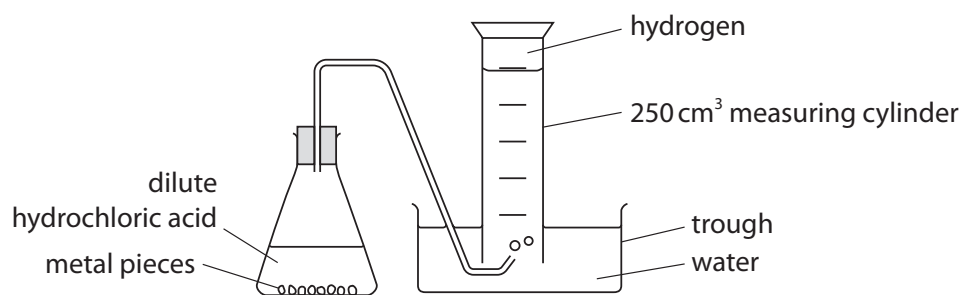


Figure 3

- (a) Figure 4 shows a graph of the student's results.

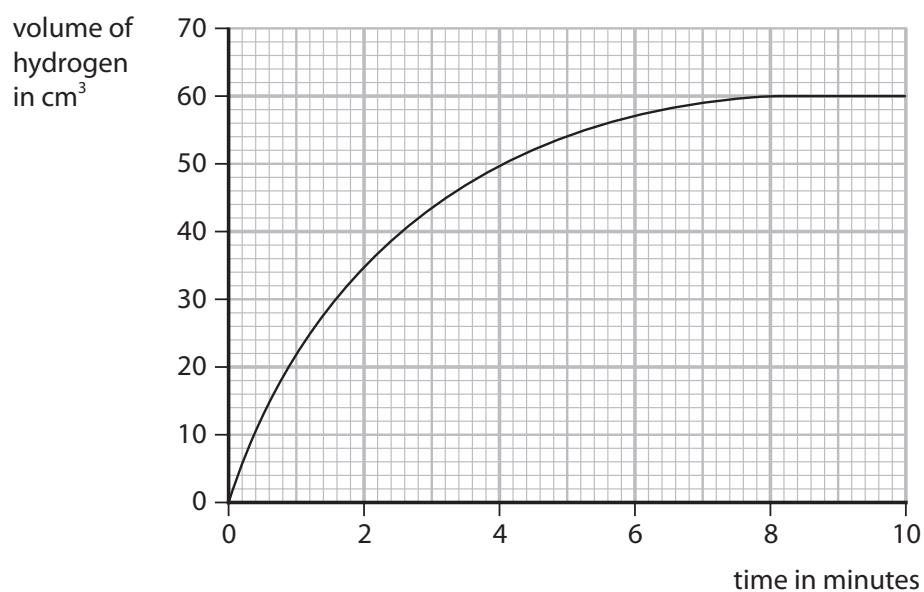


Figure 4

- (i) Name a piece of apparatus that would be better to measure the volume of gas produced, instead of the 250 cm³ measuring cylinder.

Give a reason for your answer.

(2)

name of apparatus

reason

- (ii) Calculate the mean rate of production of hydrogen over the first 90 seconds, in cm³ per second.

(3)

rate = ... cm³ per second

- (iii) The student measured the volume of gas for 10 minutes.

State why the measurements could have been stopped at 9 minutes.

(1)

- (b) The experiment was repeated, but with acid of a higher concentration.

The rate of reaction was faster.

- (i) Explain why the rate of reaction increases when the concentration of acid is increased.

(2)



(ii) Another student suggests four other ways of increasing the rate of this reaction.

Which one is correct?

(1)

- ☐ **A** use the same acid but at a lower temperature
- ☐ **B** use a larger trough
- ☐ **C** use a smaller flask
- ☐ **D** use the same metal but in a powdered form

(Total for Question 2 = 9 marks)



- 2 A student used the apparatus shown in Figure 3 to investigate the reaction between marble chips and dilute hydrochloric acid.

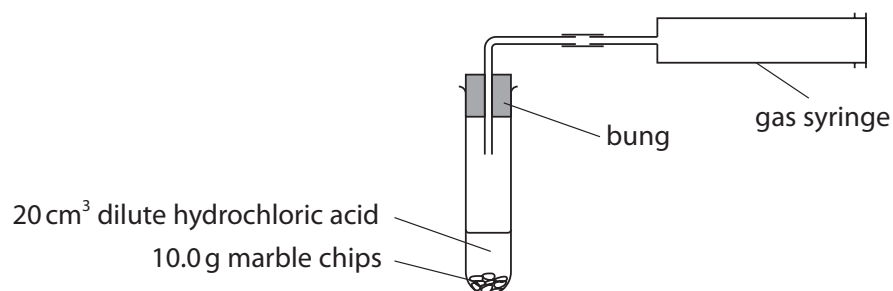


Figure 3

The student recorded the volume of gas every minute as shown in Figure 4.

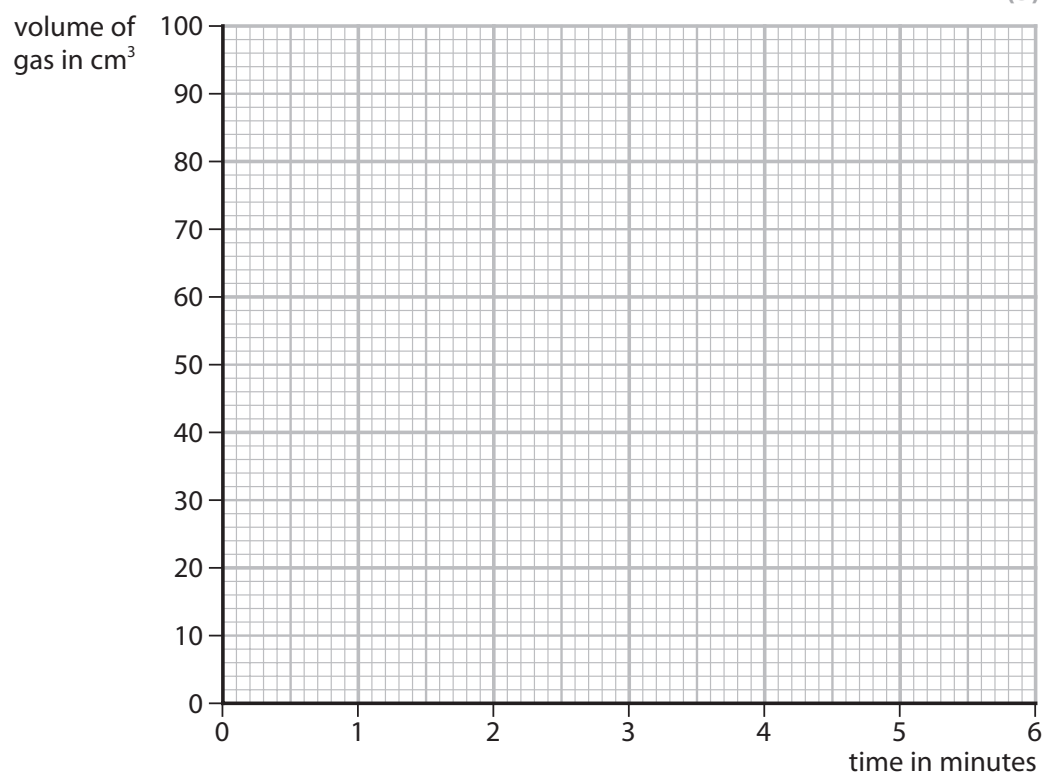
time in minutes	0	1	2	3	4	5	6
volume of gas in cm ³	0	52	78	91	97	100	100

Figure 4

- (a) On the grid, plot the results shown in Figure 4.

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 5 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 5

(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)

(Total for Question 2 = 9 marks)



- 2 A student investigates the reaction between marble chips and dilute hydrochloric acid.

The student measures the total volume of carbon dioxide gas produced each minute, for 10 minutes.

- (a) Figure 3 shows part of the apparatus used in the experiment.

Complete Figure 3 by drawing and labelling apparatus that could be used to collect and measure the volume of the carbon dioxide gas.

(2)

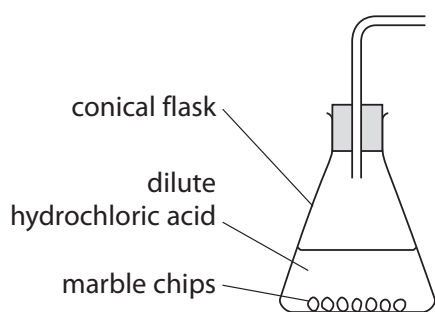


Figure 3

(b) Figure 4 shows a graph of the results of the experiment.

A tangent has been drawn on the curve at a time of 3.5 minutes.

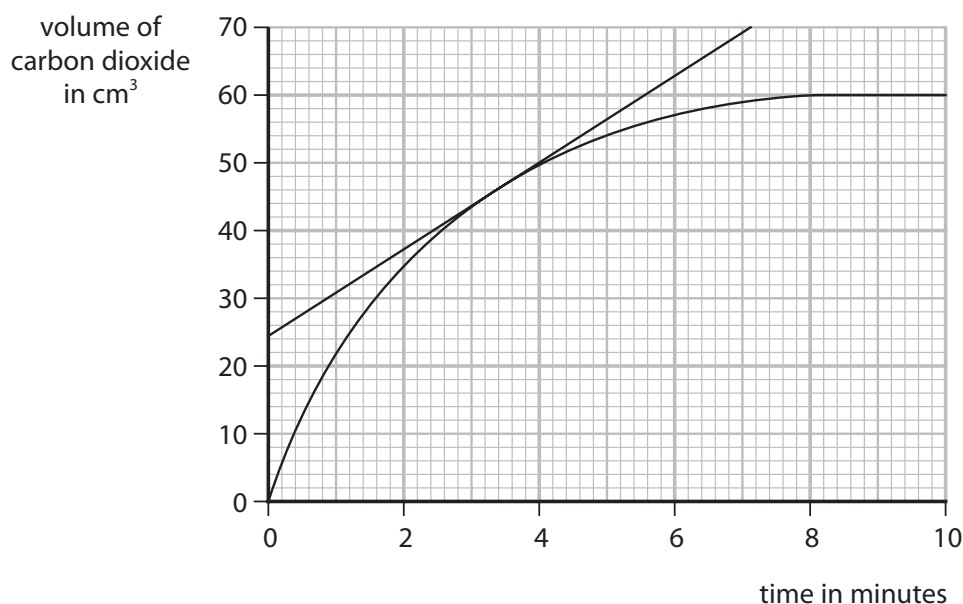


Figure 4

(i) State the total volume of carbon dioxide produced in the first 3.5 minutes.

(1)

volume = ... cm³

(ii) Using the tangent, calculate the rate of reaction at 3.5 minutes in cm³ per minute.

$$\text{rate of reaction} = \frac{\text{change in gas volume}}{\text{change in time}}$$

(3)

.....

.....

.....

.....

rate = ... cm³ per minute



(c) The student repeats the experiment using the same mass of smaller marble chips.

All other conditions remain the same.

Explain the effect on the rate of reaction of using smaller marble chips.

(2)

(d) Which change would make the rate of reaction slower?

(1)

- ☐ A using the same acid at a higher temperature
- ☐ B using acid of a lower concentration
- ☐ C using a larger flask
- ☐ D adding a catalyst

(Total for Question 2 = 9 marks)



- 2 When solutions **P** and **Q** are mixed together, a purple mixture forms. This mixture slowly becomes colourless.

(a) A student pours 25 cm^3 of solution **P** into a conical flask and then adds 25 cm^3 of solution **Q**.

The student uses a beaker to measure out these volumes.

Name a piece of apparatus that could be used to measure these volumes more accurately.

(1)

- (b) The student investigates this reaction using the apparatus shown in Figure 3. The student measures the time taken for the cross to become visible. The experiment is repeated at different temperatures.

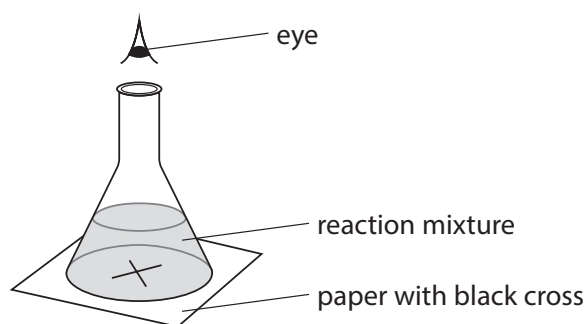


Figure 3

Figure 4 shows the results.

temperature in $^{\circ}\text{C}$	time in s
20	45
40	19
60	10

Figure 4

- (i) The concentrations of the solutions are kept constant in each experiment.

State **one** other variable that should be kept constant.

(1)

- (ii) State, and explain in terms of particles, how the time taken for the cross to become visible would change if a temperature of 80°C was used.

(3)

- (c) The concentration of solution **Q** is 26.8 g dm⁻³.

Calculate the mass of solid **Q** present in 25 cm³ of solution **Q**.

$$\text{concentration (g dm}^{-3}\text{)} = \frac{\text{mass of solid (g)}}{\text{volume of solution (dm}^3\text{)}}$$

(2)

mass of solid **Q** = ... g



(d) The student repeats the experiment at 20 °C, with the addition of a catalyst.

Explain how the addition of a catalyst will affect the rate of reaction.

(2)

(Total for Question 2 = 9 marks)

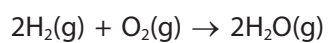


10-MARK QUESTIONS

2 questions in this booklet



10 (a) Hydrogen reacts with oxygen to form steam.



Bond energies are shown in Figure 14.

bond	bond energy in kJ mol^{-1}
H—H	435
O=O	500
O—H	460

Figure 14

Calculate the energy change for the reaction of 2 mol of hydrogen gas, H_2 , with 1 mol of oxygen gas, O_2 , to give 2 mol of steam, H_2O .

(4)

.....

.....

.....

.....

.....

.....

.....

energy change = ... kJ mol^{-1}



*(b) A student is provided with unlabelled samples of three liquids.

The three liquids are known to be

hexane, C_6H_{14} , a liquid alkane

hexene, C_6H_{12} , a liquid alkene

butanoic acid, $C_4H_8O_2$, a carboxylic acid, in aqueous solution

Aqueous solutions of carboxylic acids contain hydrogen ions and undergo reactions typical of acids with indicators and carbonates.

Describe, in detail, using the information given and your knowledge of the reactions of these liquids, tests the student should carry out to identify each of the three liquids.

You should include balanced equations for any chemical reactions described.

(6)



(Total for Question 10 = 10 marks)



- 6 This question is about the rate of reaction between calcium carbonate and dilute hydrochloric acid.

The word equation for this reaction is

calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

- (a) Which of the following is the formula for calcium carbonate?

(1)

- ☒ A CaCO_2
- ☒ B CaCO_3
- ☒ C $\text{Ca}(\text{CO})_3$
- ☒ D $\text{Ca}(\text{CO}_3)_2$

- (b) Some pieces of calcium carbonate were added to dilute hydrochloric acid in a conical flask and the volume of carbon dioxide produced was measured.

Complete the diagram in Figure 7 to show the apparatus to collect the gas produced and measure its volume.

(2)

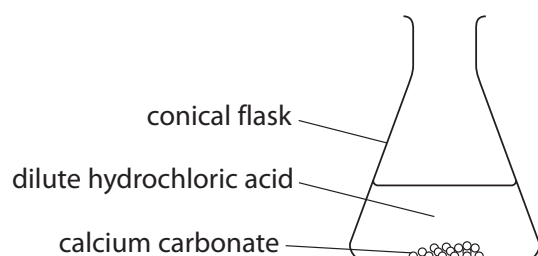


Figure 7

- (c) The reaction between calcium carbonate and dilute hydrochloric acid was investigated at different temperatures.

- (i) State what could be used to keep the temperature of the conical flask and its contents at a temperature of 45 °C throughout the reaction.

(1)

.....

.....

(ii) Figure 8 shows a graph of volume of gas collected in this investigation.

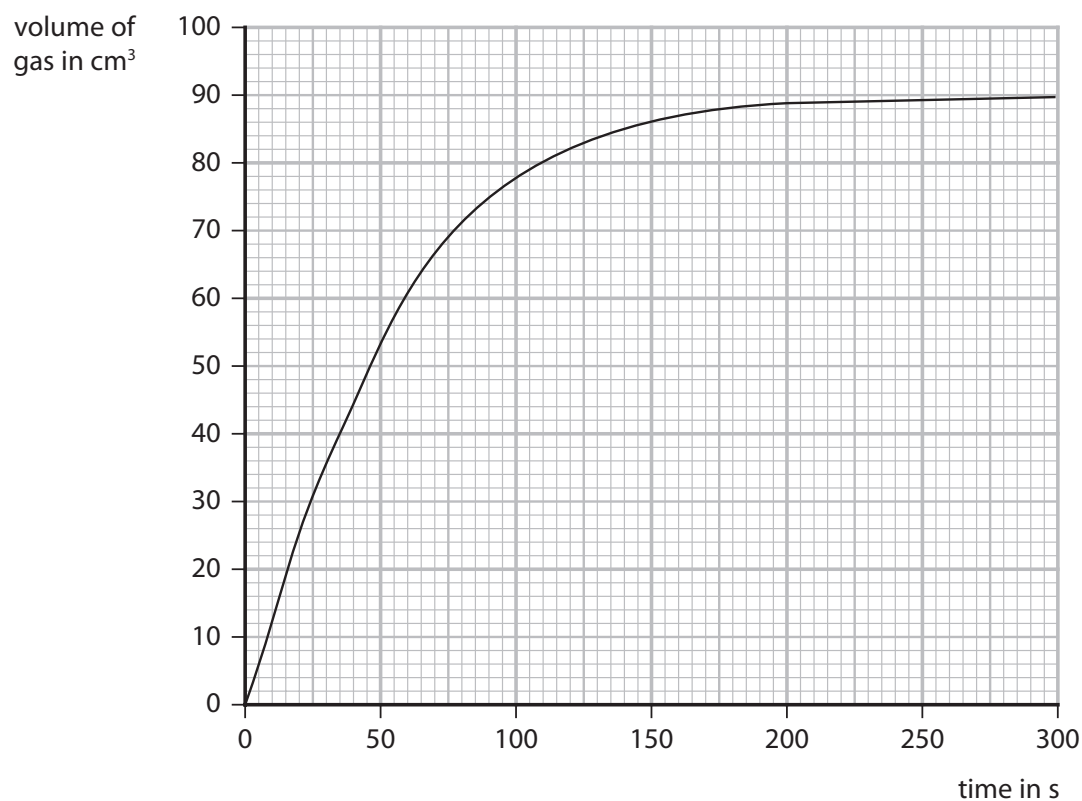


Figure 8

Draw a tangent at 100 seconds on Figure 8.
Use this tangent to calculate the rate of reaction at this time.

(2)

.....
.....

rate of reaction = ... $\text{cm}^3 \text{s}^{-1}$

(iii) The temperature of the acid was kept at 45 °C.

State **one** other variable that needs to be controlled during this investigation.

(1)

(iv) Explain, in terms of particles, how decreasing the temperature affects the rate of this reaction.

(3)

(Total for Question 6 = 10 marks)



11-MARK QUESTIONS

3 questions in this booklet



4 Ethanol can be used as a liquid fuel.

A student investigates how much heat energy is released when a known mass of ethanol is burned.

The apparatus is set up as shown in Figure 3.

A known volume of water is placed in a metal can.

The temperature of the water is measured.

The ethanol is ignited and placed under the beaker so that the flame is touching the beaker.

The water is heated by the flame.

The flame is extinguished.

The final temperature of the water is measured.

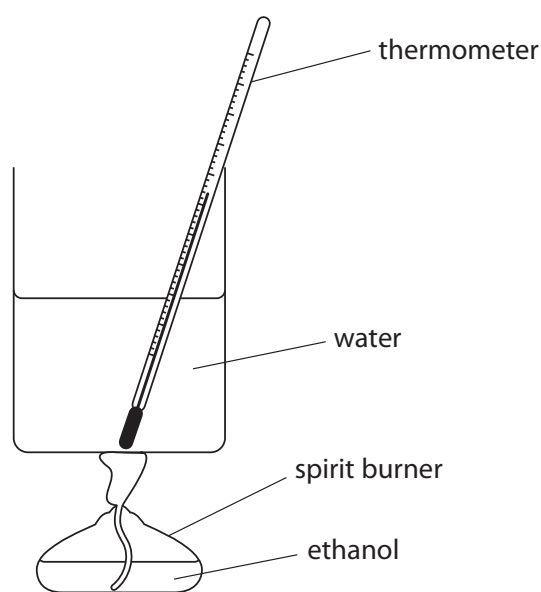


Figure 3

- (a) The theoretical temperature rise for burning a given mass of ethanol is 82.4°C .

In the experiment the actual temperature rise for burning this mass of ethanol was only 34.8°C .

One reason why the temperature rise is less than expected is that the ethanol does not burn completely.

- (i) Give a reason why, even if the ethanol burns completely, the actual temperature rise is much less than the theoretical value.

(1)

- (ii) Explain how the method described above could be improved to give a temperature rise closer to the theoretical value.

(2)

- (iii) The amount of heat energy used to raise the temperature of the water by 34.8 °C can be calculated using

$$\text{heat energy} = 210 \times \text{temperature rise}$$

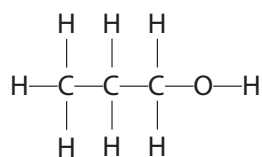
Calculate the amount of heat energy used.

(2)

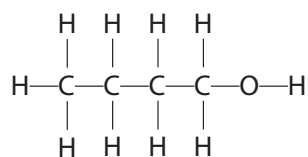
heat energy = ... (energy units)



(b) Propanol and butanol are both members of the same homologous series as ethanol.



propanol



butanol

Propanol and butanol can also be burned in the apparatus shown in Figure 3.

Give **three** reasons why ethanol, propanol and butanol are members of the same homologous series.

(3)

reason 1

reason 2

reason 3

(c) Ethanol can oxidise when exposed to air to produce ethanoic acid and water.
Propanol can also oxidise in a similar reaction when it is exposed to air.

(i) Write the word equation for the reaction when **propanol** oxidises when it is exposed to air.

(2)

(ii) What is the formula of the functional group in carboxylic acids?

(1)

- ☐ A -OH
- ☐ B -CH₃
- ☐ C -COOH
- ☐ D -CO₂

(Total for Question 4 = 11 marks)

- 9 (a) In some chemical reactions, bonds are broken in the reactant molecules and new bonds are formed to make the product molecules.

(i) Which row is correct about the energy changes for these processes?

(1)

energy change		
	breaking a bond	making a bond
☐ A	energy is released	energy is released
☐ B	energy is released	energy is absorbed
☐ C	energy is absorbed	energy is released
☐ D	energy is absorbed	energy is absorbed

(ii) Hydrogen reacts with fluorine.

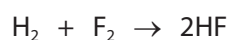


Figure 12 shows the bond energies for the bonds in the three molecules in the equation.

bond	bond energy in kJ mol^{-1}
H—H	436
F—F	158
H—F	562

Figure 12



Calculate the energy change for this reaction.

(4)

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.....

energy change = ... kJ mol^{-1}



(Total for Question 9 = 11 marks)

8 Ammonia can be produced from the reaction of hydrogen with nitrogen.

(a) What is the percentage by mass of nitrogen in ammonia, NH_3 ?

(relative atomic masses: $\text{H} = 1.0$, $\text{N} = 14$)

(1)

- ☐ A 18%
- ☐ B 42%
- ☐ C 51%
- ☐ D 82%

(b) The reaction between hydrogen and nitrogen is exothermic.

Figure 13 shows the reaction profile of this exothermic reaction.

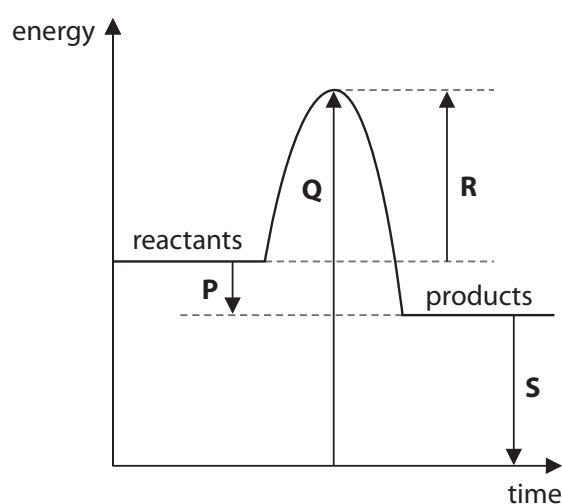


Figure 13

(i) Which arrow represents the activation energy for the reaction?

(1)

- ☐ A arrow P
- ☐ B arrow Q
- ☐ C arrow R
- ☐ D arrow S

- (ii) Describe what the reaction profile shows about the energy involved in bond breaking and bond making in this reaction.

(2)

.....

.....

.....

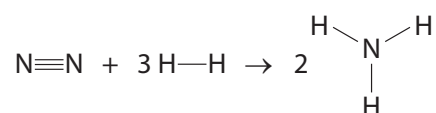
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- (iii) Figure 14 shows the energies of some bonds.

bond	bond energy in kJ mol^{-1}
$\text{N}\equiv\text{N}$	944
$\text{H}-\text{H}$	436
$\text{H}-\text{N}$	388

Figure 14

The equation for the reaction between nitrogen and hydrogen to form ammonia is



Calculate the energy change, in kJ mol^{-1} , for this reaction.

(4)

.....

.....

.....

.....

.....

.....

.....

energy change = ... kJ mol^{-1}



- (c) Ammonia, NH_3 , and silicon dioxide, SiO_2 , are both compounds that are made of two non-metallic elements.

Ammonia has a boiling point of -33°C .

Silicon dioxide has a boiling point of 2230°C .

Explain why the boiling points of ammonia and silicon dioxide are so different.

(3)

.....

.....

.....

.....

.....

.....

(Total for Question 8 = 11 marks)



12-MARK QUESTIONS

2 questions in this booklet



- 9 (a) The rate of reaction between magnesium ribbon and dilute hydrochloric acid at room temperature is investigated.

The apparatus used is shown in Figure 11.

The volume of hydrogen gas given off was measured at regular intervals during the reaction.

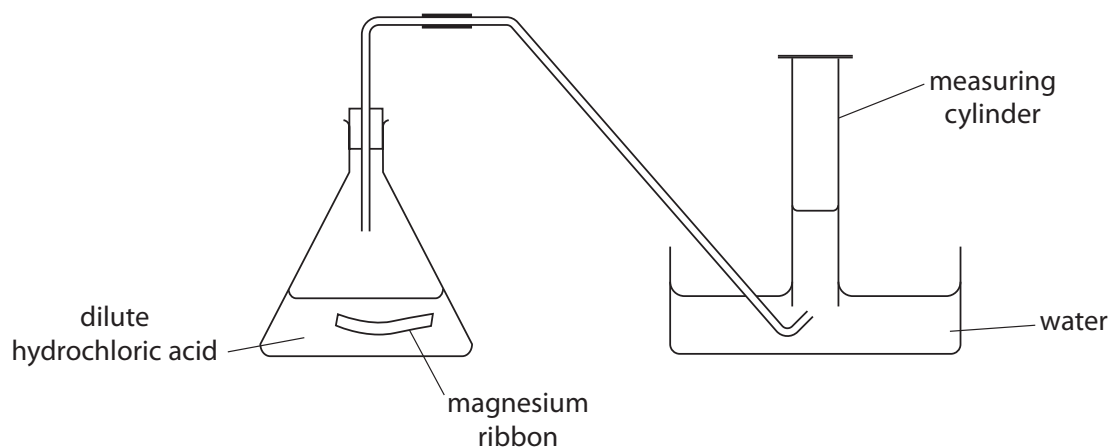


Figure 11

The graph in Figure 12 shows the results of this experiment.

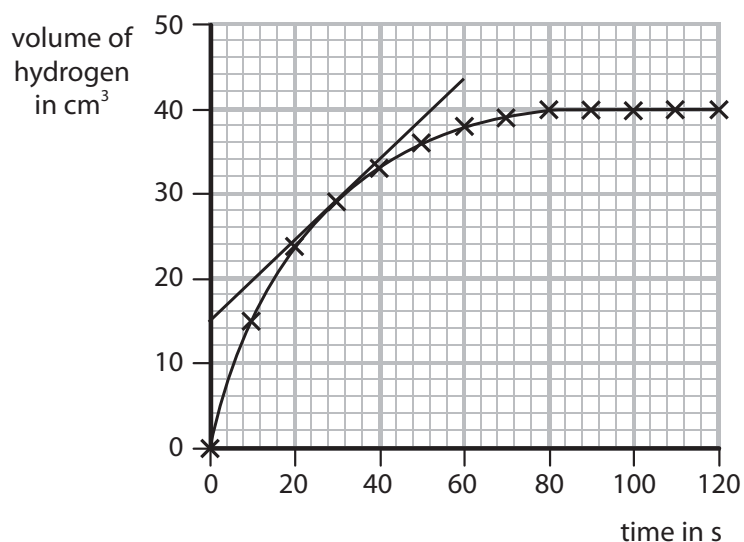


Figure 12

- (i) State a change that can be made to the apparatus in Figure 11 to measure the volumes of gas more accurately.

(1)

- (ii) A tangent has been drawn to the line on the graph in Figure 12.

Calculate the rate of reaction at this point.

(2)

.....

.....

.....

.....

rate of reaction = ... $\text{cm}^3 \text{s}^{-1}$

- (iii) On the graph in Figure 12, draw the line you would expect to obtain if the magnesium ribbon in this experiment was replaced with an equal mass of powdered magnesium. All other conditions are kept the same.

(1)

- (b) The balanced equation for this reaction is



- (i) In another experiment, 0.1 moles of hydrochloric acid, HCl , were reacted with 0.1 g of magnesium ribbon.

Calculate the number of moles of magnesium, Mg , in the 0.1 g sample of magnesium ribbon.

(relative atomic mass: $\text{Mg} = 24$)

(1)

.....

.....

.....

number of moles = ...

- (ii) In a further experiment, 0.5 mol of hydrochloric acid, HCl , were mixed with 0.5 mol of magnesium, Mg .

Use the equation to show that, in this experiment, the magnesium is in excess.

(1)

.....

.....

(Total for Question 9 = 12 marks)



10 (a) Figure 13 shows the apparatus used to burn different alcohols.

The mass of each alcohol required to raise the temperature of the water by 40°C is found.

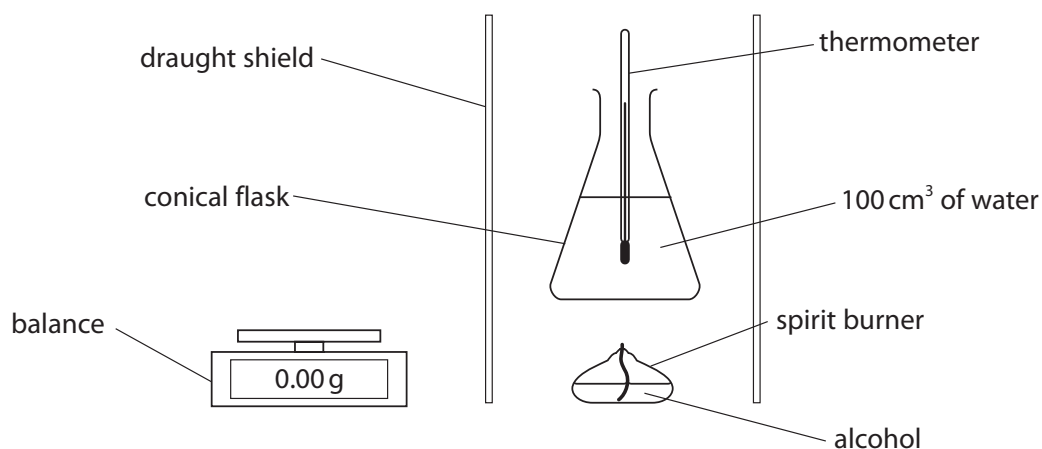


Figure 13

- (i) State **one** variable, apart from the volume of water, that should be kept the same when each alcohol is burned.

(1)

- (ii) It is found that 1.6 g of ethanol is used to raise the temperature of water by 40°C .

Calculate the number of moles of ethanol used.
Give your answer to two significant figures.
(relative formula mass: ethanol = 46)

(2)

number of moles = ...

- (iii) The mass of ethanol used to raise the temperature of the water by 40 °C is higher than the theoretical value.

The experiment is repeated and the same result obtained.

Give a reason why the mass of ethanol used is higher than expected.

(1)

- (b) Poly(phenylethene) is an addition polymer.

Figure 14 shows part of the poly(phenylethene) molecule formed in the addition reaction between three phenylethene monomer molecules.

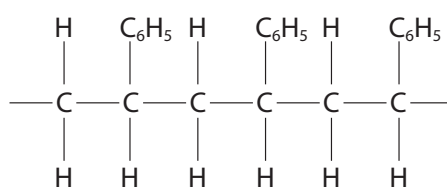


Figure 14

- (i) Draw the structure of **one** phenylethene monomer molecule.

(2)

- (ii) Explain what is **seen** when a few drops of bromine water are shaken with phenylethene.

(3)

(c) Poly(phenylethene) is an addition polymer.

Polyesters are condensation polymers.

Describe the differences between the type of monomer molecules used to form addition polymers and the type of monomer molecules used to form condensation polymers.

(3)

(Total for Question 10 = 12 marks)



MARK SCHEMES

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Question number	Answer	Additional guidance	Mark
1(a)	an answer of 0.036 / 0.04 with or without working scores 2 marks $134.67 - 133.59 = 1.08$ (1) $\frac{(1.08)}{30} = 0.036$ (1)	1.08 with no working scores 1 mark allow ECF for MP2 if all 3 pieces of data have been used in MP1	(2) AO2-1

Question number	Answer		Mark
1(b)	any two from : - distance from beaker to {flame/wick/burner} (1) - size of wick (1) - volume of water (1) - temperature increase of water (1) {size/shape/type} of beaker (1)	allow type of wick allow amount or mass for volume allow initial temperature of water ignore time ignore same person ignore volume/mass of fuel	(2) AO1-2

Question number	Answer		Mark
1(c)	any two from : • move beaker closer to spirit burner (1) • use a metal {calorimeter/beaker} instead of glass (1) • use (draft) shields (1) • place a lid on the beaker (1) • insulate the (sides of the) beaker (1)	reject use a polystyrene beaker	(2) AO3-3



Question number	Answer	Additional guidance	Mark
3(a)	larger surface area {higher / faster} rate / ORA	answer must be comparative	(1)

Question number	Answer	Additional guidance	Mark
3(b)	final answer of 0.3 with or without working scores 3 MP1 : conversion of time from minutes into seconds $5 \times 60 = 300$ (seconds) (1) MP2 : rate = volume / time rate = $\frac{90}{300}$ (1) MP3 : evaluation of the <u>fraction</u> $= 0.3 \text{ (cm}^3 \text{ s}^{-1}\text{)}$ (1)	allow $90/5$ (1) $90/5 = 18$ (2) $300/90 = 3.33$ (2) $5/90 = 0.0556$ (1)	(3)

Question number	Answer	Additional guidance	Mark
3(c)	An explanation linking three of the following - particles have more energy (1) - so (particles) move <u>faster</u> (1) (so) there are more frequent collisions between particles (1) - higher proportion of collisions have at least the activation energy to react when particles collide (1)	Allow more kinetic energy for MP1 and MP2 needs to be comparative allow greater chance of collision allow higher {proportion / chance} of collisions are successful / productive allow more particles have activation energy	(3)



Question number	Answer	Additional Guidance	Mark
6(a)(i)	An explanation to include - a solid/ precipitate (1) - of sulfur (1)		(2)

Question number	Answer	Additional Guidance	Mark
6(a)(ii)	A description to include - flask placed {over/in front of} cross (1) - measure time (1) - when cross is obscured (1)	<u>MP2 dependent on MP1</u> allow measure how long reaction takes for MP2	(3)

Question number	Answer	Mark
6(a)(iii)	B 150 cm ³ is the only correct answer. A is incorrect because this makes 16.7 g dm ⁻³ HCl C is incorrect because this makes 25.0 g dm ⁻³ HCl D is incorrect because this makes 33.3 g dm ⁻³ HCl	(1)

Question number	Answer	Additional guidance	Mark
6(b)(i)	iodine	reject iodide; ignore formulae	(1)

Question number	Answer	Additional guidance	Mark
6(b)(ii)	An explanation to include: - bromine (1) - because electrons are gained (1)	Mark independently allow any number of electrons	(2)



Question number	Answer	Additional Guidance	Mark
2(a)(i)	• 100 cm³ measuring cylinder/ (gas) syringe (1) • which has smaller gradations / higher resolution (1)	allow 'smaller measuring cylinder' ignore gas measurer reject (upturned) burette for MP1 MP2 is dependent on MP1 allow (more) precise / (more) accurate allow smaller measurements/ increments ignore easier to use / no gas will escape	(2) AO3 3b

Question number	Answer	Additional guidance	Mark
2(a)(ii)	• volume read at 90s = 29 cm³ (1) • rate = $\frac{\text{volume}}{90}$ (1) • = 0.3222.... (cm³ per second) (1)	0.31, 0.32, 0.33 with or without working scores 3 0.3 alone scores 0 all other answers require working to have marks awarded allow any value 28-30 ECF for incorrect volume ECF if fraction inverted ECF if 1.5 used instead of 90 eg $\frac{28/29/30}{1.5} = 18.66.../ 19.33.../ 20$ scores 2 MP3 must be decimal value correctly rounded – ignore fractions	(3) AO3 2

Question number	Answer	Additional guidance	Mark
2(a)(iii)	volumes were {constant / stopped rising} OR graph was {flat/plateaued/ levelled off}	allow reactant(s) used up / limiting factor allow no more hydrogen evolved allow EVIDENCE that reaction stopped: measurements stayed the same/ no more bubbles allow graph has reached zero gradient ignore graph is a straight line ignore it has reached the highest {point / volume} ignore reaction has stopped / is complete reject reaction is becoming slower	(1) AO3 2

Question number	Answer	Additional guidance	Mark
2(b)(i)	An explanation linking - more particles present (in same volume) (1) - so more frequent collisions/ more chance of collision (1)	allow atoms/ molecules/ ions for particles ignore more acid present allow more collisions per {sec/min/unit time} ignore more collisions/ more successful collisions ignore references to energy / moving faster mark independently	(2) AO1 1

Question number	Answer	Mark
2(b)(ii)	D use the same metal but in a powdered form is the only correct answer B and C are incorrect because the reactants are not changed A is incorrect because the reaction will be slower	(1) AO2 1

(Total for question 2 = 9 marks)



Question number	Answer	Additional guidance	Mark
2(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
2(b)(i)	13	answer may be given in table	(1) AO2-1



Question number	Answer	Additional guidance	Mark
2(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
2(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	Additional Guidance	Mark
2(a)	a diagram that includes - apparatus <u>that would collect and measure gas</u> using a gas syringe, measuring cylinder or burette (1) - label stating {gas syringe / measuring cylinder/ burette} (1)	mark independently ignore seals/ blockages MP2 for label, independent of drawing ignore any other labels	(2) AO1 2

Question number	Answer	Additional guidance	Mark
2(b)(i)	47	allow any value from 46-48	(1) AO3 2

Question number	Answer	Additional guidance	Mark
2(b)(ii)	answer in range 6.197 – 6.5 with or without working scores 3 Δy (gas volume) = 70 – (any no. in range 24-26) = 44-46 (1) Δx (time) = 7.1 – 0 = 7.1 (1) $\frac{\Delta y}{\Delta x}$ = 6.197 – 6.479 (1)	allow 7-7.2 with or without working allow in these ranges: 6.197-6.5 scores 3 6.10-6.196 or 6.51-6.60 scores 2 6.0-6.099 or 6.61-6.70 scores 1	(3) AO3 2



Question number	Answer	Additional guidance	Mark
2(c)	an explanation linking - rate is increased (1) - because higher surface area/ higher frequency of collisions/ more collisions <u>per second</u> (1)	if rate decreased scores 0 for whole answer allow (rate/ reaction) faster , quicker , speed of reaction increases allow reaction takes less time/ dissolves faster reject particles have more energy for MP2 allow more area (of marble) for reactions to occur/ more contact (between particles) allow more chance of collisions/ collisions happen more often ignore more (successful) collisions alone	(2) AO1 1

Question number	Answer	Mark
2(d)	B using acid of a lower concentration is the only correct answer C is incorrect because the reactants are not changed A and D are incorrect because the reaction will be faster	(1) AO1 2

Total for question 2 = 9 marks



Question number	Answer	Additional Guidance	Mark
2(a)	measuring cylinder	allow (graduated) pipette/ burette reject dropping pipette	(1) A03-3 Cler

Question number	Answer	Additional Guidance	Mark
2(b)(i)	Any one from (same) volume (same) (conical) flask (same) cross	allow amount of solution allow same surface area of liquid allow same person observing / distance of observer ignore amount of {stirring / mixing} ignore room temperature / same conditions ignore beakers ignore same solutions reject same time	(1) A03-3

Question number	Answer	Additional guidance	Mark
2(b)(ii)	an explanation linking any three from - time taken decreases (1) (because) particles have more energy (1) - more <u>frequent</u> collisions (1) - more particles have the activation energy / more successful collisions (1)	allow idea of time less than 10 s allow cross appears quicker allow rate increases / it would be faster allow particles move more/faster	(3) A02-1



Question number	Answer	Additional guidance	Mark
2(c)	0.67(g) with or without working scores 2 $25 \text{ cm}^3 = \frac{25}{1000} = 0.025 \text{ dm}^3$ (1) $0.025 \times 26.8 = 0.67(\text{g})$ (1) or $26.8 \times 25 = 670$ (1) $\frac{670}{1000} = 0.67 (\text{g})$ (1) or $1000/25 = 40$ (1) $26.8 / 40 = 0.67$ (1)	0.67 to any other power of 10 scores 1 e.g. 6.7 allow with working $(26.8 / 0.025 =) 1072$ (1) $(0.025/26.8 =) 0.0009328...$ correctly rounded (1)	(2) A02-1

Question number	Answer	Additional guidance	Mark
2(d)	an explanation linking - increases (rate) (1) (because) lowers activation energy (1)	allow speeds up (rate) / faster reaction / takes less time (1) allow alternative {pathway / route} (1) allow more {frequent/successful} collisions (1) ignore catalyst doesn't get used up reject particles speed up / have more energy	(2) A01-1

Total for Question 2 = 9 marks



Question Number	Answer	Additional guidance	Mark
10(a)	award full marks for correct numerical answer without working energy needed to break bonds $= (2 \times 435) + (1 \times 500)$ $= 1370 \text{ (kJ mol}^{-1}\text{)} (1)$ energy released when bonds are formed $= 4 \times 460$ $= 1840 (1)$ energy change $= 1370 - 1840$ $= (-) 470 \text{ (kJ mol}^{-1}\text{)} (1)$ negative sign or 'energy released' (1)	allow $1840 - 1370 = 470 (1)$ ignore sign allow exothermic (reaction) final answer 450 award 2 marks -450 award 2 marks final answer +450 award 3 marks	(4) AO 2 1



Question Number	Indicative content	Mark
*10(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • (add) sodium carbonate (or any suitable carbonate) / test with blue litmus • carboxylic acid sample effervesces / blue litmus turns red • alkane and alkene sample give no effervescence / does not affect litmus • therefore liquid is butanoic acid • butanoic acid + sodium carbonate → sodium butanoate + carbon dioxide + water • (balanced equation) $2 \text{C}_3\text{H}_7\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2 \text{C}_3\text{H}_7\text{COONa} + \text{CO}_2 + \text{H}_2\text{O}$ • (add) bromine water (to separate samples of each liquid) • (bromine water) orange colour • shake • alkene sample changes from orange to colourless • alkane (and carboxylic acid) stay orange • therefore liquid changing is hexene • hexene + bromine → 1,2-dibromohexane (allow any suitable isomer product / ignore numbers) • structural formula of product, e.g. • (balanced equation / addition reaction) $\text{C}_6\text{H}_{12} + \text{Br}_2 \rightarrow \text{C}_6\text{H}_{12}\text{Br}_2$ credit any appropriate test for an acid, e.g. specific indicator with correct colour change(s) • liquid giving negative results with both the test for acids and the bromine water is the alkane/hexane credit any appropriate test which would distinguish between the substances	(6) AO 1 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. (AO1) • Presents an explanation with some structure and coherence. (AO1)
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. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

(Total for Question 10 = 10 marks)



Question number	Answer	Mark
6(a)	B CaCO_3 is the only correct answer A, C and D are incorrect formulae	(1) AO1

Question number	Answer	Mark
6(b)	diagram of • delivery tube with bung in flask connected to (1) • gas syringe / gas syringe labelled (1) or • delivery tube with bung in flask leading into water trough (below upturned measuring cylinder) (1) • upturned measuring cylinder containing water / measuring cylinder labelled (1) allow • connected delivery tube from flask to upturned test tube in water trough (1)	(2) AO1

Question number	Answer	Additional guidance	Mark
6(c)(i)	conical flask in water bath [could be shown on diagram]	Reject heat with a Bunsen burner warm water alone is not enough.	(1) AO3



Question number	Answer	Mark
6(c)(ii)	Using tangent drawn on graph eg $\frac{\text{vertical difference}}{\text{horizontal difference}} = \frac{(100 - 52)}{180} = 0.267$ (1) calculation will depend on final graph 2 marks for rate being within a range eg 0.250 – 0.290 1 mark for rate being in range 0.230 – 0.249 or 0.291 – 0.310	(2) AO3

Question number	Answer	Additional guidance	Mark
6(c)(iii)	particle size / concentration of acid / volume of acid / mass of calcium carbonate	allow marble chips for calcium carbonate allow amount of calcium carbonate ignore size of container	(1) AO1

Question number	Answer	Mark
6(c)(iv)	An explanation linking - fewer successful collisions (between acid and calcium carbonate particles) / fewer collisions with activation energy (1) and any two from (because) decreasing temperature (of the acid) particles have lower energy (1) (because) the particles move slower (1) (so) rate of reaction decreases (1)	(3) AO1

Total for Question 6 = 10 marks



Question Number	Answer	Additional guidance	Mark
4(a)(i)	{heat/energy} is lost/escapes	allow anywhere heat is transferred e.g. can absorb heat, heat lost to air <i>etc</i>	(1) AO 3 2b

Question Number	Answer	Additional guidance	Mark
4(a)(ii)	An explanation including: - add a lid / use of draught shield (1) - so more {heat/energy} goes to water/ less {heat/energy} escapes (1) MP2 dependent on MP1	ignore altering distance between flame and can allow any <u>suitable</u> insulating material ignore burning more fuel/ less water	(2) AO 3 3b

Question Number	Answer	Additional guidance	Mark
4(a)(iii)	final answer of 7308 with or without working scores 2 210×34.8 (1) = 7308 (1)	allow 1 for $210 \times$ (any temp change) correctly evaluated with working e.g. $210 \times 82.4 = 17304$ (1) allow 7300, 7310 do not allow 7000 ignore any units	(2) AO 2 1



Question Number	Answer	Additional guidance	Mark
4(b)	Any three of the following - all have –OH group/ hydroxyl group / same functional group (1) - same general formula/ $C_nH_{2n+1}OH$ (1) - formulae differ by CH_2 units (1) - react similarly with oxygen/all burn to form carbon dioxide and water (1) - trend in physical properties	ignore 'all alcohols' do not allow 'hydroxide' allow similar chemical reactions / a specified reaction allow any sensible physical property e.g. increase in boiling point ignore reference to containing C,H,O or single bonds or no double bonds	(3) AO 2 1

Question Number	Answer	Additional guidance	Mark
4(c)(i)	propanol + oxygen → propanoic acid + water (2) allow $CH_3CH_2CH_2OH + O_2 \rightarrow CH_3CH_2COOH + H_2O$ (2)	allow 1 mark for any three correctly named substances air is not acceptable for oxygen if a mixture of words and symbols, ignore all of the symbols if 5 substances in equation remove 1 mark if 6 or more substances in equation, score 0	(2) AO 2 1



Question Number	Answer	Mark
4(c)(ii)	C -COOH The only correct answer is C <i>A is not correct because this is the functional group of alcohols</i> <i>B is not correct because this is a methyl group</i> <i>D is not correct because this is not a functional group</i>	(1) AO 1 1

(Total for Question 4 = 11 marks)



Question number	Answer	Mark
9(a)(i)	C energy is absorbed energy is released is the only correct answer. B, C and D are incorrect because at least one energy change is reversed.	(1) AO1 1

Question number	Answer	Additional guidance	Mark
9(a)(ii)	- energy change in reactants = $436 + 158 (= 594)$ (1) - energy change in products = $2 \times 562 (= 1124)$ (1) - overall energy change = $594 - 1124$ (1) $= -530$ (1) (kJ mol^{-1})	allow ECF throughout ignore sign/unit in MP1 ignore sign/unit in MP2 MP3 for the difference between MP1 and MP2 ignore sign / unit in MP3 MP4 for correct sign or stating exothermic / endothermic based on MP3 (+)530 scores 3 marks (loses MP4) (+)64 scores 3 marks (MP1 doubled) -64 scores 2 marks (MP1 doubled and loses MP4) (+)32 scores 3 marks (MP2 not doubled) -32 scores 2 marks (MP2 not doubled and loses MP4)	(4) AO2 1



Question number	Indicative content	Mark
*9(b)	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. AO1 DESCRIPTION • increases the rate of reaction • does not alter products of reaction • is chemically unchanged by reaction • does not get used up • so catalyst mass does not change FUNCTION • particles must have minimum energy for reactions to occur • this is called activation energy • reaction proceeds by an alternative route • which reduces activation energy • so a greater proportion of collisions are successful DIAGRAM • reaction profile with catalyst has start and end energies the same • because reactants and products the same (label or in text) • new profile has lower peak • this represents lower activation energy (label or in text) EXAMPLES • Haber process to make ammonia uses iron catalyst • cracking to make smaller alkanes uses catalyst • (fermentation) to make alcoholic drinks uses (yeast which contains) an enzyme • hydrogen peroxide decomposition uses catalysts • used in catalytic converters • use of enzymes as biological catalysts	(6) AO1



Level	Mark	Additional Guidance	General additional guidance – the decision between levels
	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> identifies a catalysed reaction describes simply the role of a catalyst or labelling activation energy on the diagram	<u>Possible Candidate Responses</u> - Haber process to make ammonia (uses iron catalyst) - enzymes are catalysts - a catalyst speeds up a reaction but does not get used up
Level 2	3-4	<u>Additional Guidance</u> Two from identifies at least one catalysed reaction gives a good description of the role of catalyst describes the function of a catalyst OR draws a labelled reaction profile (or amends that on question)	<u>Possible Candidate Responses</u> Two from: - Haber process to make ammonia (uses iron catalyst) and cracking to make smaller alkanes - a catalyst increases the rate of a reaction without affecting the products; the catalyst is chemically unchanged and its mass remains the same - a catalyst provides an alternative route for a reaction in which the activation energy is lowered so a greater proportion of collisions lead to products OR provides a labelled reaction profile (or amended the one in the question)
Level 3	5-6	<u>Additional Guidance</u> Identifies at least one catalysed reactions AND Gives a good description of the role of catalyst AND describes the function of a catalyst OR draws a labelled reaction profile (or amends that on question)	<u>Possible Candidate Responses</u> Haber process to make ammonia uses iron catalyst / cracking to make smaller alkanes a catalyst increases the rate of a reaction without affecting the products; the catalyst is chemically unchanged and its mass remains the same a catalyst provides an alternative route for a reaction in which the activation energy is lowered so a greater proportion of collisions lead to products OR provides a labelled reaction profile (or amended the one in the question)



Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	- Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) - Deconstructs scientific information but understanding and connections are flawed. An unbalanced or incomplete argument that provides limited synthesis of understanding. (AO3)
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. (AO1) - Deconstructs scientific information and provides some logical connections between scientific concepts. An imbalanced argument that synthesises mostly relevant understanding, but not entirely coherently (AO3)
Level 3	5-6	- Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) - Deconstructs scientific information and provide logical connections between scientific concepts throughout. A balanced, well-developed argument that synthesises relevant understanding coherently. (AO3)

(Total for question 9 = 11 marks)



Question number	Answer	Mark
8 (a)	D 82% is the only correct answer A is not correct as this is percentage of hydrogen in ammonia B is not correct as this is the mass of hydrogen multiplied by the mass of nitrogen C is not correct as this is the mass of hydrogen multiplied by the mass of ammonia	(1) AO2-1

Question number	Answer	Mark
8 (b)(i)	C arrow R is the only correct answer A, B and D are incorrect because they do not show the activation energy	(1) AO2-1



Question number	Answer	Additional guidance	Mark
8 (b)(ii)	A description to include: any two for 1 mark all three for 2 marks - energy is taken in breaking bonds (in the reactants) - energy is given out making bonds (in the products) - more energy is given out than taken in	allow breaking bonds is endothermic allow forming bonds is exothermic allow less energy taken in than given out ignore products have less energy than reactants ignore reaction is exothermic / gives out energy alone for energy taken in allow : absorbed / needed / used / required for energy given out allow: released	(2) AO1-1

Question number	Answer	Additional guidance	Mark
8 (b)(iii)	-76 with or without working scores 4 BROKEN $944 + (3 \times 436) = 2252$ (1) MADE $2 \times (3 \times 388) = 2328$ (1) DIFFERENCE (broken) 2252 – (made) 2328 (1) ANSWER = - 76 (1)	allow ecf ignore sign ignore sign MP3 for difference between their 2 values MP4 for correct evaluation, including correct sign, of <u>bonds broken – bonds made</u> using their values (+)76 scores 3 (+)1088 scores 3 (+)604 scores 3 (+)1476 scores 3 -1088 scores 2 -604 scores 2	(4) A02-1



Question number	Answer	Additional guidance	Mark
8 (c)	an explanation linking AMMONIA ammonia {is simple molecular / has weak intermolecular forces} SILICON DIOXIDE silicon dioxide is {giant covalent / has strong covalent bonds} (1) DIFFERENCE more {heat / energy} to break bonds in silicon dioxide than intermolecular forces in ammonia	Mark independently allow weak {forces / bonds} <u>between molecules</u> allow <u>intermolecular</u> bonds reject anything ionic for MP1 allow macromolecular reject anything ionic / simple molecular for MP2 in MP3 mark is for saying more energy/ heat needed to break the 'attractions' <u>in silicon dioxide</u> than in ammonia. The 'attractions' do not have to be correct. allow the energy required to break the attractions in ammonia is small and the energy required to break the attractions in silicon dioxide is large	(3) AO1-1



Question Number	Answer	Additional guidance	Mark
9(a)(i)	(gas) syringe / graduated tube / burette (instead of measuring cylinder)		(1) AO 3 3b

Question Number	Answer	Additional guidance	Mark
9(a)(ii)	final answer in range 0.44 – 0.52 inclusive with or without working (2) If answer not in range: $\frac{\text{difference in volume}}{\text{difference in time}} = \frac{(43 - 15)}{(60 - 0)} \quad (1)$ $= 0.47 \quad / \quad 0.467 \quad (1)$	allow ecf throughout where values are less than 1 (1 max) use of inverted gradient expression giving 2.27 – 1.92 scores 1 mark (evidence of working required)	(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
9(a)(iii)	steeper curve to the left of printed curve and same final volume	line must not go above 40 cm ³ and curve back down	(1) AO 2 2



Question Number	Answer	Additional guidance	Mark
9(b)(i)	number of moles = $0.1 / 24 = 0.0042$ or 4.2×10^{-3} (1)	ignore answer left as fraction 1/240 rounding must be correct: reject 0.00416 (no dot) allow 0.00416̇ (with dot above the 6) allow 0.004	(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
9(b)(ii)	the equation shows two HCl reacting with one Mg	allow ratio is 2:1 allow 1 mol HCl reacts with 0.5 mol of Mg allow 0.5 mol HCl reacts with 0.25 mol Mg	(1) AO 2 1



Question Number	Indicative content		Mark
*9(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • reactions occur when particle collisions have sufficient energy (activation energy) • reaction rates are increased when the energy collisions is increased • and / or the frequency of collisions is increased • two factors in the reaction have been changed (temperature and concentration of one of the reactants) • experiment 2 was carried out at a higher temperature than experiment 1 • concentrations of reactant are the same in experiment 1 and 2 • particles have more (kinetic energy), so move faster • so there are more frequent collisions between particles in solution A solution and solution B • collisions will also occur with greater energy • so more collisions will have the minimum activation energy to react when they collide • so greater frequency of successful collisions (so decreased reaction time/increased rate in experiment 2 compared to experiment 1) • experiment 3 was carried out at a higher concentration than experiment 2/ a fourfold increase • temperatures of the reactants are the same in experiment 2 and 3 • there are more reacting particles in the same volume of reaction mixture • so there are more frequent collisions between particles in solution A and solution B • so greater frequency of successful collisions (so decreased reaction time/increased rate in experiment 3 compared to experiment 2) • reaction rate in experiment 3 is greatest due to combined effects of increased temperature and increased concentration		(6) AO 2 2 AO 3 2a
Level	Mark	Descriptor	
	0	No rewardable material.	
Level 1	1-2	• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3)	



		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. (AO2)
Level 2	3-4	- Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) - 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. (AO2)
Level 3	5-6	- Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) - 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. (AO2)

Total for Question 9 = 12 marks)

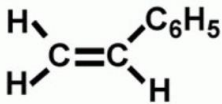
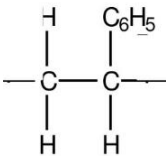


Question number	Answer	Mark
10(a)(i)	distance between {burner/ flame} and flask / height of flask / {length/ size} of wick	(1) AO1 2

Question number	Answer	Additional guidance	Mark
10(a)(ii)	0.035 with or without working scores 2 $\frac{1.6}{46}$ (1) = 0.035 (1)	29 scores 1 MP1 for showing the fraction (whatever number shown) or if no fraction shown 0.03478260869565 CORRECTLY ROUNDED to any no. of sig figs NO ECF for MP2 except allow 1 mark for 29	(2) AO2 1

Question number	Answer	Additional guidance	Mark
10(a)(iii)	{heat/ energy} lost / incomplete combustion / ethanol evaporates	ignore generic statements such as side reactions or incomplete reactions or not a closed system	(1) AO1 2



Question number	Answer	Additional guidance	Mark
10(b)(i)	 one C=C only in any molecule with <u>8 carbons</u> (1) monomer fully correct (2)	For MP1 all that is required is one, and only one, C=C bond and any other 6 C atoms in any structure [but ignore any C=C in attempted structure of the phenyl group], even if molecule does not exist. no continuation bonds allowed in fully correct molecule allow 1 mark for correct repeating unit (with or without brackets or continuation bonds but reject if includes n) 	(2) AO3 1
Question number	Answer	Additional guidance	Mark
10(b)(ii)	an explanation to include: (bromine water is) {orange/ yellow} (1) - turns colourless/ decolourises (1)	mark independently reject red or brown ignore clear	(3) AO2 1

