Controlling Reactions

Q1. (2018) – 18c, 18d

18 A student investigates the reaction between marble chips, $CaCO_3$, and hydrochloric acid.

Calcium chloride, $CaCl_2$, carbon dioxide and water are made.

A)

(c) The rate of reaction between marble and hydrochloric acid can be decreased by:

- Using a more dilute solution of hydrochloric acid
- Cooling the acid.

Explain how each of these methods make the reaction slower.

Use ideas about collisions between particles.

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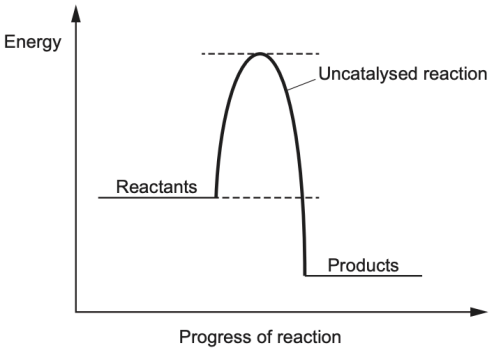
B)

(d) A catalyst can be used to increase the rate of a reaction.

Look at the energy profile diagram for a reaction **without** a catalyst.



Complete the energy profile diagram to show

(i) The reaction profile for the reaction with a catalyst. **[1]**

C)

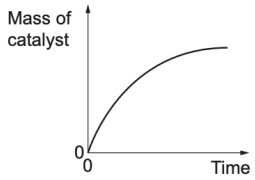
(ii) Label the **activation energy** for the reaction **with** a catalyst. **[1]**

Q2. (2019)

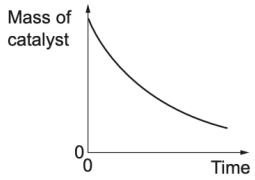
8 A catalyst can be used to increase the rate of a reaction.

Which graph shows the **mass of the catalyst** as the reaction takes place?

A



B



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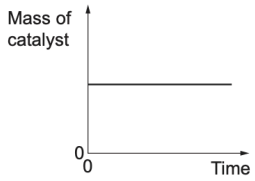
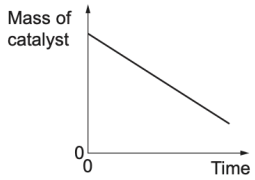


D

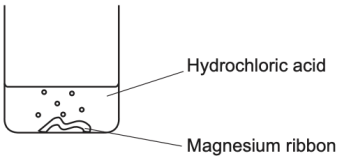


Your answer ☐ **[1]**

Q3. (2019) – 19b, 19c

19 A student investigates the reaction between magnesium and dilute hydrochloric acid, HC*l*.

The student adds magnesium ribbon to hydrochloric acid in a beaker, as shown in the diagram.



A)

(b)* The student measures the time it takes for all the magnesium to react. This is the reaction time.

The student does five experiments.

This is the student's prediction:

"The smaller the volume of acid and the greater the concentration of acid, the faster the reaction rate."

Look at the student's results.

Experiment	Mass of magnesium used (g)	Volume of acid used (cm^3)	Concentration of acid (mol/dm^3)	Reaction time (s)
1	0.05	25	1.0	30
2	0.05	50	1.0	30
3	0.05	50	2.0	15
4	0.10	25	1.0	30
5	0.10	50	2.0	15

Describe and explain whether the student's results support his prediction.

Include ideas about the reacting particle model in your answer.

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B)

(c) The student repeats experiment **1**. This time he uses acid at a **higher** temperature.

Explain, using the reacting particle model, **what happens to the rate of reaction** and **predict the reaction time** for this reaction.

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Q4. (2020)

1 A student investigates the decomposition of hydrogen peroxide.

$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

0.2 g of oxygen gas is produced in the reaction.

The student uses 0.5 g of manganese(IV) oxide as a catalyst in the reaction.

How much manganese(IV) oxide remains at the end of the reaction?

A 0.2 g

B 0.3 g

C 0.5 g

D 0.7 g

Your answer ☐ **[1]**

Q5. (2020)

6 Enzymes are a type of catalyst.

Which of the following catalysts is an example of an enzyme?

A Amylase – a catalyst found in human saliva.

B Iron – a catalyst used in the Haber process.

C Manganese(IV) oxide – a catalyst used in the decomposition of hydrogen peroxide.

D Vanadium(V) oxide – a catalyst used in the Contact process.

Your answer ☐ **[1]**

Q6. (2020)

15 The rate of reaction of marble chips with dilute hydrochloric acid depends on the surface area of the marble chips.

Which surface area of the marble chips gives the **highest** rate of reaction?

A $0.673\,mm^2$

B $1030\,mm^2$

C $2.18 \times 10^3\,mm^2$

D $4.98 \times 10^{-2}\,mm^2$

Your answer ☐ **[1]**

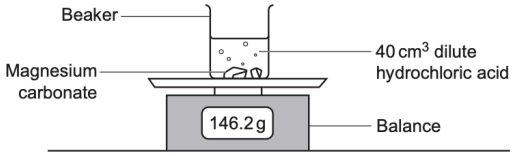
Q7. (2020) – 19b (ii, iii)

Context:

19 A student investigates the rate of reaction between dilute hydrochloric acid and magnesium carbonate.

She wants to find out how the concentration of the acid changes the rate of reaction.

Look at the apparatus she uses.



Carbon dioxide gas is given off in the reaction.

The student measures the loss in mass every 30 seconds for 5 minutes.

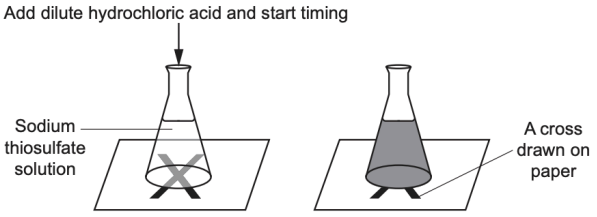
(a) Another student also investigates the rate of reaction between dilute hydrochloric acid and magnesium carbonate.

He also wants to find out how the **concentration** of the acid changes the rate of reaction. He uses a **different** method.

(b) The students now investigate the reaction between sodium thiosulfate and dilute hydrochloric acid.

They want to find out how **temperature** changes the rate of reaction.

Look at the diagram of their experiment.



A yellow solid is made during the reaction.

The students time how long it takes for the cross to disappear. This is the reaction time.

Look at their results.

Temperature (°C)	Reaction time (s)	Rate of reaction (s^{-1})
10	140	7×10^{-3}
20	56	2×10^{-2}
30	34	3×10^{-2}
40	26	4×10^{-2}
50	22	5×10^{-2}

Question:

A)

(ii) What happens to the **rate of reaction** as the temperature increases?

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B)

(iii) Explain your answer to **(b)(ii)**.

Use ideas about collisions between particles in your answer.

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Q8. (2021)

2 Lumps of zinc react with dilute sulfuric acid.

What change would **decrease** the rate of this reaction?

A Further diluting the sulfuric acid with water.

B Using a larger volume of sulfuric acid.

C Using warmer sulfuric acid.

D Using zinc powder instead of zinc lumps.

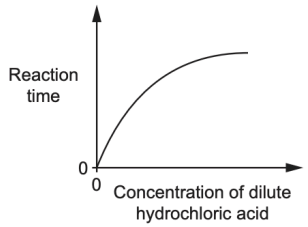
Your answer ☐ **[1]**

Q9. (2021)

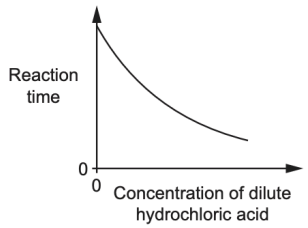
11 A student investigates the reaction between magnesium and dilute hydrochloric acid.

Which graph shows the effect of the **concentration** of the dilute hydrochloric acid on the reaction time?

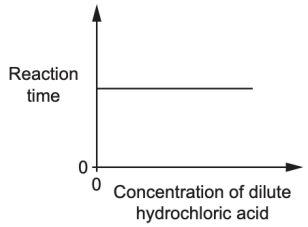
A



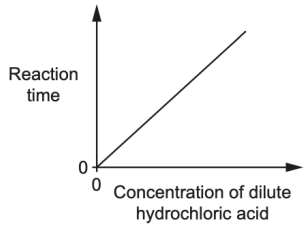
B



C



D



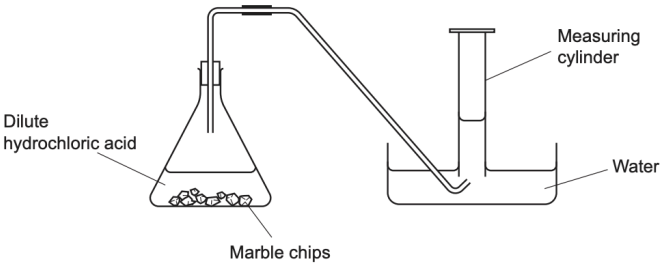
Your answer ☐ **[1]**

Q10. (2021) – 18d

18 A student investigates the rate of reaction between large marble chips and dilute hydrochloric acid.

The student measures the volume of carbon dioxide gas given off every 30 seconds.

Look at the apparatus they use.



(d)* Another student investigates the effect of changing the temperature of the dilute hydrochloric acid on the rate of the reaction.

The table shows the student's results.

Experiment	Concentration of acid (g/dm^3)	Temperature (°C)	Time for reaction to finish (s)
1	10	20	300
2	10	40	80
3	40	40	20

Explain, using the student's results and the reacting particle model, the effect of changing the temperature and of changing the concentration on the **rate** of this reaction.

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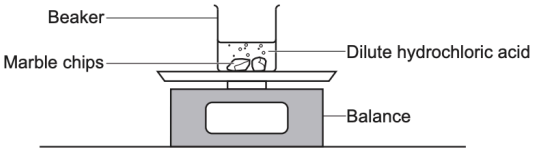
Q11. (2022)

2 Dilute hydrochloric acid reacts with marble chips.



Which statement about the reaction is correct?

A The reaction is faster after 10 seconds than it is after 3 seconds.

B The reaction slows down with time.

C The reaction proceeds at a constant rate.

D The mass of the beaker and its contents stay the same.

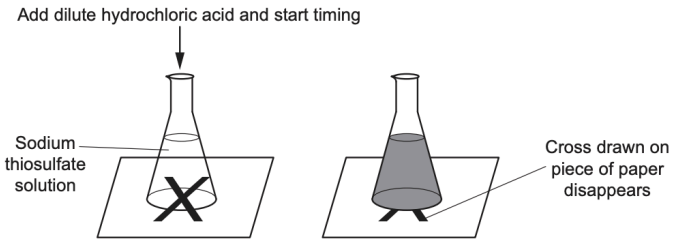
Your answer ☐ **[1]**

Q12. (2022)

5 A student investigates the reaction between sodium thiosulfate solution and dilute hydrochloric acid.

They want to find out how temperature changes the rate of reaction.

The diagram shows their experiment.



Which two variables should the student keep constant in the experiment?

	Variables	
A	temperature	volume of hydrochloric acid
B	time	volume of sodium thiosulfate
C	volume of hydrochloric acid	time
D	volume of hydrochloric acid	volume of sodium thiosulfate

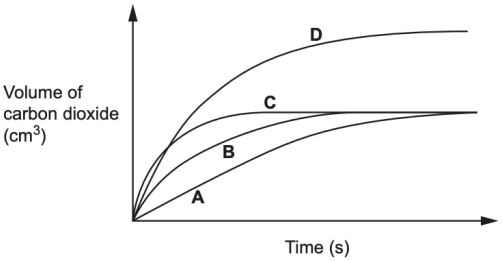
Your answer ☐ **[1]**

Q13. (2022)

9 A student reacts dilute hydrochloric acid with marble chips. Carbon dioxide gas is made.

- The student repeats the experiment with different size marble chips.
- They use 20 g of marble chips in each experiment.

The graph shows the student's results



Which line shows the result for the **smallest** marble chips?

Your answer ☐ **[1]**

Q14. (2022) – 16b, 16c, 16d, 16e, 16f

16 Hydrogen peroxide, H_2O_2, is used as a source of oxygen gas.

Hydrogen peroxide decomposes to make oxygen gas, O_2, and water.

A)

(b) The decomposition of hydrogen peroxide is very slow at room temperature. The reaction can be speeded up by adding a catalyst.

- A student investigates the decomposition of hydrogen peroxide using two different catalysts, **A** and **B**.
- The student uses 50 cm^3 of hydrogen peroxide and 0.5 g of the catalyst in each experiment.

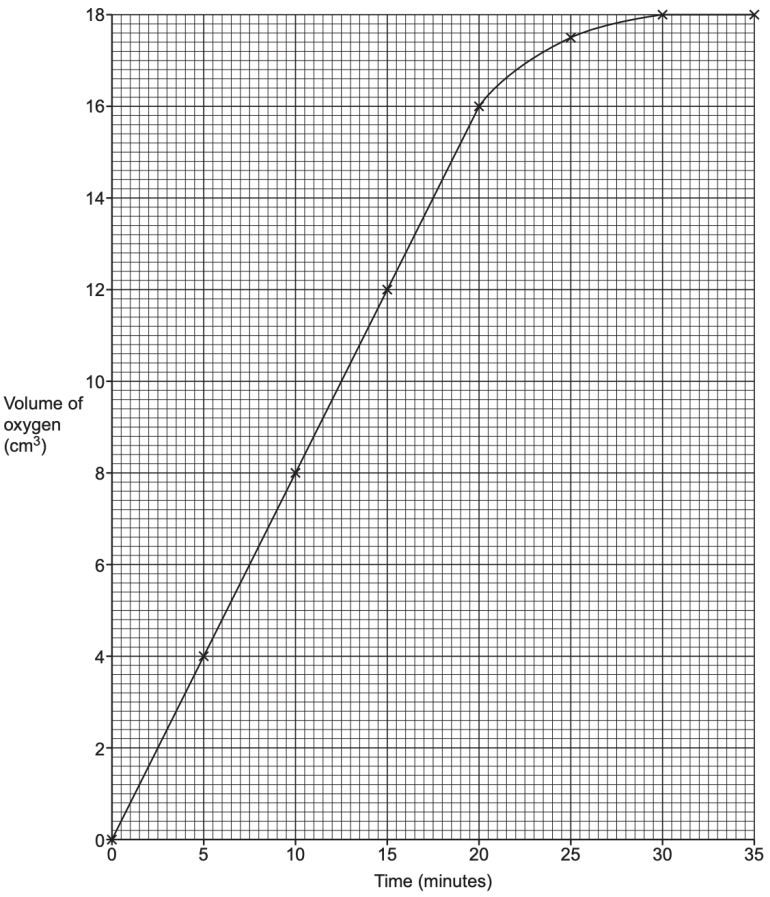
The table shows the student's results.

	Volume of oxygen (cm^3)	
Time (minutes)	Catalyst **A**	Catalyst **B**
0	0.0	0.0
5	4.0	5.0
10	8.0	10.0
15	12.0	15.0
20	16.0	16.5
25	17.5	18.0
30	18.0	18.0
35	18.0	18.0

The results for catalyst **A** are shown on **Fig. 16.1**.

Plot the results for catalyst **B** on **Fig. 16.1** and draw a line of best fit. **[2]**

Fig. 16.1



B)

(c) The student thinks catalyst **B** is the better catalyst.

Explain why the student is correct. Use data from the graph.

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C)

(d) The volume of oxygen made in each experiment is 18 cm^3.

Explain why it is the same value.

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..... **[1]**

D)

(e) The student repeats the experiment with **1.0 g** of catalyst **A** instead of 0.5 g.

What is the volume of oxygen gas made at the end of the experiment?

Volume of oxygen gas = ... cm^3 **[1]**

E)

(f) The student thinks the decomposition of hydrogen peroxide will be faster at 30 °C than at room temperature.

Describe an experiment the student could do, and its results, to show the reaction is faster at 30 °C.

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Q15. (2022) – 18g

18 The table shows information about some compounds of carbon.

Compound	Formula
A	C_2H_4
B	C_2H_5OH
C	C_3H_7COOH
D	C_4H_{10}
E	C_6H_{14}

(g) Most cars have catalytic converters which catalyse the reaction between nitrogen monoxide and carbon monoxide to make nitrogen and carbon dioxide gases.

(i) Explain how the use of a catalyst in the catalytic converter increases this rate of reaction.

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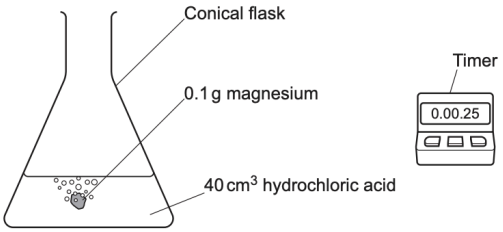
Q16. (2023) – 18b

18 A teacher investigates the reaction between hydrochloric acid and magnesium.

The diagram shows the teacher's experiment.



The teacher uses five different concentrations of hydrochloric acid. Each time they react the hydrochloric acid with 0.1 g of magnesium powder.

The table shows the teacher's results.

Concentration of hydrochloric acid (mol / dm^3)	Time for magnesium powder to react (s)
0.5	117
1.0	82
1.5	48
2.0	24
2.5	16

(b) The teacher says, 'The reaction is faster the more concentrated the hydrochloric acid'.

Use the results to explain why the teacher is **correct**.

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..... **[1]**

Q17. (2024)

13 Which statement about activation energy is correct?

A Activation energy is increased by the addition of a catalyst.

B Activation energy is lowered when the temperature is increased.

C Activation energy is the minimum amount of energy for a reaction to occur.

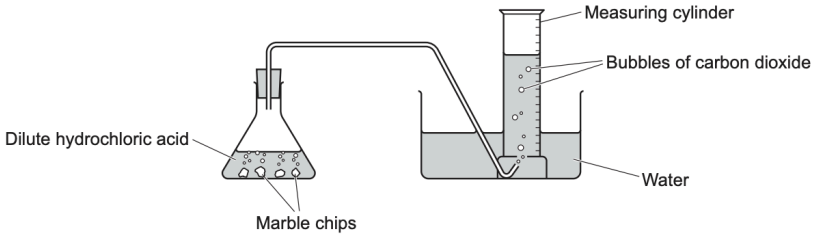
D The greater the activation energy, the greater the rate of reaction.

Your answer ☐ **[1]**

Q18. (2024) – 22d

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

The diagram shows their experiment.



The student measures the volume of carbon dioxide gas collected in the measuring cylinder every 30 seconds.

(d)* Another student reacts dilute hydrochloric acid with magnesium.

The student does two experiments.

In each experiment they use the **same**
- concentration of dilute hydrochloric acid
- mass of magnesium.

The table shows their results.

	Experiment 1	**Experiment 2**
Magnesium	large pieces	small pieces
Temperature of dilute hydrochloric acid (°C)	20	42
Rate of reaction (/s)	0.0044	0.04

Evaluate the student's results, explaining the difference in the rate of reaction.

Use the reacting particle model.

State how the student's experiment could be improved.

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