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EDEXCEL GCSE CHEMISTRY: QUESTIONS BY TOPIC

Rates of Reaction and Energy Changes (7)

GCSE Chemistry (Foundation) Topic 7

16 questions · 161 marks · Mark schemes included

Pearson Edexcel GCSE (9-1) Chemistry 1CH0, Foundation 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.

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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.

QUESTION	SOURCE	MARKS	PAGE
1. Q1	Paper 2 June 2018	7	4
2. Q2	Paper 2 November 2021	7	7
3. Q2	Paper 2 June 2023	7	9
4. Q3	Paper 2 June 2025	8	12
5. Q3	Paper 2 June 2018	9	15
6. Q4	Paper 2 June 2022	9	18
7. Q4	Paper 2 June 2024	9	20
8. Q10	Paper 2 June 2018	11	23
9. Q8	Paper 2 June 2022	11	26
10. Q8	Paper 2 June 2023	11	29
11. Q8	Paper 2 June 2024	11	32
12. Q6	Paper 2 November 2021	12	36
13. Q7 <i>also Topic 9</i>	Paper 2 November 2021	12	39
14. Q7	Paper 2 June 2025	12	43
15. Q8	Paper 2 June 2025	12	47
16. Q9	Paper 2 November 2020	13	51



QUESTIONS

16 questions · 161 marks · lowest tariff first



7-MARK QUESTIONS

3 questions in this booklet



- 1 Students are investigating exothermic and endothermic reactions. They are finding the temperature change in 50 cm^3 water when a solid dissolves in it. The apparatus is shown in Figure 1.

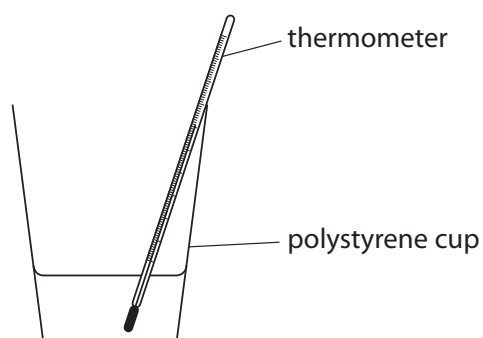


Figure 1

- (a) The steps needed to carry out this experiment are **P, Q, R, S** and **T**. They are shown below.

They are not in the correct order.

- P** pour the 50 cm^3 water into the polystyrene cup
- Q** add the solid to the water and stir
- R** measure 50 cm^3 water using a beaker
- S** measure the initial temperature of the water
- T** measure the final temperature of the solution when all the solid has dissolved

Write the steps in the correct order, from left to right.

(2)

--	--	--	--	--

- (b) The dissolving of this solid in water is an exothermic change.
The experiment is repeated a number of times.
Compared with the initial temperature of the water, the final temperature of the solution is

(1)

- ☐ **A** always higher
- ☐ **B** always lower
- ☐ **C** sometimes higher and sometimes lower
- ☐ **D** always unchanged

- (c) State how step **R** could be changed to measure the volume of water more accurately.

(1)



(d) Figure 2 shows a cold pack.

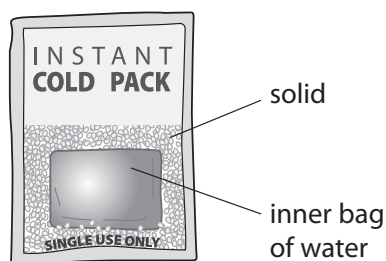


Figure 2

When the pack is squeezed hard the inner bag bursts.
Then the pack goes cold.

(i) Explain why the pack goes cold.

(2)

.....

.....

.....

.....

(ii) Give the reason why the pack can be used only once.

(1)

.....

.....

.....

.....

(Total for Question 1 = 7 marks)

2 Magnesium reacts with dilute sulfuric acid to form magnesium sulfate and hydrogen gas.

A student wants to find out the effect of temperature on the rate of this reaction.

The student used the following method.

step 1 pour 25 cm³ of dilute sulfuric acid into a conical flask

step 2 warm the acid until its temperature is 30 °C

step 3 add a piece of magnesium to the acid

step 4 start a stopwatch

step 5 wait until the reaction has finished

step 6 stop the stopwatch

step 7 repeat steps 1–6 but at 50 °C.

(a) The student kept the volume of sulfuric acid the same when they repeated the method at 50 °C.

State two other variables that should be kept the same.

(2)

1

2

(b) Which piece of equipment can be used to find the volume of 25 cm³ of sulfuric acid?

(1)

- ☐ A balance
- ☐ B measuring cylinder
- ☐ C ruler
- ☐ D thermometer

(c) State how the student will know that the reaction has finished.

(1)

.....

(d) The reaction at 50 °C was faster than the reaction at 30 °C.

Give **one** reason, in terms of particles, why the reaction at 50 °C was faster than the reaction at 30 °C.

(1)

.....

.....



(e) At 50 °C, 15.0 cm³ of gas was produced during the first 60 seconds of the reaction.

Calculate the average rate of reaction, in cm³ s⁻¹, for the first 60 seconds of the reaction.

(2)

.....

.....

.....

.....

average rate of reaction = ... cm³ s⁻¹

(Total for Question 2 = 7 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.

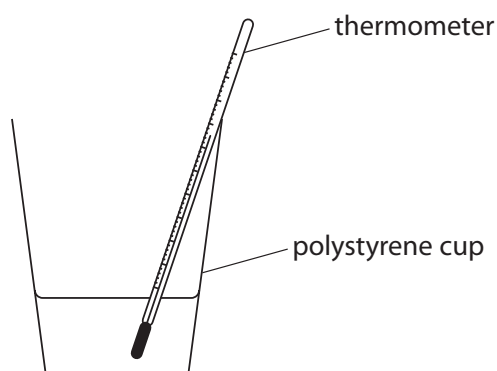


Figure 3

- (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)



8-MARK QUESTIONS

1 question in this booklet



- 3 A student investigates the temperature change when 10 g of solid magnesium chloride is dissolved in 100 cm^3 of water.

Figure 2 shows the apparatus the student uses.

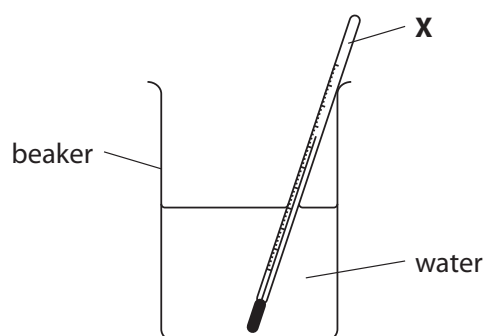


Figure 2

- (a) Name the piece of apparatus labelled X in Figure 2.

(1)

- (b) The student carries out the following steps

step 1 measure the initial temperature of the water in the beaker

step 2 add the magnesium chloride

step 3 stir the mixture

step 4 record the new temperature.

- (i) State why the mixture is stirred in step 3.

(1)

- (ii) State **two** ways the apparatus could be changed to reduce the heat energy lost during the investigation.

(2)

1

2

- (iii) The student carries out the experiment three times.

Figure 3 shows the results.

initial temperature of water in °C	temperature of mixture after stirring in °C	temperature change in °C
20.0	33.5	+13.5
20.0	32.8	+12.8
20.0	33.9	+13.9

Figure 3

Calculate the mean temperature change for this investigation.

(2)

.....

.....

mean temperature change = ... °C

- (iv) Explain, using the information in Figure 3, the type of reaction that occurs when magnesium chloride dissolves in water.

(2)

.....

.....

.....

.....

(Total for Question 3 = 8 marks)



9-MARK QUESTIONS

3 questions in this booklet



3 Hydrogen peroxide decomposes to form water and oxygen.

The rate of this reaction can be found by measuring the volume of oxygen formed after different time intervals.

Hydrogen peroxide solution is placed in a conical flask.
The apparatus is set up as shown in Figure 5.

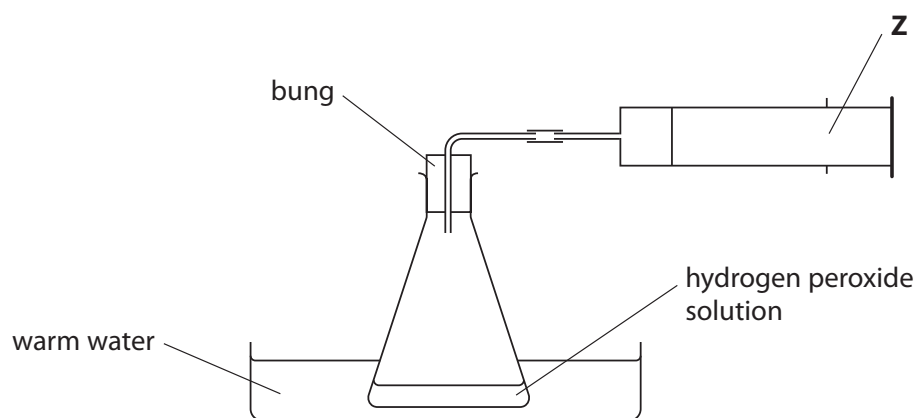


Figure 5

(a) State the name of the piece of apparatus labelled **Z** in Figure 5.

(1)

(b) At the end of the reaction the bung is removed from the conical flask.
A glowing splint is put into the gas in the flask.

State what you would **see**.

(1)

(c) A solid catalyst can be used for this reaction.

- (i) The experiment is repeated under identical conditions but with the catalyst added.

(1)

In the experiment **with** the catalyst added

- ☐ **A** the rate of reaction is the same as when no catalyst is present
- ☐ **B** water and oxygen are the only products of the reaction
- ☐ **C** some of the catalyst is used up
- ☐ **D** the volume of oxygen produced when all the hydrogen peroxide is decomposed is larger than when no catalyst is present

- (ii) At the end of the experiment with the catalyst added, the mass of the catalyst remaining is found.

The method used to find the mass of the catalyst remaining is
filter the mixture of products and catalyst
determine the mass of the filter paper and solid catalyst
subtract the mass of a filter paper from the mass of filter paper and solid catalyst.

This method would not give the accurate mass of catalyst remaining.

Which of the following needs to be done to give a more accurate mass?

(1)

- ☐ **A** dry the filter paper and catalyst before finding their mass
- ☐ **B** scrape the catalyst off the filter paper and find the mass of the catalyst
- ☐ **C** find the mass of the filtrate and not the filter paper and catalyst
- ☐ **D** repeat the experiment

- (iii) A given mass of catalyst is more effective if it has a large surface area.

State how you could increase the surface area of some lumps of solid catalyst.

(1)



- (d) The experiment is repeated three times
once using a more dilute solution of hydrogen peroxide
once using a lower temperature
once using a larger flask

In each case, all other conditions are kept the same.

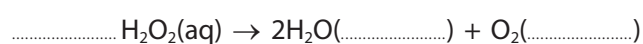
Circle the word that shows the change in the rate of decomposition in each case.

(2)

	change in rate		
hydrogen peroxide solution is more dilute	faster	slower	unchanged
the temperature used is lower	faster	slower	unchanged
the reaction is carried out in a larger flask	faster	slower	unchanged

- (e) Complete the balanced equation for the reaction and fill in the two missing state symbols.

(2)



(Total for Question 3 = 9 marks)



4 Some reactions are exothermic and some reactions are endothermic.

(a) What does an exothermic reaction always give out?

(1)

- ☒ **A** heat energy
- ☒ **B** light
- ☒ **C** a gas
- ☒ **D** sound

(b) In an experiment, a solid is mixed with a liquid.
The temperature change of the mixture is measured.

Figure 6 shows the apparatus that is used.

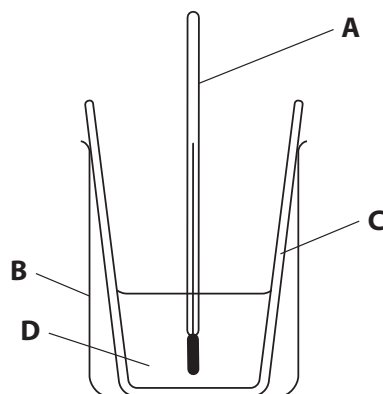


Figure 6

(i) Give the letter of the piece of apparatus, **A**, **B**, **C** or **D**, in Figure 6 that is used to measure the temperature.

(1)

.....

(ii) Give the name of the piece of apparatus **B** shown in Figure 6.

(1)

.....

(iii) The piece of apparatus labelled **C** is made from polystyrene.

State why polystyrene is a better material than glass for this piece of apparatus.

(1)

.....
.....

(iv) The results of the experiment are given in Figure 7.

temperature of liquid at start in °C	18.6
temperature of products at end in °C	16.1

Figure 7

Calculate the change in temperature.

Give a sign and a unit in your answer.

(3)

temperature change = ...

(v) The solid used in this experiment contained only NH_4^+ ions and NO_3^- ions.

Give the formula and the name of the solid.

(2)

formula

name

(Total for Question 4 = 9 marks)



- 4 (a) In one reaction the temperature of the reaction mixture decreases.

Which word describes this type of reaction?

(1)

- ☐ A displacement
- ☐ B endothermic
- ☐ C exothermic
- ☐ D neutralisation

- (b) In an experiment, a salt is dissolved in water.

The temperature change is measured.

Figure 7 shows the apparatus that is used.

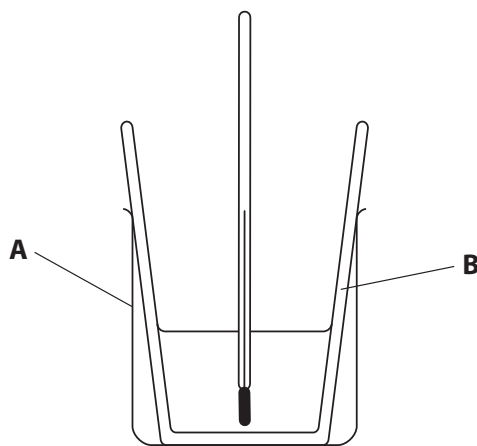


Figure 7

- (i) State what is used to measure the temperature change in Figure 7.

(1)

.....

- (ii) State **one** reason for using the piece of equipment **A** in Figure 7.

(1)

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

- (iii) A student suggests putting a lid on piece of equipment **B**.

State why this would help to give a more accurate value for the temperature change.

(1)

- (iv) Four different salts, **P**, **Q**, **R** and **S**, are dissolved in water.

Figure 8 shows the starting temperature of the water and the final temperature of the solution after the salt dissolves.

	salt P	salt Q	salt R	salt S
starting temperature in °C	20.0	20.0	20.0	20.0
final temperature in °C	22.4	19.5	23.0	18.5
temperature change in °C	+2.4	−0.5		
salt that absorbed most heat energy when it dissolved				

Figure 8

Complete the table

- to show the temperature changes when salt **R** and salt **S** dissolve
- by placing a tick (✓) in the box, on the bottom row, for the salt that **absorbs** the most heat energy when it dissolves.

(4)

- (v) One of the salts dissolved is barium chloride, BaCl_2 .

Barium chloride contains the chloride ion, Cl^- .

Give the **formula** of the barium ion in barium chloride.

(1)

(Total for Question 4 = 9 marks)



11-MARK QUESTIONS

4 questions in this booklet



10 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 15.

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.

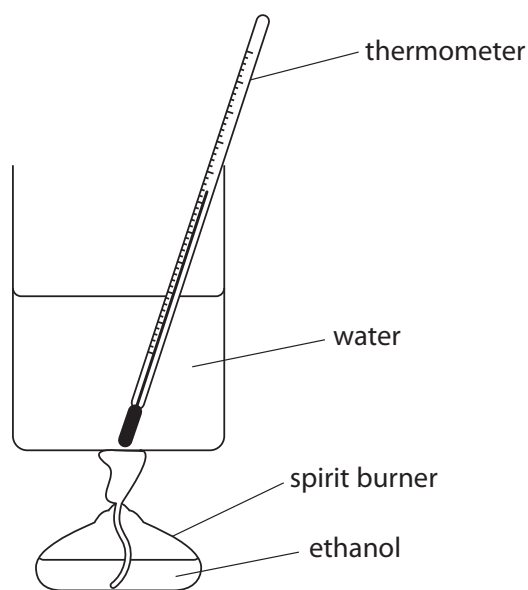


Figure 15

- (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

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

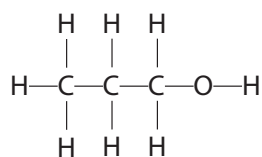
Calculate the amount of heat energy used.

(2)

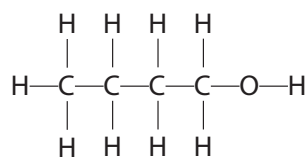
heat energy = ... (energy units)



(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 15.

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 10 = 11 marks)

- 8 A student used the apparatus in Figure 13 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.

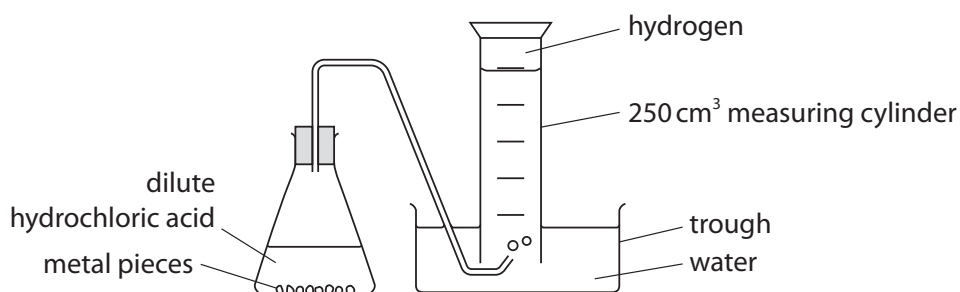


Figure 13

- (a) Figure 14 shows a graph of the student's results.

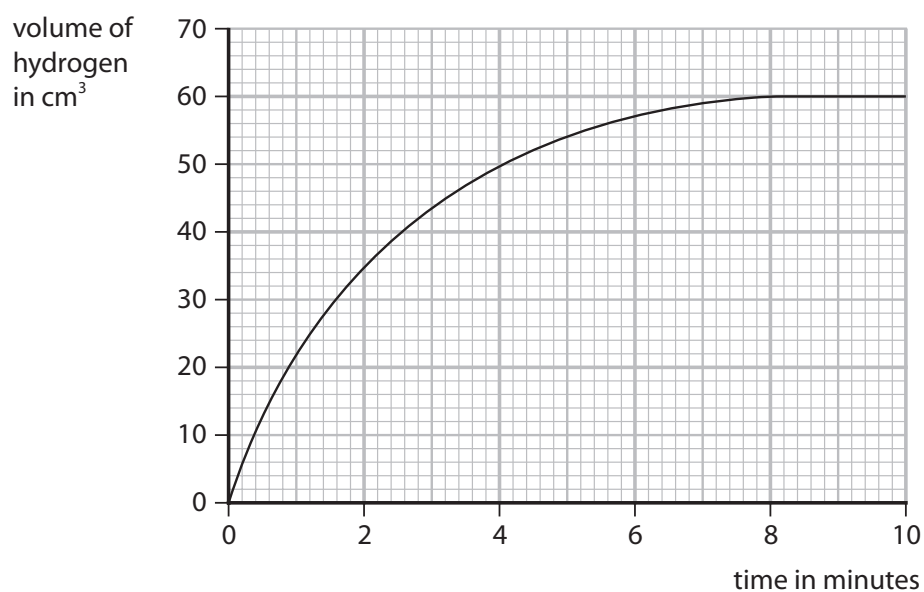


Figure 14

- (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

- (c) The apparatus in Figure 13 can be used to measure the rate of the reaction between marble chips and hydrochloric acid.

The student needs different sized marble chips.

Describe how the student can make small and medium sized marble chips from large chips.

(2)

.....

.....

.....

(Total for Question 8 = 11 marks)

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

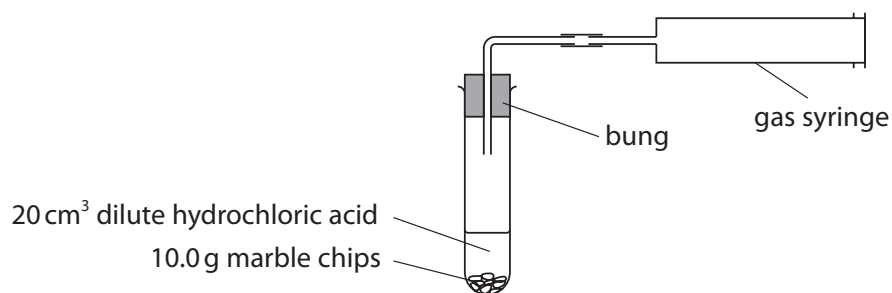


Figure 15

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

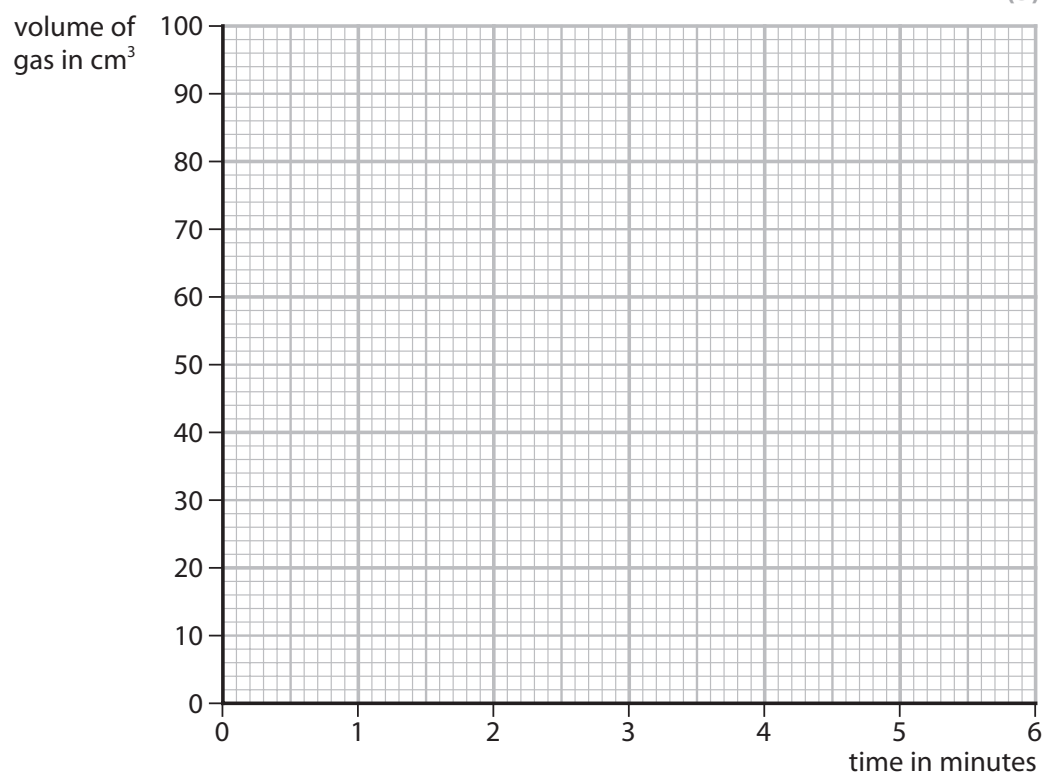
time in minutes	0	1	2	3	4	5	6
volume of gas in cm ³	0	52	78	91	97	100	100

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)



- 8** 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 14 shows part of the apparatus used in the experiment.

Complete Figure 14 by drawing and labelling apparatus that could be used to collect and measure the volume of the carbon dioxide gas.

(2)

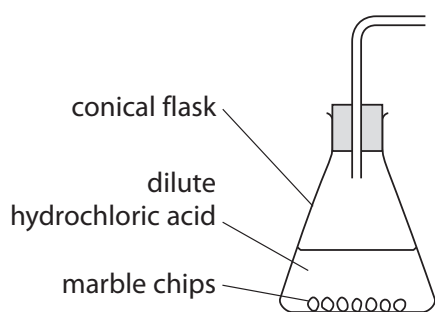


Figure 14

(b) Figure 15 shows a graph of the results of the experiment.

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

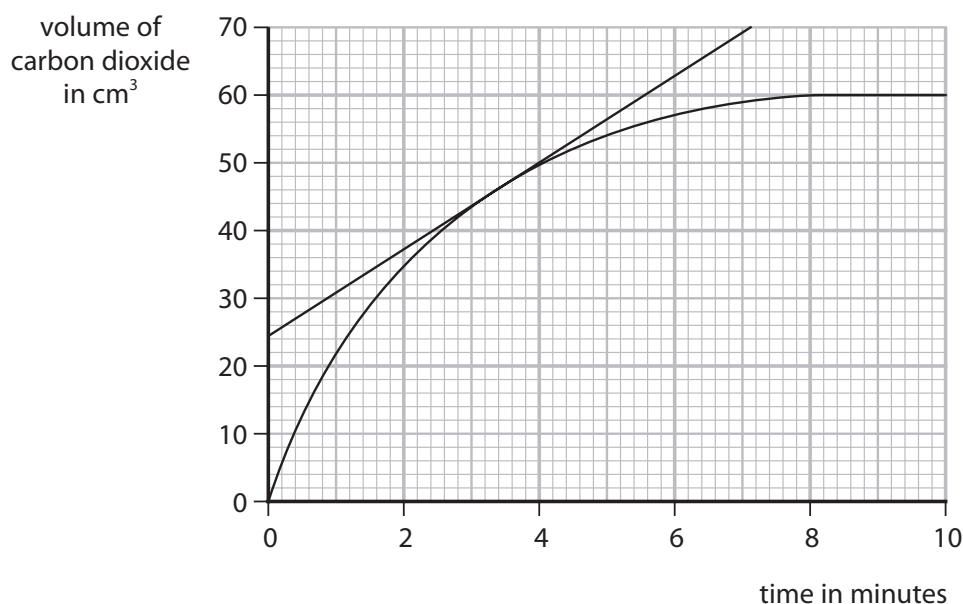


Figure 15

(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

(e) In this experiment the volume of carbon dioxide gas produced is measured.

Give a different way that the amount of carbon dioxide produced can be measured.

(1)

(f) In this experiment there is an excess of dilute hydrochloric acid.

State what you would **see** in the conical flask at the end of the experiment.

(1)

(Total for Question 8 = 11 marks)



12-MARK QUESTIONS

4 questions in this booklet



- 6 Figure 9 shows a sample of hydrogen peroxide solution decomposing to form water and oxygen gas.

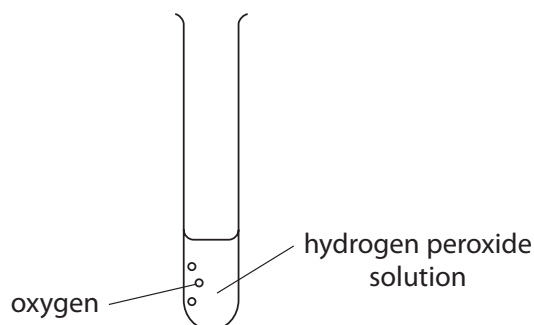


Figure 9

- (a) (i) Write the word equation for hydrogen peroxide solution decomposing.

(1)

→

- (ii) In this reaction hydrogen peroxide is a solution, water is a liquid and oxygen is a gas.

Draw one straight line from each substance to its correct state symbol.

(2)

substance

state symbol

hydrogen peroxide
solution

(aq)

liquid water

(g)

oxygen gas

(l)

- (b) Describe the test to show the gas produced is oxygen.

(2)

- (c) Figure 10 shows the electron arrangement for an atom of hydrogen and an atom of oxygen.

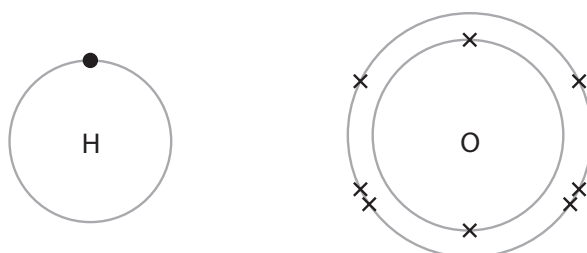


Figure 10

Complete the dot and cross diagram in Figure 11 for a molecule of water, H_2O .

Draw outer shell electrons only.

(2)

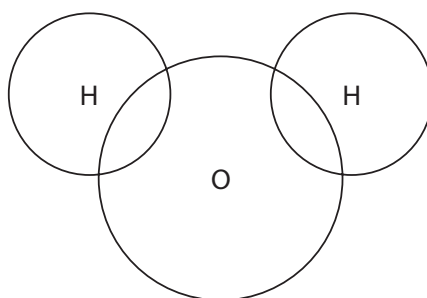


Figure 11

- (d) Liver contains the enzyme catalase.

A piece of liver was added to another sample of hydrogen peroxide solution.

Figure 12 shows the results.

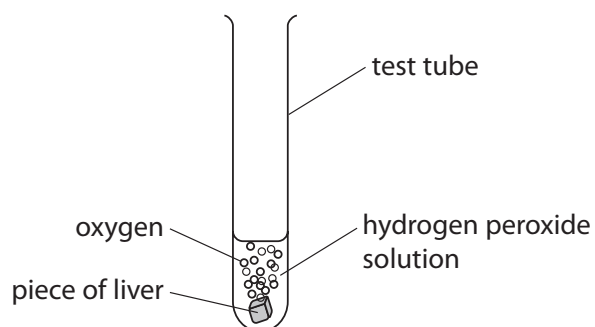


Figure 12

Figure 13 shows a graph of the volume of oxygen produced from the hydrogen peroxide with and without liver.

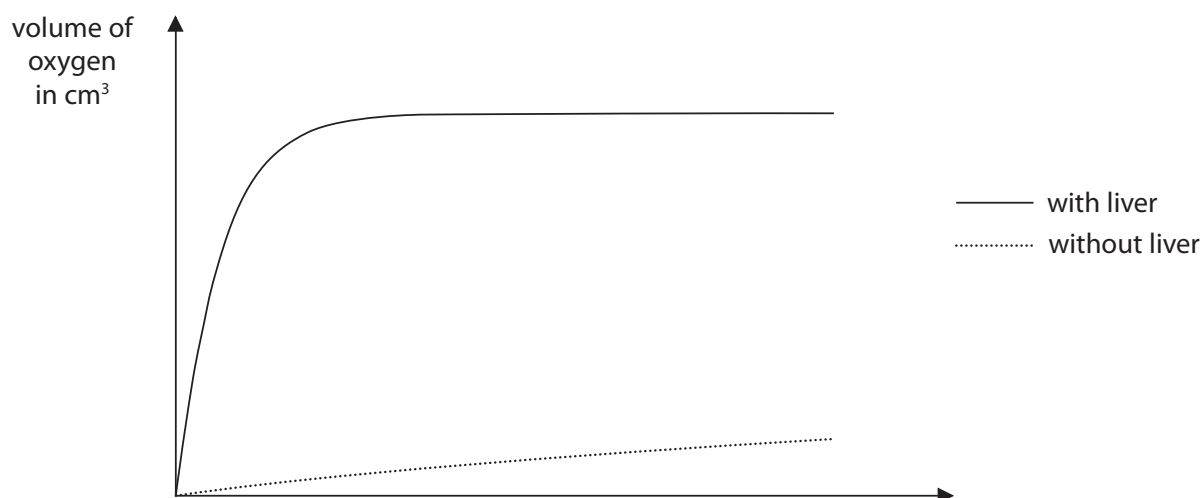


Figure 13

(i) Complete the missing label on the axis of the graph.

(1)

(ii) Describe what the graph shows about the difference in decomposition of hydrogen peroxide with and without liver.

(2)

.....

.....

.....

.....

(iii) Describe how the apparatus in Figure 12 could be modified to find the volume of gas produced when the liver is added to the hydrogen peroxide.

(2)

.....

.....

.....

.....

(Total for Question 6 = 12 marks)

7 This question is about alcohols.

- (a) (i) Figure 14 shows an incomplete diagram of the structure of a molecule of propanol, $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$.

Complete the structure of the molecule of propanol in Figure 14.

(2)

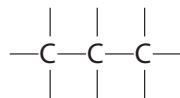


Figure 14

- (ii) Propanol can be converted into propanoic acid.

What happens to propanol in this reaction?

(1)

- ☐ A it is dehydrated
- ☐ B it is neutralised
- ☐ C it is oxidised
- ☐ D it is polymerised

- (b) A student used an alcohol burner to find the mass of different alcohols needed to raise the temperature of 100 cm^3 of water by 20°C .

Figure 15 shows their results.

alcohol	initial mass of alcohol burner and alcohol in g	final mass of alcohol burner and alcohol in g	mass of alcohol used in g
ethanol	122.51	122.02	0.49
propanol	168.55	168.13	0.42
butanol	152.62	152.23	
pentanol	67.22	66.86	0.36

Figure 15

- (i) Calculate the mass of butanol used.

(1)

mass of butanol = ... g

- *(ii) Figure 16 shows equipment that can be used to obtain the results shown in Figure 15.

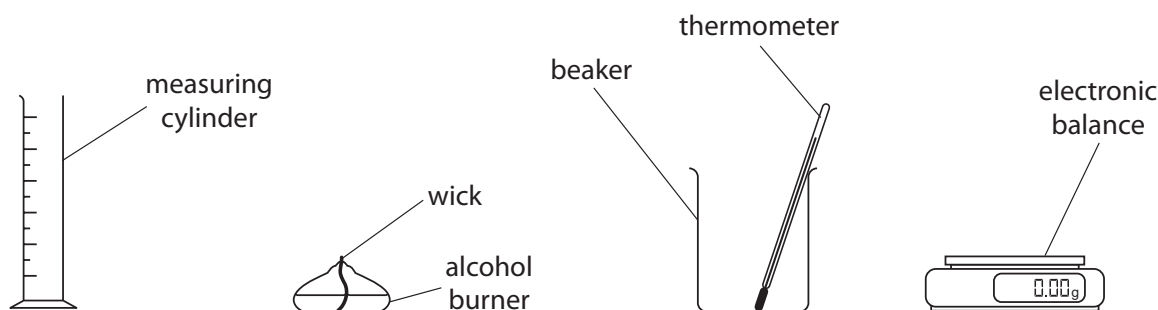


Figure 16

Describe an experiment, using the equipment in Figure 16, that could be used to obtain results like those shown in Figure 15.

(6)

[illegible]

(iii) The results show that 0.36 g of pentanol was needed to raise the temperature of the water by 20°C.

Calculate the mass of pentanol needed to raise the temperature of water by 1°C.

Give your answer to 2 decimal places.

Show your working.

(2)

.....

.....

.....

mass of pentanol = ... g

(Total for Question 7 = 12 marks)



- 7 (a) A student heats a known volume of water by burning propanol.

The student investigates the mass of propanol needed to increase the temperature of the water by 50°C .

Figure 9 shows the apparatus the student uses.

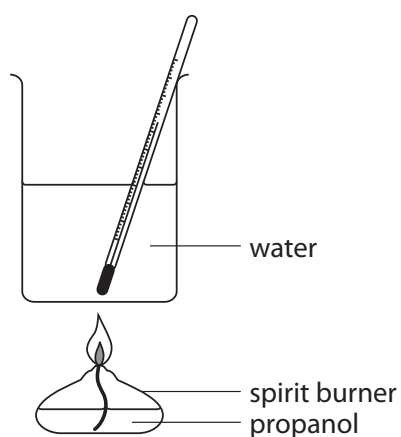


Figure 9

- (i) The student carries out the investigation using the following six steps.

The steps are **not** shown in the correct order.

step P find the final mass of the spirit burner containing propanol

step Q measure the initial temperature of the water

step R put 100 cm^3 water into the beaker

step S find the initial mass of the spirit burner containing propanol

step T when the temperature of the water has increased by 50°C extinguish the flame

step U place the spirit burner under the beaker of water and light the spirit burner

Write the steps in the correct order.

The first two steps have been completed for you.

(2)

R	Q				
---	---	--	--	--	--

(ii) State what should be used to find the mass of the spirit burner.

(1)

(iii) The student finds that 1.40 g of propanol is needed to increase the temperature of the water by 50 °C.

Calculate the mass of propanol needed to increase the temperature of the water by 1 °C.

(1)

mass of propanol = ... g

(b) Alcohols can be oxidised to produce carboxylic acids.

Propanol can be oxidised to propanoic acid.

Complete Figure 10 by giving the names of the missing compounds.

(2)

name of alcohol	name of carboxylic acid produced
ethanol	
propanol	propanoic acid
.....	butanoic acid

Figure 10



(Total for Question 7 = 12 marks)

- 8 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 12. The student measures the time taken for the cross to become visible. The experiment is repeated at different temperatures.

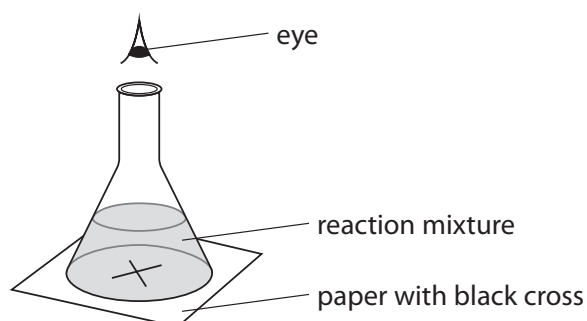


Figure 12

Figure 13 shows the results.

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

Figure 13

- (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)

- (e) Hydrogen peroxide, H_2O_2 , decomposes into oxygen and water.

A catalyst can be used to increase the rate of this reaction.

- (i) Use a word or phrase from the box to complete the sentence about the mass of the catalyst in a reaction.

(1)

stays the same

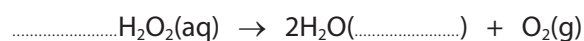
increases

decreases

During a reaction, the mass of a catalyst

- (ii) Complete the balanced equation for this reaction and add the missing state symbol.

(2)



(Total for Question 8 = 12 marks)



13-MARK QUESTIONS

1 question in this booklet



- 9 (a) 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.

- (i) 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 15.

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 15

State, using the information in Figure 15, the effect of the surface area of the calcium carbonate on the rate of this reaction.

(1)

.....

.....

.....

- (ii) 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 = ... $\text{cm}^3 \text{ s}^{-1}$



- (iii) 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 9 = 13 marks)



MARK SCHEMES

official Pearson Edexcel mark schemes



Question Number	Answer	Mark
1(a)	R P S Q T R P S as first 3 (1) Q T as last 2 (1)	(2) AO 3 2a AO 3 2b

Question Number	Answer	Mark
1(b)	A always higher The only correct answer is A <i>B is not correct because temperature rise</i> <i>C is not correct because temperature always rises</i> <i>D is not correct because temperature rises</i>	(1) AO 2 2

Question Number	Answer	Additional guidance	Mark
1(c)	use a measuring cylinder	allow pipette/ burette ignore syringe , measuring jug/tube etc.	(1) AO 3 3a

Question Number	Answer	Additional guidance	Mark
1(d)(i)	An explanation including - the solid {dissolves/ reacts with the water} (1) {takes in /absorbs} heat / is endothermic (1)	Ignore just 'a (chemical) reaction occurs' etc allow energy for heat ignore reference to temperature change	(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
1(d)(ii)	(reaction) irreversible	allow reaction can only occur once allow reactants are used up / reaction is complete / the reaction has happened allow bag can only burst once/ cannot get water back into bag	(1) AO 3 1a

(Total for Question 1 = 7 marks)



Question number	Answer	Mark
2(a)	any two from: concentration of acid (1) {size / shape / surface area / length} area of magnesium ribbon (1) mass of magnesium (1)	(2) AO2

Question number	Answer	Mark
2(b)	B measuring cylinder A, C and D do not measure volumes	(1) AO2

Question number	Answer	Mark
2(c)	magnesium has gone / no more bubbles	(1) AO2

Question number	Answer	Additional guidance	Mark
2(d)	(particles) have more energy / (particles) collide more frequently / more successful collisions	allow particles move faster	(1) AO1

Question number	Answer	Additional guidance	Mark
2(e)	$\frac{15.0}{60.0}$ (1) $= 0.25$ (1) ($\text{cm}^3 \text{s}^{-1}$)	$\frac{60}{15} = 4$ (1)	(2) AO2



Question number	Answer	Mark
2(a)	$24.16 - 22.52 = 1.64$ (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)	thermometer		A02 2 (1)

Question number	Answer	Additional guidance	Mark
3(b)(i)	to make the {magnesium chloride / solid} dissolve	allow 'so it dissolves' allow to increase the rate of the reaction allow to {mix / spread / distribute} the reactants allow so it reacts allow to help 'break up' the {magnesium chloride / solid} allow to get an even temperature ignore to make it more accurate / more reliable	A02 2 (1)

Question number	Answer	Additional guidance	Mark
3(b)(ii)	- use a polystyrene cup / insulate the beaker (1) - add a lid to the beaker (1)	allow any relevant wrapping e.g. foil, cotton wool ignore draught shield ignore 'trap heat' ignore close the beaker / use a bung / cover (the beaker) / seal the beaker max 1 mark if methods of keeping a constant temperature e.g. water bath are given	A03 3b (2)



Question number	Answer	Additional guidance	Mark
3(b)(iii)	13.4 with or without working scores 2 13.5 + 12.8 + 13.9 = 40.2 (1) $\frac{40.2}{3} = 13.4$ (1)	-13.4 scores 1 40.2 with or without working scores 1 33.4 with or without working scores 1 allow ecf MP2 for correctly dividing by 3 a value derived from an attempt at adding the three temperature changes $\frac{13.5 + 13.9}{2} = 13.7$ scores 2 only with working	A01 2 (2)

Question number	Answer	Additional guidance	Mark
3(b)(iv)	an explanation linking: - exothermic (1) (because) temperature increases (1)	mark independently allow heat is {given out / released / lost} / gets {hotter / warmer} allow energy is released	A03 2 (2)

Total for Question 3 = 8 marks



Question Number	Answer	Mark
3(a)	(gas) syringe	(1) AO 1 2

Question Number	Answer	Additional guidance	Mark
3(b)	(splint) (re)lights	allow alternatives indicating that splint burns e.g. flame allow glows more brightly reject squeaky pop	(1) AO 1 1

Question Number	Answer	Mark
3(c)(i)	B water and oxygen are the only products of the reaction The only correct answer is B <i>A is not correct because rate increases</i> <i>C is not correct because catalysts do not get used up</i> <i>D is not correct because amount of product is unaltered by catalyst</i>	(1) AO 1 1

Question Number	Answer	Mark
3(c)(ii)	A dry the filter paper and catalyst before finding their mass The only correct answer is A <i>B this does not remove the water</i> <i>C dry residue is needed, not filtrate</i> <i>D water would still be present</i>	(1) AO 3 3a

Question Number	Answer	Additional guidance	Mark
3(c)(iii)	powder / cut up / break up / use smaller pieces	ignore reference to surface area/ squash / flatten	(1) AO 1 2

Question Number	Answer	Additional guidance	Mark
3(d)	• slower • slower • unchanged all 3 rows correct – 2 marks one or two rows correct – 1 mark	may indicate correct answer in any way e.g. by underlining do not credit a row if more than one answer is indicated in a row	(2) AO 1 1

Question Number	Answer	Additional guidance	Mark
3(e)	$2\text{H}_2\text{O}_2(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$ (2) OR $2\text{H}_2\text{O}_2$ (1) state symbols l, g (1)	do not allow first marking point if equation unbalanced allow capital or small letters for state symbols do not allow words for state symbols	(2) AO 1 1 AO 2 1

(Total for Question 3 = 9 marks)



Question number	Answer	Mark
4(a)(i)	A Heat energy is the only correct answer. B, C and D are incorrect as all exothermic reactions give out heat	(1) A01 1

Question number	Answer	Mark
4(b)(i)	A / thermometer	(1) A02 2

Question number	Answer	Additional guidance	Mark
4(b)(ii)	beaker	allow measuring beaker/ plastic beaker reject measuring cup/ jug	(1) A02 2

Question number	Answer	Additional guidance	Mark
4(b)(iii)	it is a (good heat) insulator	allow would hold / trap heat / keeps heat in / doesn't absorb heat / reduces heat loss / poor conductor allow correct comparison of heat conductivity with glass e.g polystyrene is a better insulator than glass ignore keeps temperature in / heat resistant ignore not breakable / glass is breakable ignore 'traps energy' alone	(1) A02 2



Question number	Answer	Additional guidance	Mark
4(b)(iv)	-2.5°C scores 3 with or without working 16.1 – 18.6 (1) = -2.5 (1) °C (1)	2.5°C scores 2 with or without working 2.5 scores 1 with or without working MP3 standalone mark ignore 'C' / '°' alone ignore 'deg C'	(3) A02 1

Question number	Answer	Additional guidance	Mark
4(b)(v)	formula: NH_4NO_3 (1) name: ammonium nitrate (1)	letters must be capitals and 4, 3 must be subscripts allow $\text{NH}_4^+\text{NO}_3^-$ allow $\text{N}_2\text{H}_4\text{O}_3$ ignore state symbols ignore $\text{NH}_4^+ + \text{NO}_3^-$ reject ammonia nitrate	(2) A02 1

Question number	Answer	Mark
4(a)	B endothermic is the only correct answer. A , C and D are incorrect as all endothermic reactions absorb heat.	(1) AO1 1

Question number	Answer	Additional guidance	Mark
4(b)(i)	thermometer	ignore temperature probe	(1) AO2 2

Question number	Answer	Additional guidance	Mark
4(b)(ii)	stops polystyrene cup from falling over	allow keeps {heat / thermal energy} {in / out} allow provides insulation ignore references to keeping temperature in ignore prevents burns / too hot to pick up	(1) AO3 1

Question number	Answer	Additional guidance	Mark
4(b)(iii)	reduces {heat/thermal energy} loss / traps heat	allow maintains the temperature allow reduces {heat / thermal energy} gain allow insulation ignore references to keeping temperature in ignore references to cold {entering/leaving} polystyrene cup	(1) AO3 1



Question number	Answer	Additional guidance	Mark
4(b)(iv)	salt R: (+) 3(.0) (1) salt S: -1.5 (2) salt with most negative value only ticked (1)	reject -3(.0) for MP1 (+)1.5 scores 1	(4) AO2 2

Question number	Answer	Additional guidance	Mark
4(b)(v)	Ba ²⁺	allow Ba ⁺² / Ba2+ ignore any other ions reject subscript reject incorrect cases	(1) AO2 1

Total for question 4 = 9 marks



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

Question Number	Answer	Additional guidance	Mark
10(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
10(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
10(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/ chemical properties/ 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
10(c)(i)	propanol + oxygen → propanoic acid + water (2) allow $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{O}_2 \rightarrow \text{CH}_3\text{CH}_2\text{COOH} + \text{H}_2\text{O}$ (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
10(c)(ii)	C -COOH The only correct answer is C <i>A is not correct because this is 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 10 = 11 marks)



Question number	Answer	Additional Guidance	Mark
8(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
8(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 all other answers require working to have marks awarded 0.3 alone scores 0 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
8(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
8(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
8(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



Question number	Answer	Additional guidance	Mark
8(c)	A description including any two from: • {crush/ break} the large chips (1) • in pestle and mortar (1) • use sieves to separate different sized chips/ sort the chips by size (1)	ignore {cut / chop} them up ignore breaking down by cutting / chopping / tearing / heating etc allow any suitable <u>laboratory</u> apparatus/ tool e.g. hammer ignore domestic equipment e.g. scissors / rolling pin allow leave in acid (to reduce size) for MP2 but MP1 cannot score allow pick out the sizes you need allow repeat the method to get even smaller chips	(2) A01 2

Question number	Answer	Mark
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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
8(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
8(b)(i)	47	allow any value from 46-48	(1) AO3 2



Question number	Answer	Additional guidance	Mark
8(b)(ii)	Answer in range 6.197 – 6.5 with or without working scores 3 Δy (gas volume) = 70 – (any number 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 12.50 – 13.20 scores 2 13.21–13.75 scores 1 If answer is rounded, mark pre-rounded answer and ignore rounding if final answer not given or outside 6.0–6.70, or 12.50–13.75, then max 2 for MP1 and/ or MP2	(3) AO3 2



Question number	Answer	Additional guidance	Mark
8(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 allow more chance of collisions/ collisions happen more often ignore more (successful) collisions alone	(2) AO1 1

Question number	Answer	Mark
8(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

Question number	Answer	Additional guidance	Mark
8(e)	measure mass (of flask)	allow weigh the flask / use {a balance / scales} ignore scale alone / syringe	(1) AO1 2

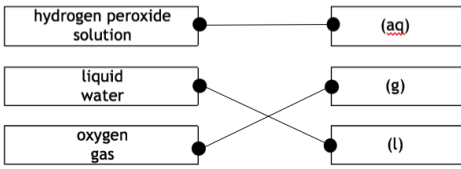


Question number	Answer	Additional guidance	Mark
8(f)	colourless {liquid / solution} / no marble chips (remaining) / bubbling has stopped / clear {liquid / solution} (1)	allow no solid / no bubbling / no fizzing reject colours	(1) AO1 2

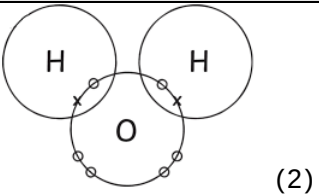
Total for question 8 = 11 marks



Question number	Answer	Additional guidance	Mark
6(a)(i)	hydrogen peroxide → water + oxygen	allow symbol equation if all symbols and balancing are correct	(1) AO2

Question number	Answer	Additional guidance	Mark
6(a)(ii)	 (2) all correct (2) 1 correct (1)	reject multiple lines	(2) AO1

Question number	Answer	Additional guidance	Mark
6(b)	A description to include glowing splint (1) relights (1)	MP2 is dependent on MP1	(2) AO1

Question number	Answer	Additional guidance	Mark
6(c)	 (2) OR shared pair of electrons between the oxygen and a hydrogen (1) rest of molecule correct (1)	allow dots or crosses or a mixture of both	(2) AO1

Question number	Answer	Additional guidance	Mark
6(d)(i)	Time in {s/min}	allow seconds/minutes	(1) AO3

Question number	Answer	Additional guidance	Mark
6(d)(ii)	A description to include reaction is faster with liver (1) more {gas/oxygen} produced with liver (1)	allow ORA	(2) AO3

Question number	Answer	Mark
6(d)(iii)	A description to include bung and delivery tube (1) connected to {a gas syringe / upturned burette / upturned measuring cylinder} (1)	(2) AO3



Question number	Answer	Additional guidance	Mark
7(a)(i)	$\begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{H} & \\ & & & & & & \\ \text{H} & -\text{C} & - & \text{C} & - & \text{C} & -\text{O}-\text{H} \\ & & & & & & \\ & \text{H} & & \text{H} & & \text{H} & \end{array}$ (2) OR hydroxyl group on a carbon (1) rest of molecule correct (1)	allow OH for O-H reject any multiple bonds drawn	(2) AO1

Question number	Answer	Mark
7(a)(ii)	C it is oxidised A, B and D are incorrect as this is an oxidation reaction.	(1) AO2

Question number	Answer	Mark
7(b)(i)	0.39 with or without working scores 1 mark $152.62 - 152.23 (= 0.39)$ (1)	(1) AO2

Question number	Indicative content	Mark
*7(b)(ii)	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 (6 marks) • measure 100 cm³ of water into a beaker. • place the beaker above the burner • place draft shields around the equipment • weigh the (alcohol) burner containing the alcohol • record this mass and the name of the alcohol. • place a thermometer in the water • record the initial temperature of the water • place a lid on beaker • light the wick. • heat the water so the temperature rises by 20°C. • extinguish the flame. • re-weigh the (alcohol) burner • subtract final mass from initial mass of burner and alcohol/ calculate the mass of alcohol used. • repeat with the next alcohol • using same volume of water • keep the height of the beaker the same	(6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	Heat the water by 20°C and then subtract the final mass from the initial mass of the burner and alcohol
Level 2	3–4	Measure 100 cm ³ of water into a conical flask, allow the alcohol to heat the water so the temperature rises by about 20°C. re-weigh the spirit burner and cap then calculate the mass of alcohol used.
Level 3	5–6	Measure 100 cm ³ of water into a conical flask/beaker. Weigh the burner and cap containing the alcohol. Record the initial temperature of the water in the flask. Allow the alcohol to heat the water so the temperature rises by about 20°C. Re-weigh the spirit burner and cap, subtract final mass from initial mass of burner and alcohol.

Question number	Answer	Mark
7(b)(iii)	0.02 with or without working scores 2 marks $\frac{0.36}{20} = (0.018)$ (1) 0.02 (1)	(2) AO2



Question number	Answer	Additional guidance	Mark						
7(a)(i)	<table><tr><td>R</td><td>Q</td><td>S</td><td>U</td><td>T</td><td>P</td></tr></table>	R	Q	S	U	T	P	allow 1 mark for P in correct position	A01 2 (2)
R	Q	S	U	T	P				

Question number	Answer	Additional guidance	Mark
7(a)(ii)	(electronic) balance	allow scales allow weighing scale ignore scale alone	A01 2 (1)

Question number	Answer	Additional guidance	Mark
7(a)(iii)	0.028		A02 1 (1)

Question number	Answer	Additional guidance	Mark						
7(b)	<table><tr><td>ethanol</td><td>ethanoic acid (1)</td></tr><tr><td>propanol</td><td>propanoic acid</td></tr><tr><td>butanol (1)</td><td>butanoic acid</td></tr></table>	ethanol	ethanoic acid (1)	propanol	propanoic acid	butanol (1)	butanoic acid		A03 2 (2)
ethanol	ethanoic acid (1)								
propanol	propanoic acid								
butanol (1)	butanoic acid								



Question number	Indicative content	Mark
*7(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. AO1 (3 marks) AO3 (3 marks) ATOMS similarities • both contain carbon atom, hydrogen atoms and oxygen atoms • both have an oxygen joined to a hydrogen • both contain one carbon differences • J contains two hydrogens, K contains four • J contains two oxygens, K contains one STRUCTURE AND BONDING similarities • both have 5 bonds • both have covalent bonds differences • J contains a (carbon-oxygen) double bond and K has all single bonds • Functional group for K is OH • K is methanol • Functional group for J is COOH • J is methanoic acid PROPERTIES similarities • both have low melting points differences • solution of K has a neutral pH • solution of J is acidic • J shows acidic properties	AO1 2 AO3 3a (6)



Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents a description which is not logically ordered and with significant gaps. (AO1) • 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)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1) • Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1) • Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (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> Fully describes one aspect in terms of similarities and/or differences or States two similarities and/or differences	<u>Possible candidate response</u> • K is neutral (1) • K has all single bonds, whereas J has a double bond (1) • Both contain carbon, hydrogen and oxygen atoms (1) • K has 3 more hydrogens and one more oxygen than J (2) • Both contain one carbon (2) • J acid is acidic whereas K is neutral (2) • Both contain carbon, hydrogen and oxygen atoms joined by covalent bonds (2)
Level 2	3–4	<u>Additional Guidance</u> Fully describes two aspects in terms of similarities and/or differences. OR Fully describes one aspect in terms and partially describes two of similarities and/or differences OR Fully describes one aspect in terms of similarities AND differences.	<u>Possible candidate response</u> • J acid is acidic whereas K is neutral and J is has a double bond whereas K has only single bonds (3) • Both contain carbon, hydrogen and oxygen atoms joined by covalent bonds, they both have low melting points (3) • K is neutral and has a all single bonds covalent bonds, whereas J acid is acidic and a double covalent bond (4) • Both contain carbon, hydrogen and oxygen atoms joined by covalent bonds but K is called methanol, whereas J is called methanoic acid (4)
Level 3	5–6	<u>Additional Guidance</u> Fully describes from all three aspects including similarities AND differences	<u>Possible candidate response</u> • K has 3 more hydrogens than J. K is called methanol, is neutral and only has single bonds, whereas J is called methanoic acid, is acidic and has a double bond. K has the functional group OH whereas J has the functional group COOH (5) • Both contain carbon, hydrogen and oxygen atoms joined by covalent bonds but K has 3 more hydrogens than J. K is called methanol, is neutral and only has single bonds, whereas J is called methanoic acid is acidic (6)

Total for Question 7 = 12 marks



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

Question number	Answer	Additional Guidance	Mark
8(b)(i)	any one from (same) volume (same) (conical) flask (same) cross	allow (same) 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	A03 3a (1)

Question number	Answer	Additional guidance	Mark
8(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	A02 1 (3)



Question number	Answer	Additional guidance	Mark
8(c)	0.67 with or without working scores 2 $25 \text{ cm}^3 = \frac{25}{1000} = 0.025 \text{ dm}^3$ (1) $0.025 \times 26.8 = 0.67$ (1) or $26.8 \times 25 = 670$ (1) $\frac{670}{1000} = 0.67$ (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)	A02 1 (2)



Question number	Answer	Additional guidance	Mark
8(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 for MP2	A01 1 (2)

Question number	Answer	Additional guidance	Mark
8(e)(i)	stays the same	if no answer on answer line, allow stays the same circled or underlined in box	A01 1 (1)

Question number	Answer	Additional guidance	Mark
8(e)(ii)	$2\text{H}_2\text{O}_2(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$ 1 mark for 2 with no other numbers added 1 mark for l	allow L reject liquid	A02 1 (2)

Total for Question 8 = 12 marks



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

Question number	Answer	Additional guidance	Mark
9(a)(ii)	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> = $0.3 \text{ (cm}^3 \text{ s}^{-1})$ (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
9(a)(iii)	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	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. A plan to include some of the following points • measure equal masses of zinc using balance • measure equal volumes of acid using measuring cylinder/pipette/suitable named piece of apparatus • pour acid in suitable container • record initial temperature • use of thermometer • add zinc to acid • place bung with delivery tube in container / reaction vessel immediately after the zinc is added • use of timer • start timer on addition of zinc • measure volume of gas evolved using a delivery tube and inverted measuring cylinder/burette over water OR delivery tube and (gas) syringe • record time to collect fixed volume of gas • record final/highest temperature • calculate the temperature increase • repeat for procedure • same initial temperature • same size pieces of zinc • same volume of acid credit use a suitable labelled diagram of apparatus for rate measurement/ temperature of acid	(6)



Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated backed up by planning detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> Identifies relevant practical operations such as - carries out basic reaction – add zinc to acid - measures at least one of mass, time, volume, temperature	<u>Possible candidate responses</u> - put zinc in test tube and add some acid - find the mass of zinc - measure volume of the acid - carries out basic reaction or measures at least one factor with details scores upper part of level
Level 2	3–4	<u>Additional guidance</u> Some correct sequencing of correct operations - carries out basic reaction with dilute acid and repeat with the more concentrated acid <u>and</u> - carries out reaction makes some relevant observation or obtains a result <u>or</u> - measures at least two of mass, time, volume, temperature	<u>Possible candidate responses</u> - put zinc in test tube, add acid and time the reaction - put zinc in test tube, add dilute acid, then repeat experiment and add more concentrated acid - measures mass of zinc and measures volume of acid before adding together - measures temperature of acid before adding to zinc and measures temperature at end of reaction - a similar description, but with detail of apparatus scores the upper part of the level
Level 3	5–6	<u>Additional guidance</u> Sequence of operations of an experiment to include two from - measures temperature and volume of acid, and mass of zinc - repeats expt but with more concentrated acid - measure temperature of reaction mixture at end and finds temperature rise	<u>Possible candidate responses</u> - record temperature of 25 cm³ dilute acid, add to known mass of zinc, record temperature after reaction - using suitable apparatus measure volume of gas every minute - repeat experiment using same conditions but using the more concentrated acid - work out temperature rises for both reactions - descriptions with detail or workable method scores upper part of level

Total for Question 9 = 13 marks

