

PAG C8 Rates of Reaction

Question	Maximum Mark	Mark Awarded
1	7	
2	7	
3	7	
4	5	
5	10	
Total Mark		

1.

The following word equation represents the reaction between zinc and dilute hydrochloric acid.



You are asked to carry out an experiment to show how **particle size** affects the speed of this reaction.

(a) (i) Describe how you would carry out the experiment. [2]

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

(ii) State how you would make it a fair test. [2]

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

(iii) State how you would know which particle size gives the fastest reaction. [1]

.....
.....

(b) A catalyst was added to the reaction mixture above.

(i) State how the catalyst would affect the **time** needed to produce a given volume of hydrogen. [1]

.....
.....

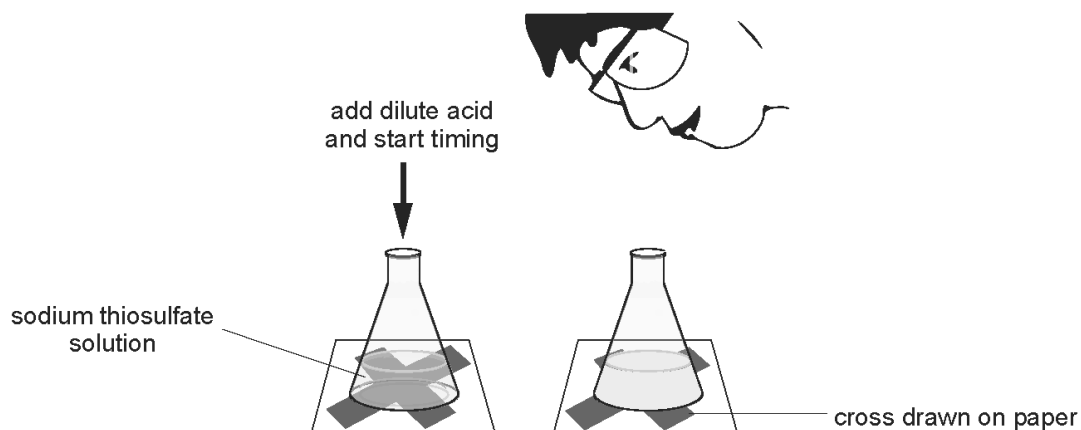
(ii) State how you would expect the catalyst to affect the total **volume** of hydrogen produced. [1]

.....
.....

7

2.

When sodium thiosulfate solution reacts with dilute acid, sulfur forms as a precipitate. The precipitate causes the solution to go cloudy. The rate of reaction can be measured by placing a cross beneath the flask and measuring the time taken for the cross to disappear.

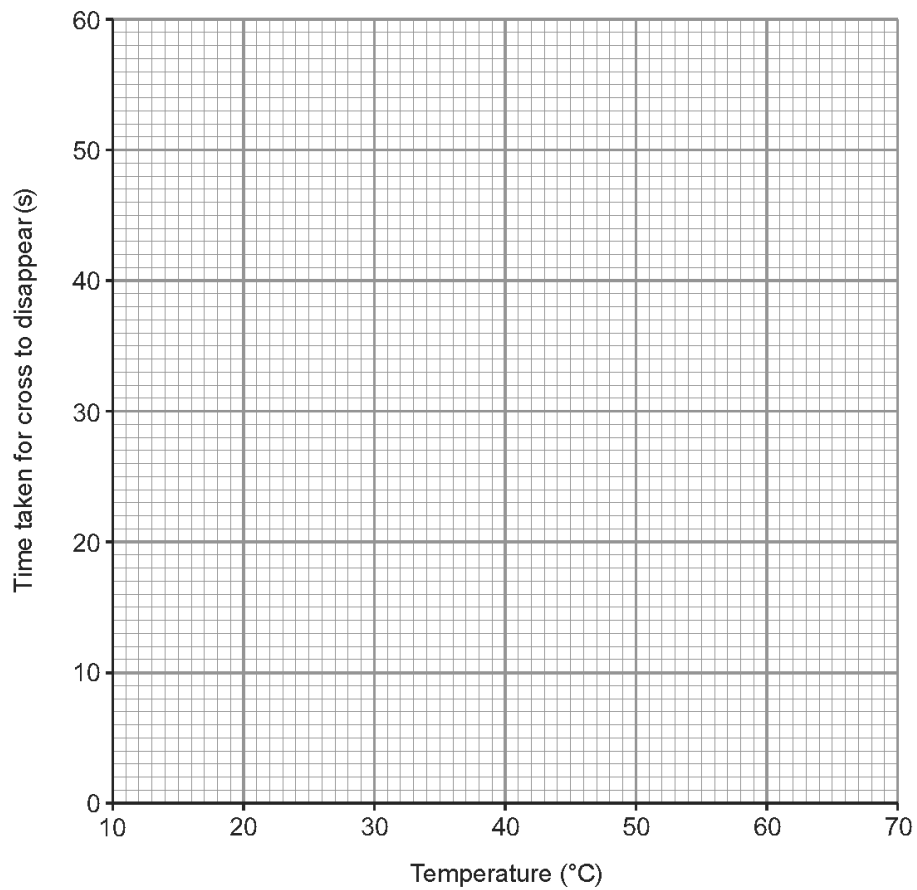


A pupil studied the effect of temperature on the reaction and obtained the following results.

Temperature (°C)	20	30	40	50	60
Time taken for cross to disappear (s)	50	32	25	20	17

(a) (i) Plot the results on the grid below and draw a suitable line.

[3]



(ii) Describe the trend in the results.

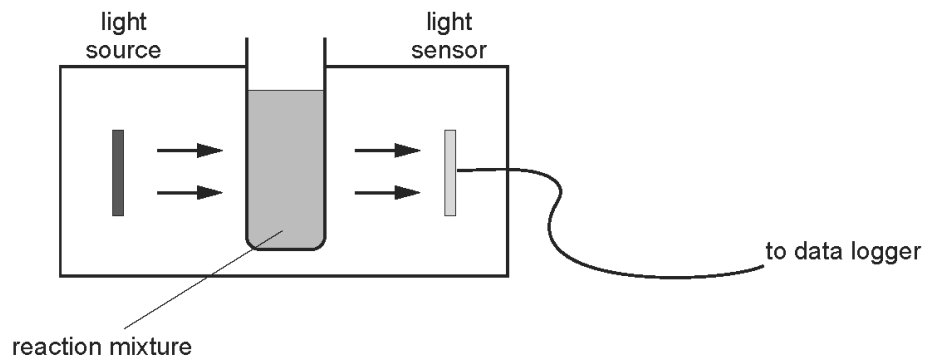
[1]

.....

.....

(iii) A second student carried out the same experiment using a higher concentration of acid. Draw the line you would expect him to obtain on the same grid. [1]

(b) Another student suggested using a light sensor and data logger to study the reaction rate.



Describe how the light intensity detected by the sensor would change during the reaction and give **one** advantage of using a light sensor. [2]

.....

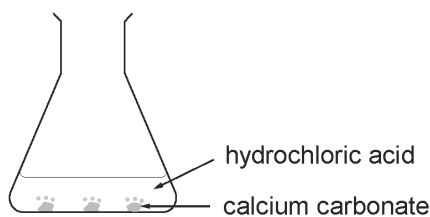
.....

.....

7

3.

An investigation was carried out to find the effect of different factors on the rate of reaction of calcium carbonate and hydrochloric acid.



The time taken for the calcium carbonate to disappear in each experiment is shown in the table below.

Experiment number	Form of calcium carbonate	Temperature of acid (°C)	Time taken for calcium carbonate to disappear (s)
1	marble chips	20	600
2	powder	20	150
3	marble chips	40	400

(a) (i) Use the results to describe the effect of changing temperature on reaction time. [1]

.....
.....

(ii) Name the factor that has changed between experiments 1 and 2 and describe what effect this factor has on reaction time. [2]

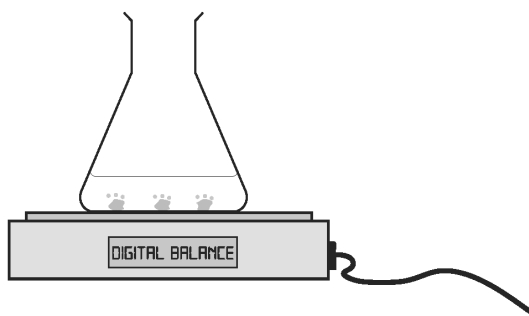
.....
.....

(iii) State **two other** factors that should be kept the same in order to make this investigation a fair test. [2]

Factor 1

Factor 2

(b) The rate of reaction can also be investigated by recording the change in mass.



Explain what will happen to the mass during the reaction.

[2]

.....

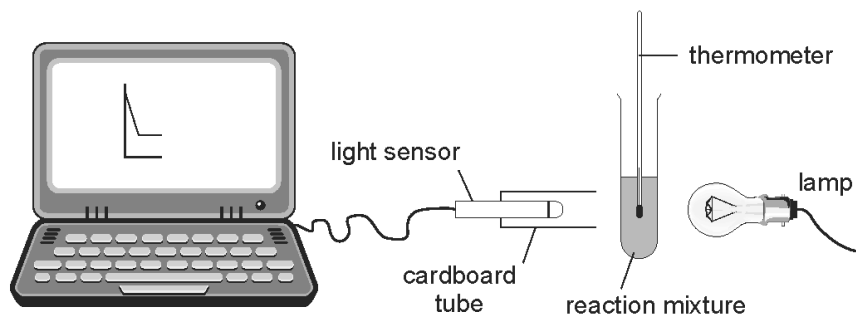
.....

.....

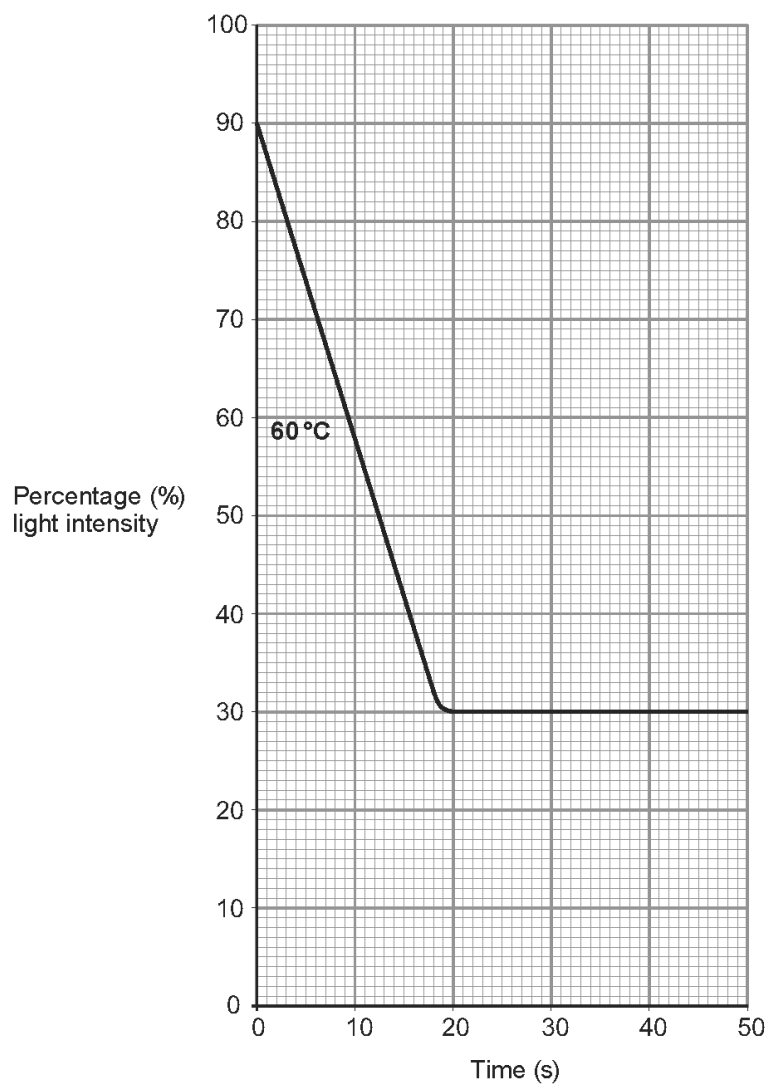
7

4.

Sodium thiosulfate solution reacts with dilute hydrochloric acid forming a yellow precipitate. This reaction was investigated using the equipment below.



5 cm³ of dilute hydrochloric acid was added to 10 cm³ sodium thiosulfate solution at 60 °C and the light intensity was measured over time. The results are shown on the grid below.



(a) Use the graph to find the time taken for the reaction to stop. [1]

Time = s

(b) The experiment was repeated at 40°C. The reaction stopped after 35s. Carefully draw the graph of this experiment on the same grid. [1]

(c) Explain why the light intensity decreases as this reaction takes place. [2]

.....
.....

(d) Suggest one possible reason why the light intensity does not fall to 0%. [1]

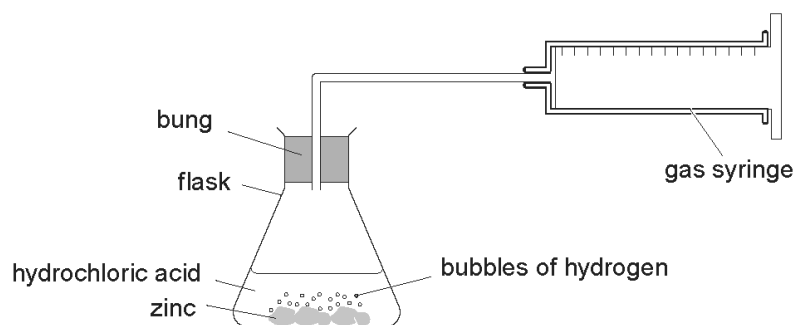
.....

5

5.

(a) Zinc reacts with dilute hydrochloric acid to produce hydrogen gas.

The diagram below shows apparatus that can be used to investigate the rate of the reaction between zinc and hydrochloric acid. A small amount of copper sulfate is added because it acts as a catalyst for the reaction.



A few pieces of zinc were placed in excess dilute hydrochloric acid and the volume of hydrogen produced was recorded every 10 seconds. The experiment was carried out at room temperature. The results obtained are shown below.

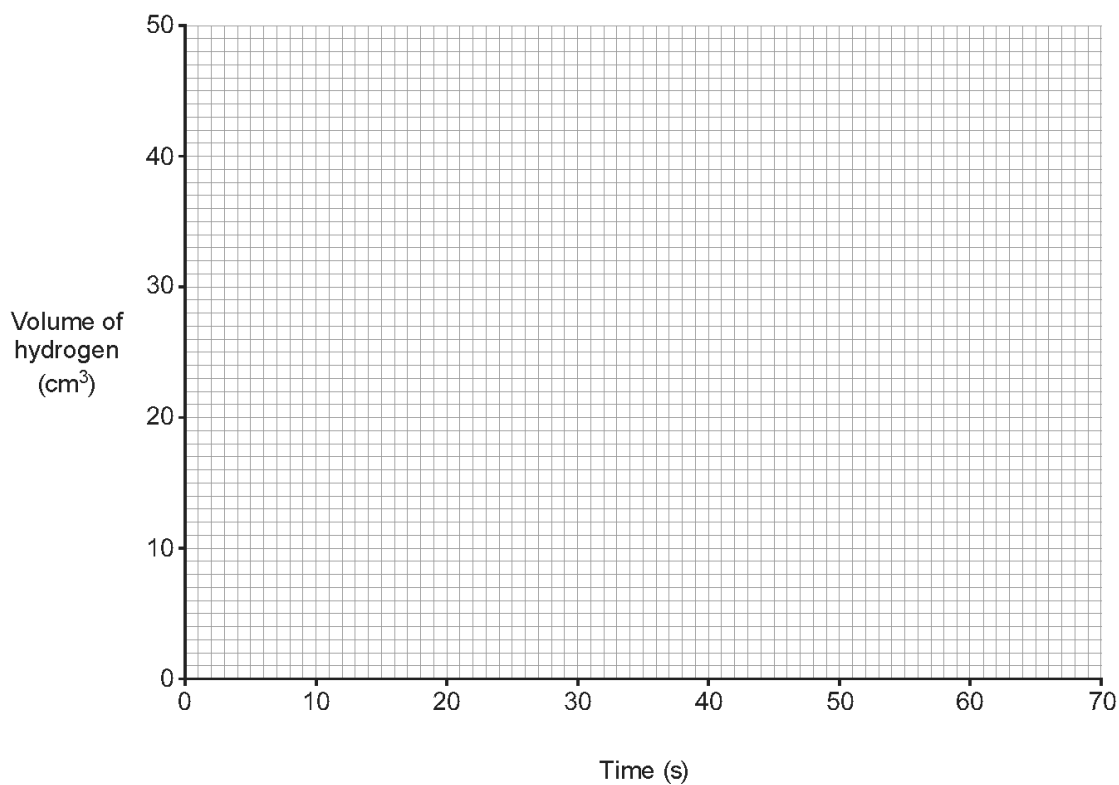
Time (s)	0	10	20	30	40	50	60	70
Volume of hydrogen (cm ³)	0	8	33	40	45	48	49	49

- (i) All the results were measured accurately but the volume recorded after 10 seconds is lower than expected. Suggest a possible reason for this. [1]

.....

.....

- (ii) Plot all the results from the table on the grid below and draw a suitable line. [3]



- (iii) Use your graph to give the volume of hydrogen expected after 10 seconds. [1]

..... cm³

- (iv) State how the graph shows that the reaction has stopped. [1]

.....
.....

(v) Choose statements from the box below to complete the following sentences.

less time	more time	the same time
-----------	-----------	---------------

Each statement may be used once, more than once or not at all. [2]

Using zinc powder instead of the larger pieces of zinc the reaction takes

.....

When the experiment is repeated without the copper sulfate catalyst the reaction

takes

(b) A chemical reaction takes twice as long if the temperature is decreased by 10°C.

At 30°C, milk undergoes a chemical reaction that makes it go sour in 1 day.

Calculate how long it will take milk to go sour at 10°C. [2]

.....

.....

10

Marking Scheme

1.

Question Number		Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT							
7		(a)	(i)	2	collection of gas (e.g. in a gas syringe or gas jar) (1) experiment repeated with different particle size of zinc (1)	mass method disappearing zinc		
			(ii)	2	same mass (or amount) of zinc / same volume (or amount) of acid / same concentration of acid / same temperature or room temperature – any two for (1) each		repeat readings same apparatus	
			(iii)	1	the fastest is the experiment that gives the volume of gas in the least time	fastest reaction is the one giving off most bubbles in a given time		
		(b)	(i)	1	less time / time decrease		faster reaction	
			(ii)	1	volume of gas remains the same			

2.

Question Number		Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT							
6		(a)	(i)	3	all points plotted correctly (2) 4 correct (1) smooth curve through points (1)			line drawn using ruler
			(ii)	1	the higher the temperature, the shorter the time / faster the reaction / higher the rate	'faster the rate'		'faster / quicker the time'
			(iii)	1	curve must be below original curve and steeper – ignore end point			
		(b)		2	light intensity decreases (1) continuous readings / graph plotted automatically / more precise end point (1)	light blocked more reliable than eyesight / more repeatable / no judgement required	reference to 'reliability' or 'accuracy' or to 'human error' needs qualification	'no chance of human error'

3.

Question Number		Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT							
3		(a)	(i)	1	the higher the temperature the shorter the reaction time	higher temp, faster reaction		
			(ii)	2	surface area (1) the greater the surface area the shorter the reaction time / faster reaction (1) or particle size (1) the smaller the particle size the shorter the reaction time / faster reaction (1) both marks could be credited for one statement e.g. smaller particles react faster	'form' of calcium carbonate 'powder takes less time than chips'		molecules become smaller
			(iii)	2	volume of acid (1) concentration of acid (1) mass/weight of calcium carbonate (1) max (2)	'amount of' once only	pH type of acid	
		(b)		2	mass decreases (1) gas / carbon dioxide lost from container / released (1)	gets lighter	gas produced	incorrect gas named

4.

Question Number		Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT							
5		(a)		1	value in the range 19–20			
		(b)		1	line right of original graph from (0,90) to (35,30) – tolerance of 1 small square			
		(c)		2	precipitate formed/insoluble substance formed (1) light cannot travel through/ stops light / blocks light (1)	goes cloudy/ milky		
		(d)		1	any of following (apparatus) not light tight / light can get in around tube precipitate formed not dense enough / thick enough / precipitate formed does not block all the light		light all around / light present	

5.

Question Number		Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
5		(a)	(i)	1	gas escaped during time taken to place the bung in the flask	gas syringe 'sticks'	human error	
			(ii)	3	all points plotted correctly [$\pm\frac{1}{2}$ square] (2) seven points plotted correctly (1) smooth curve drawn, not passing through (10,8) (1)	curve through (10,8) if (0,0) not plotted		
			(iii)	1	value read correctly from graph [$\pm\frac{1}{2}$ cm ³] ecf possible from any curve – except to give 8			8
			(iv)	1	line continues horizontally / volume stops increasing		straight line	
			(v)	2	less time (1) more time (1)			
		(b)		2	4 days - correct answer only (2) if answer incorrect (1) for any indication of correct working e.g. from 30-20°C doubles time from 1 day to 2 days			