AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.6.1 RATE OF REACTION (PACK 2)

SCORE	PERCENTAGE
/239	%

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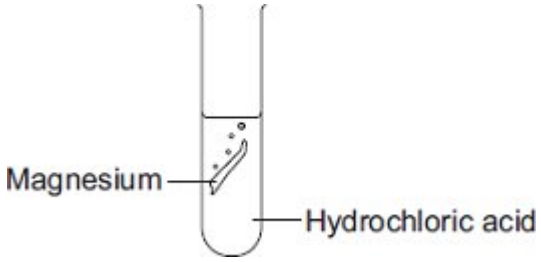
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Q1.

A student investigated the reaction between magnesium and hydrochloric acid.



The equation for the reaction is:

$$\underset{\text{magnesium}}{Mg(s)} + \underset{\text{hydrochloric acid}}{2\,HCl(aq)} \longrightarrow \underset{\text{magnesium chloride}}{MgCl_2(aq)} + \underset{\text{hydrogen}}{H_2(g)}$$

(a) Give **two** observations the student could make during the reaction.

1. _____

_____

2. _____

_____

(2)

(b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The student investigated how the rate of this reaction changed when the concentration of hydrochloric acid was changed.

Write a plan the student could use.

In your plan you should:

- describe how you would carry out the investigation and make it a fair test
- describe the measurements you would make.

_____

_____

_____

_____

_____

_____

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_____

_____

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_____

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_____

_____

_____

(6)

(Total 8 marks)

Q2.

(a) Ammonia solution is used in cleaning products to remove grease from kitchen surfaces.



Ammonia solution is alkaline.

(i) Draw a ring around the number most likely to be the pH of ammonia solution.

1 **3** **7** **10**

(1)

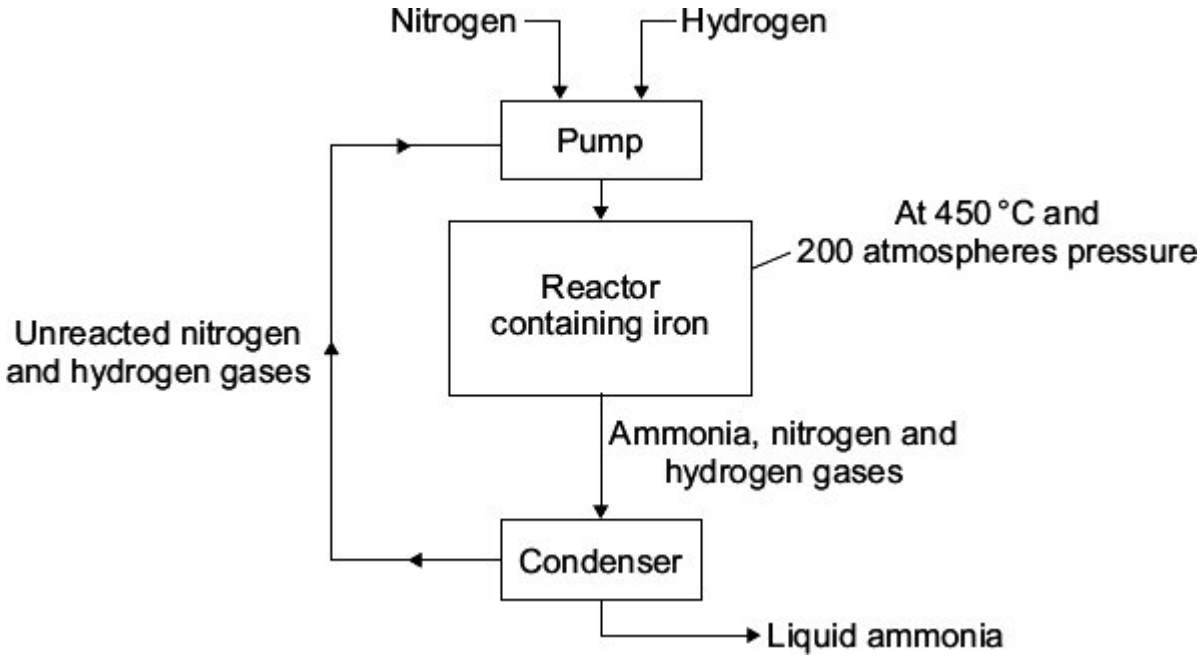
(ii) Draw a ring around the ion in ammonia solution which makes it alkaline.

Cl^- **H^+** **Na^+** **OH^-**

(1)

(b) Ammonia is made using the Haber process.

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(i) Where does the nitrogen used in the Haber process come from?

Draw a ring around your answer.

air **natural gas** **water**

(1)

(ii) A high temperature of 450 °C is used in the reactor.

Tick (✓) **two** reasons in the table which explain why high temperatures make reactions faster.

Reasons	**Tick (✓)**
Particles move faster	
Particles are closer together	
Particles collide more often	
Particles have less energy	

(2)

(iii) The iron in the reactor speeds up the reaction but is not used up.

What is the name given to substances that speed up the chemical reaction but which are not used up during the reaction?

_____

(1)

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(c) Complete the sentence.

The condenser separates the ammonia from the unreacted nitrogen and hydrogen

by turning the ammonia into a _____

(1)

(Total 7 marks)

Q3.

(a) The symbol equation for the decomposition of hydrogen peroxide is:

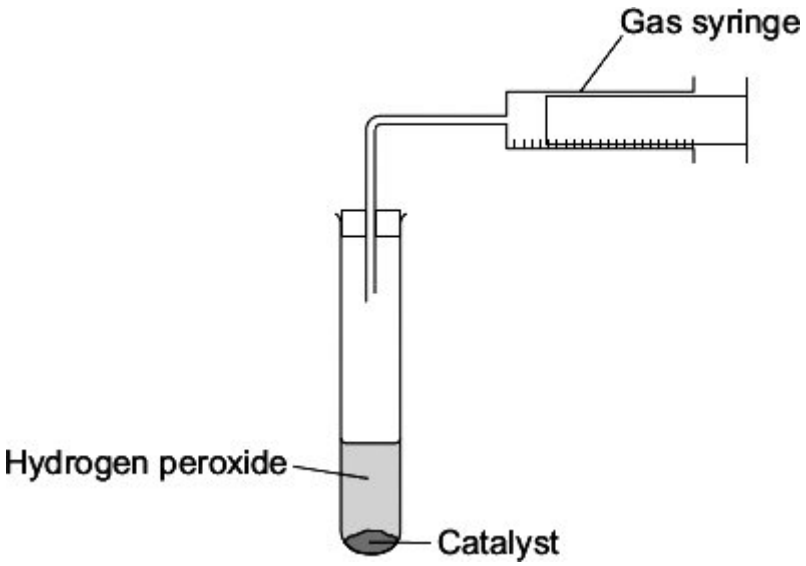
$$2H_2O_2 \rightarrow 2H_2O + O_2$$

Complete the word equation for the decomposition of hydrogen peroxide.

Hydrogen peroxide → _____ + _____

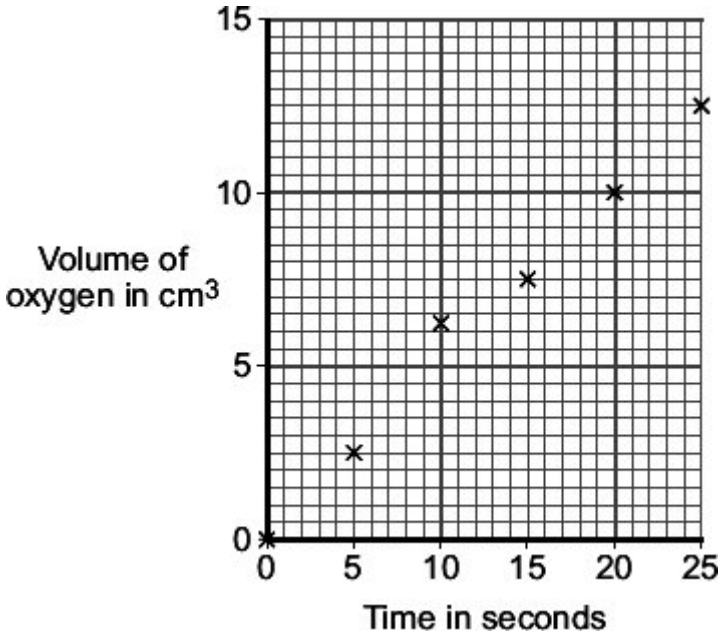
(1)

(b) A student did an experiment to see how quickly hydrogen peroxide decomposes. The student used the apparatus shown below to measure the volume of oxygen.



(i) Draw a straight line of best fit to complete the graph.

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(1)

(ii) Draw a circle around the anomalous point on the graph.

(1)

(iii) What is the volume of oxygen given off after 15 seconds?

_____ cm^3

(1)

(iv) How did the volume of oxygen change between 0 and 25 seconds?

_____

(1)

(c) The student wanted to make the reaction faster.

Draw a ring around the correct answer to complete each sentence.

(i) To make the reaction faster, the temperature should be

higher.
lower.
the same.

(1)

(ii) To make the reaction faster, the hydrogen peroxide should be

more dilute.
more concentrated.
the same.

(1)

(d) The diagram represents the bonding in oxygen.

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O=O

Draw a ring around the correct answer to complete each sentence.

(i) When two oxygen atoms bond, the atoms [share / transfer / delocalise] electrons.

(1)

(ii) The oxygen atoms are joined by [ionic / metallic / covalent] bonds.

(1)

(iii) Oxygen is made of [simple molecules. / a giant lattice. / macromolecules.]

(1)

(e) When hydrogen peroxide decomposes water is produced.
Which **two** statements in the table explain why water is a liquid at room temperature?

Tick (✓) the **two** statements.

Statement	Tick (✓)
Water has a boiling point of 100 °C.	
Water is made of ions.	
Water has a melting point lower than room temperature.	
Water has a giant covalent structure.	

(2)

(Total 12 marks)

Q4.

The symbol equation for the decomposition of hydrogen peroxide is:

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

(a) This reaction is *exothermic*.

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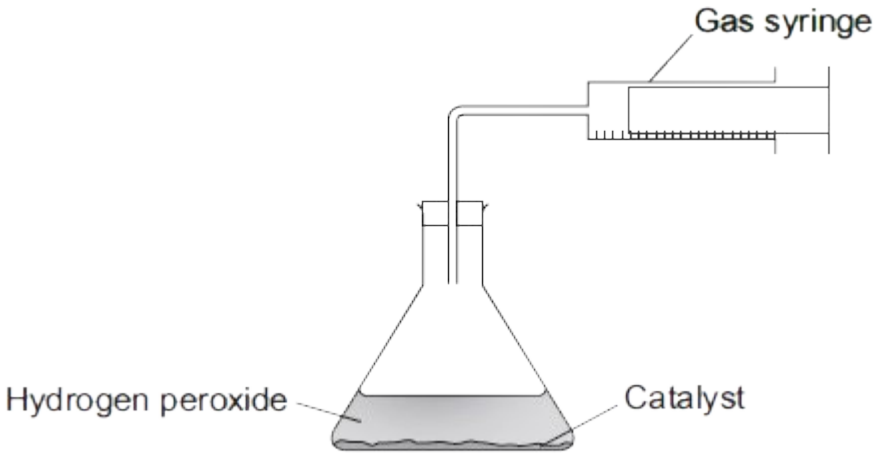
What is an *exothermic* reaction?

_____

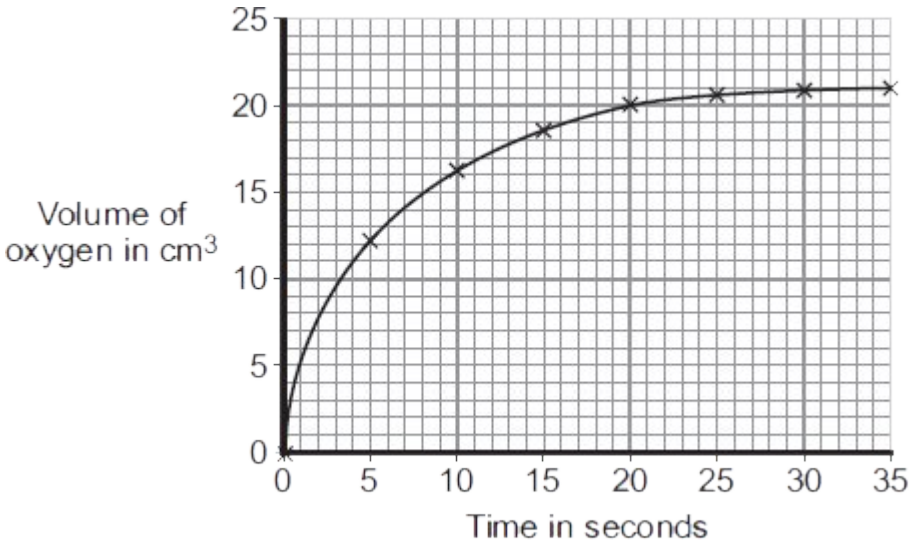
_____

(1)

(b) A student measured the volume of oxygen produced by 50 cm^3 of hydrogen peroxide.



The graph shows the results.



(i) Use the graph to describe the changes in the rate of the reaction from 0 to 35 seconds.

_____

_____

_____

_____

_____

_____

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(3)

(ii) What was the total volume of oxygen gas collected?

_____ cm^3

(1)

(iii) The student had calculated that the hydrogen peroxide used should produce 25 cm^3 of oxygen.

Calculate the percentage yield of oxygen.

_____

_____

_____

Answer = _____ %

(2)

(c) An increase in the temperature of the hydrogen peroxide increases the rate of the reaction.

Use your knowledge of particles to explain why.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

Q5.

This question is about gold (Au).

(a) An atom of gold is represented as:

$$^{197}_{79}Au$$

How many neutrons are in this atom of gold? _____

(1)

(b) Gold ions are used as a catalyst.

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How does a gold atom (Au) become a gold ion (Au^{3+})?

_____

_____

_____

_____

(2)

(c) A gold catalyst can be used when carbon monoxide reacts with oxygen to make carbon dioxide.

(i) Complete and balance the equation for this reaction.

__ CO + _____ → ___ CO_2

(2)

(ii) Carbon dioxide has a very low boiling point.

Explain why.

_____

_____

_____

_____

_____

_____

(3)

(d) Gold is used as a catalyst in industrial processes. Gold is rare and increasingly expensive.

Suggest **three** reasons why gold is still used in industrial processes.

_____

_____

_____

_____

_____

_____

(3)

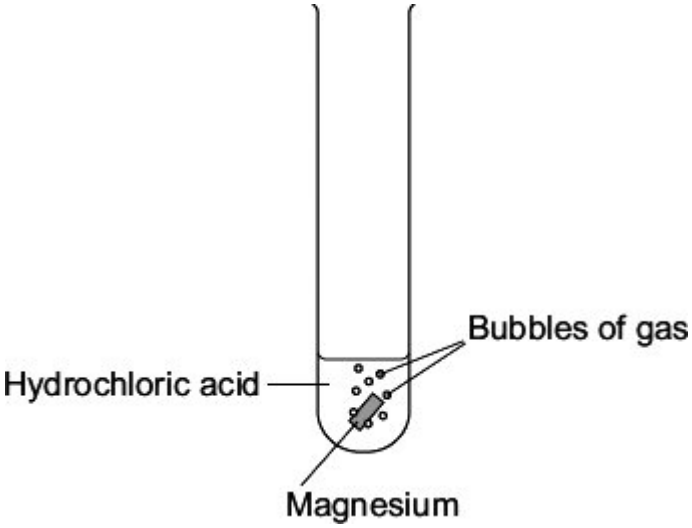
(Total 11 marks)

Q6.

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A student investigated the reaction of magnesium with hydrochloric acid.

(a) A piece of magnesium was dropped into the hydrochloric acid.



Bubbles of gas were produced and the magnesium disappeared.

The reaction is exothermic.

(i) What measurements would the student make to show that the reaction is exothermic?

_____

_____

_____

_____

(2)

(ii) How would these measurements show that the reaction is exothermic?

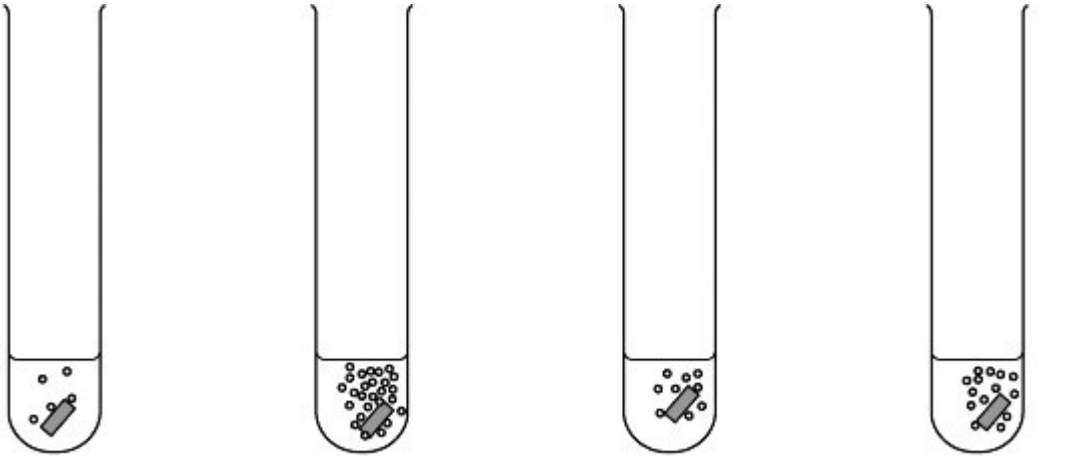
_____

(1)

The student investigated how changing the concentration of the hydrochloric acid affects this reaction.

Each test tube contained a different concentration of hydrochloric acid.
The diagrams show the results of this experiment.

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(b) Suggest **one** control variable in this investigation.

_____

_____

(1)

(c) (i) Which test tube, **A**, **B**, **C** or **D**, contained the greatest concentration of hydrochloric acid?

Test tube ☐

(1)

(ii) Why did you choose this test tube?

_____

_____

(1)

(d) The student predicted that if the temperature of the acid was increased the reaction would take place faster.

Tick (✓) **two** statements in the table which explain why.

Statement	Tick (✓)
The particles move faster	
The particles collide with less energy	
The particles collide more often	
The particles are bigger	

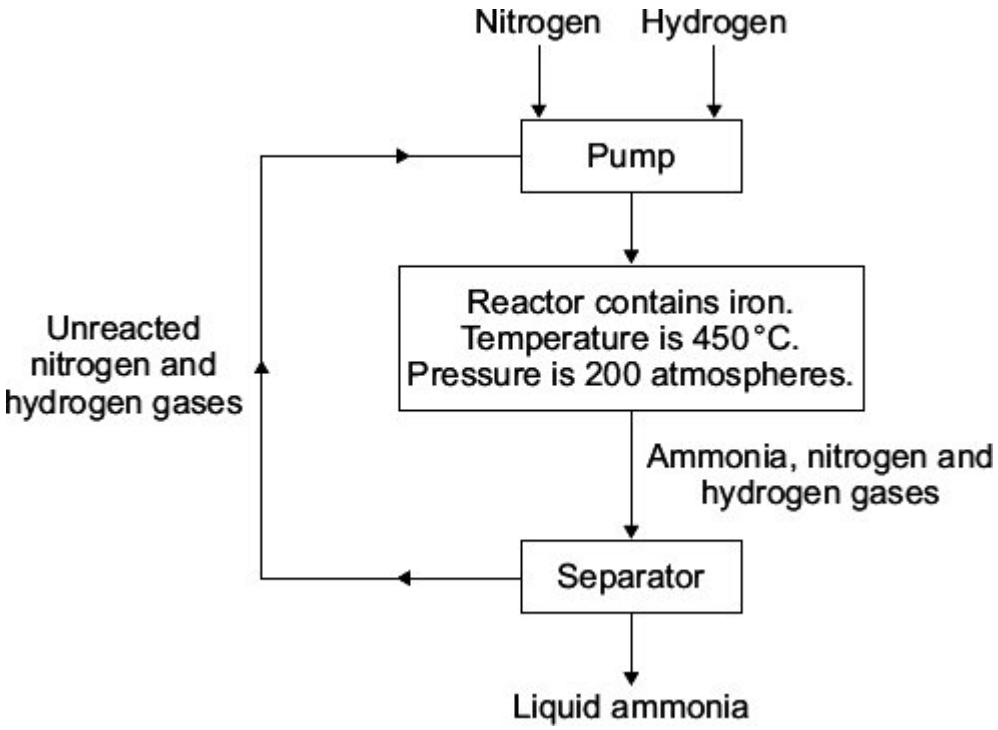
(2)

(Total 8 marks)

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Q7.

Ammonia is made using the Haber process.



(a) How is ammonia separated from unreacted nitrogen and hydrogen in the separator?

_____

_____

_____

_____

(2)

(b) The equation shows the reaction which takes place in the reactor:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(i) Why does the yield of ammonia at equilibrium increase as the temperature is decreased?

_____

_____

(1)

(ii) A temperature of 450 °C is used in the reactor to make the reaction take place quickly.

Explain, in terms of particles, why increasing the temperature makes a reaction go faster.

_____

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_____

_____

_____

(2)

(iii) Why does the yield of ammonia at equilibrium increase as the pressure is increased?

_____

_____

(1)

(iv) The pressure used in the reactor is 200 atmospheres.
Suggest why a much higher pressure is **not** used.

_____

_____

(1)

(c) Use the equation for the reaction in the reactor to help you to answer these questions.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(i) It is important to mix the correct amounts of hydrogen and nitrogen in the reactor.

20 m^3 of nitrogen is reacted with hydrogen.

What volume of hydrogen (measured at the same temperature and pressure as the nitrogen) is needed to have the correct number of molecules to react with the nitrogen?

Volume of hydrogen needed = _____ m^3

(1)

(ii) Calculate the maximum mass of ammonia that can be made from 2 g of nitrogen.

Relative atomic masses: H = 1; N = 14.

_____

_____

_____

_____

_____

_____

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Maximum mass of ammonia = _____ g

(3)

(d) The expected maximum mass of ammonia produced by the Haber process can be calculated.

(i) In one process, the maximum mass of ammonia should be 80 kg.

The actual mass of ammonia obtained was 12 kg.

Calculate the percentage yield of ammonia in this process.

_____

_____

Percentage yield of ammonia = _____ %

(1)

(ii) Give **two** reasons why it does **not** matter that the percentage yield of ammonia is low.
Use the flow diagram at the start of this question to help you.

_____

_____

_____

_____

(2)

(Total 14 marks)

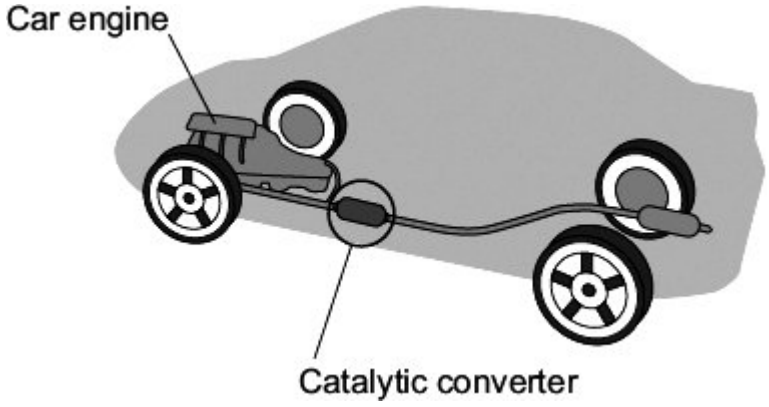
Q8.

Read the information about car engines.

Burning petrol in air is an exothermic reaction. This reaction is used in car engines.

When petrol burns it produces harmful substances such as nitrogen oxides and carbon monoxide.

A catalytic converter stops these harmful substances being released into the air.



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(a) Draw a ring around the correct answer to complete each sentence.

(i) The exothermic reaction makes the temperature

of the engine

decrease.
increase.
stay the same.

(1)

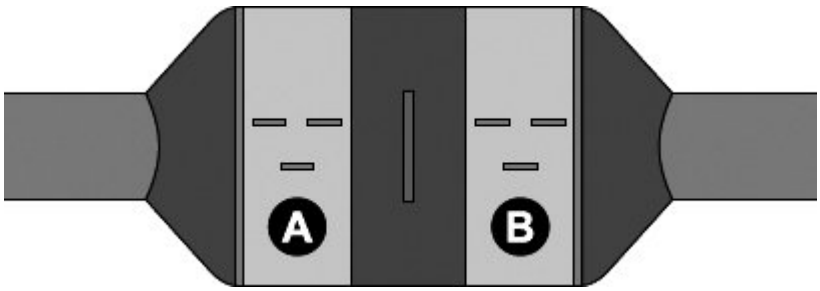
(ii) This is because during

exothermic reactions

energy is taken in from the surroundings.
energy is given out to the surroundings.
there is no energy change.

(1)

(b) The diagram shows a catalytic converter which removes harmful substances.
The catalytic converter has two parts, **A** and **B**, which contain different catalysts.



(i) The equation for the reaction that takes place in part **A** is:

$$2NO \rightarrow N_2 + O_2$$

Which **one** of the substances shown in the equation is a compound?

Give the formula of this compound.

_____

(1)

(ii) The equation for the reaction that takes place in part **B** is:

$$2CO + O_2 \rightarrow 2CO_2$$

Why is it important to stop carbon monoxide (CO) from being released into the air?

_____

_____

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(1)

(c) The table lists some statements about catalysts. Only **two** statements are correct.

Tick (✓) the **two** correct statements.

Statement	Tick (✓)
A catalyst can speed up a chemical reaction.	
A catalyst is used up in a chemical reaction.	
Different reactions need different catalysts.	
A catalyst does **not** change the rate of a chemical reaction.	

(2)

(d) Modern catalytic converters contain nanosized particles of catalyst.
Less catalyst is needed when nanosized catalyst particles are used.

(i) Complete the sentence.

The size of nanosized particles is _____ than normal sized particles.

(1)

(ii) The catalysts contain platinum.

Suggest why a manufacturer of catalytic converters would want to use less catalyst.

_____

_____

(1)

(Total 8 marks)

Q9.

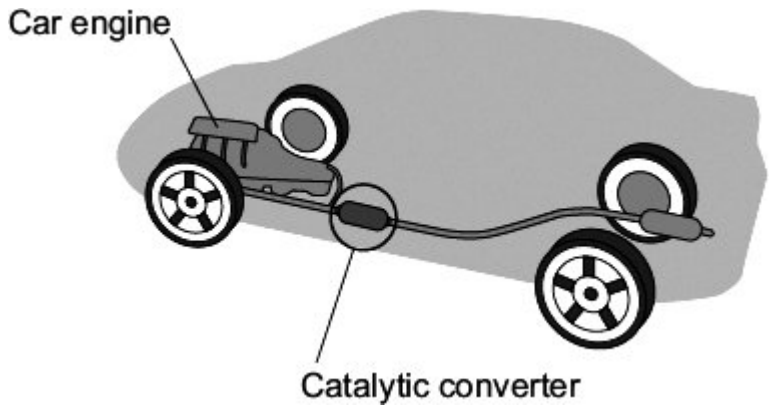
Read the information about car engines.

Burning petrol in air is an *exothermic* reaction. This reaction is used in car engines.

When petrol burns it produces harmful substances such as nitrogen oxides and carbon monoxide.

A catalytic converter stops these harmful substances being released into the air.

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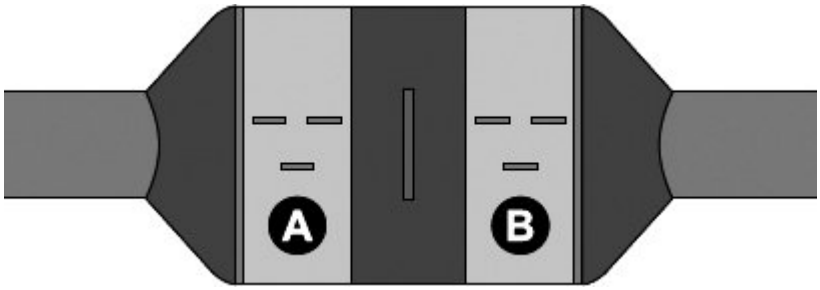
(a) The reaction is *exothermic*. What is the meaning of *exothermic*?

_____

_____

(1)

(b) The catalytic converter has two parts shown as **A** and **B** in the diagram.



Part **A** contains a catalyst made from platinum and rhodium.

Part **B** contains a catalyst made from platinum and palladium.

(i) Why are catalysts used in chemical reactions?

_____

_____

(1)

(ii) One reaction in part **A** is shown by this equation.

$$2NO \rightarrow N_2 + O_2$$

Suggest why this reaction helps the environment.

_____

_____

(1)

(iii) The equation for one of the reactions in part **B** is shown below.

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Balance this equation.

____ CO + O_2 → ____ CO_2

(1)

(iv) The catalytic converter works for many years without replacing the catalyst.

Explain why the catalyst does not need to be replaced.

_____

_____

(1)

(v) Suggest why different catalysts are used in parts **A** and **B**.

_____

_____

(1)

(c) Modern catalytic converters contain nanosized particles of catalyst. Using nanosized particles reduces the cost of the catalytic converter.

Suggest and explain why the use of nanosized catalyst particles reduces the cost of the catalytic converter.

Your answer should include information about the size and surface area of the particles.

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q10.

The picture shows a lump of phosphate rock.

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Rob Lavinsky, iRocks.com – CC-BY-SA-3.0 [CC-BY-SA-3.0], via Wikimedia Commons

Phosphoric acid is made by reacting phosphate rock with sulfuric acid.

Only **three** of the methods shown below will **increase** the rate of this reaction.

Put a **tick (✓)** next to each of the **three** methods that will **increase** the rate of this reaction.

Method	**Tick (✓)**
Use a more concentrated solution of sulfuric acid	
Use larger lumps of phosphate rock	
Cool the mixture of phosphate rock and sulfuric acid	
Grind the phosphate rock into a powder before adding the acid	
Increase the temperature of the sulfuric acid	
Dilute the sulfuric acid solution with water	

(3)

(Total 3 marks)

Q11.

The picture shows a lump of phosphate rock.

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Rob Lavinsky, iRocks.com – CC-BY-SA-3.0 [CC-BY-SA-3.0], via Wikimedia Commons

Phosphoric acid is made by adding sulfuric acid to phosphate rock.

(a) The rate of reaction between sulfuric acid and phosphate rock can be increased if the mixture is heated to a higher temperature.

Explain, in terms of particles, why an increase in temperature increases the rate of reaction.

_____

_____

_____

_____

_____

_____

(2)

(b) State **one** other way in which the rate of reaction between sulfuric acid and phosphate rock can be increased.

_____

_____

(1)

(Total 3 marks)

Q12.

Hydrogen peroxide decomposes slowly to give water and oxygen.

The reaction is *exothermic*.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

(a) In an *exothermic* reaction, energy is given out.

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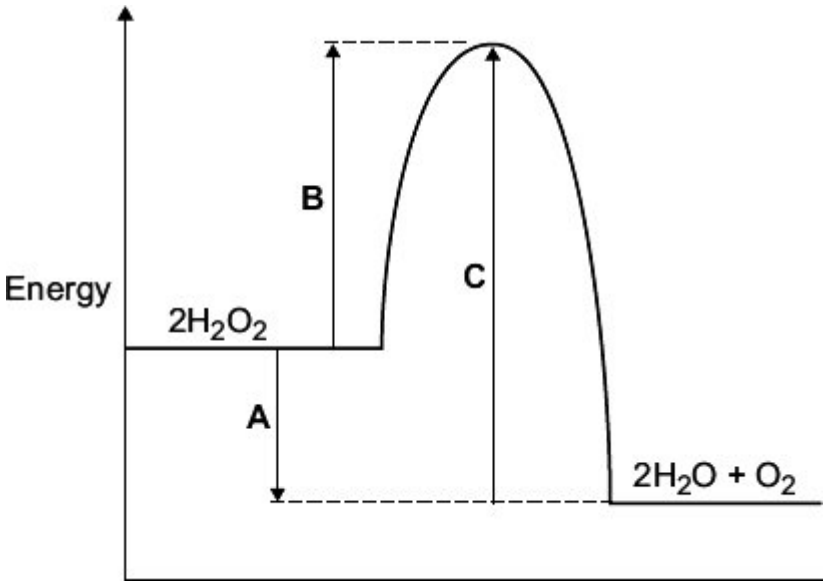
Draw a ring around the correct answer to complete the sentence.

In an *exothermic* reaction, the temperature

goes down.
goes up.
stays the same.

(1)

(b) The energy level diagram for this reaction is shown below.



The energy changes, **A**, **B** and **C**, are shown on the diagram.

Use the diagram to help you answer these questions.

(i) Which energy change, **A**, **B** or **C**, is the activation energy?

(1)

(ii) Which energy change, **A**, **B** or **C**, shows that this reaction is exothermic?

(1)

(iii) Hydrogen peroxide decomposes quickly when a small amount of manganese(IV) oxide is added.

Draw a ring around the correct answer to complete each sentence.

Hydrogen peroxide decomposes quickly because

manganese(IV) oxide is

a catalyst.
an element.

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a solid.

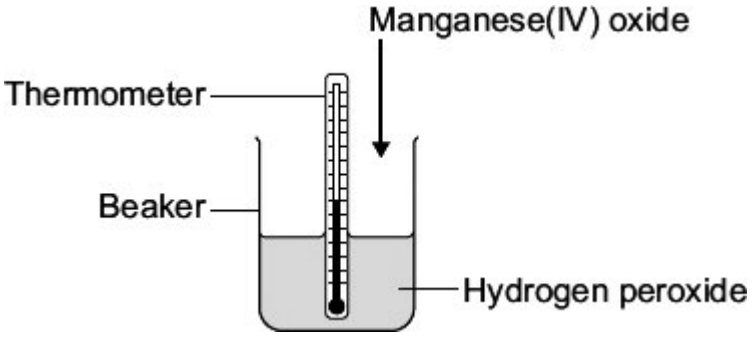
The manganese(IV) oxide has lowered the

activation energy.
boiling point.
temperature.

(2)

(c) A student did an experiment to find the amount of energy produced when hydrogen peroxide solution is decomposed using manganese(IV) oxide.

The apparatus the student used is shown in the diagram.



The student first measured the temperature of the hydrogen peroxide. Then the student added the manganese(IV) oxide, stirred the mixture and recorded the highest temperature.

(i) Suggest why the student stirred the mixture before recording the highest temperature.

_____

_____

(1)

(ii) The biggest error in this experiment is heat loss.

Suggest how the student could change the apparatus so that less heat is lost.

_____

_____

(1)

(Total 7 marks)

Q13.

Hydrogen peroxide decomposes to give water and oxygen.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

The reaction is *exothermic*.

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(a) Explain, in terms of bond breaking and bond making, why the decomposition of hydrogen peroxide is *exothermic*.

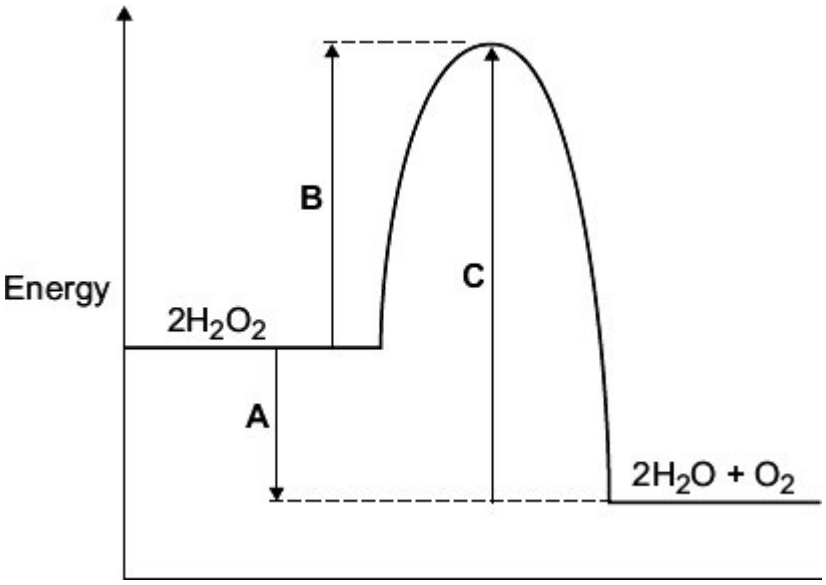
_____

_____

_____

(1)

(b) The energy level diagram for this reaction is shown below.



The energy changes, **A**, **B** and **C**, are shown on the diagram.

Use the diagram to help you answer these questions.

(i) How do you know that this reaction is *exothermic*?

_____

_____

_____

(1)

(ii) The decomposition of hydrogen peroxide is slow.
What does this suggest about energy change **B**?

_____

_____

_____

(1)

(iii) Hydrogen peroxide decomposes quickly when a small amount of manganese(IV) oxide is added.

Explain why.

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_____

_____

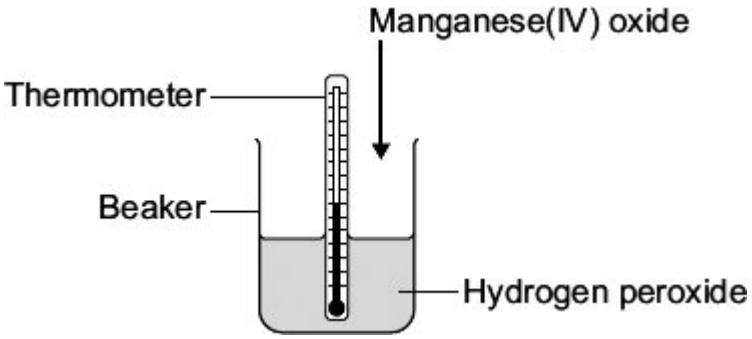
_____

_____

(2)

(c) A student did an experiment to find the amount of energy produced when hydrogen peroxide solution is decomposed using manganese(IV) oxide.

The apparatus the student used is shown in the diagram.



The student first measured the temperature of the hydrogen peroxide. Then the student added the manganese(IV) oxide and recorded the highest temperature.

The temperature rise was smaller than expected.

Suggest why.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q14.

Hydrogen fluoride is used to make hydrofluoric acid.

(a) A company makes hydrogen fluoride by reacting solid calcium fluoride with sulfuric acid. The reaction takes place in a rotating kiln.

calcium fluoride + sulfuric acid → calcium sulfate + hydrogen fluoride

The company want this reaction to take place quickly.

(i) Rotating the kiln makes the reaction take place faster.

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Suggest why.

_____

_____

(1)

(ii) Draw a ring around the correct word in each box.

To make the reaction take place **faster**:

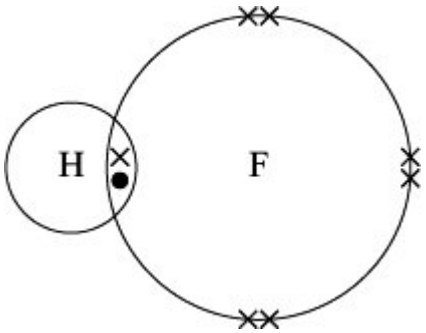
the temperature should be [higher / lower] so that the particles have [less / more] energy

the solid calcium fluoride should be [powder / lumps] to give a [small / big] surface area

the sulfuric acid solution should be [dilute / concentrated] to give [less / more] collisions between the particles each second.

(3)

(b) The diagram represents a molecule of hydrogen fluoride.



The hydrogen and fluorine atoms are joined by a covalent bond.

Use the correct word from the box to complete the sentence.

electrons	**neutrons**	**protons**

In a covalent bond the atoms share _____ .

(1)

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(c) Hydrogen fluoride is dissolved in water to make an acidic solution of hydrofluoric acid.

Draw a ring around the symbol of the ion that makes the solution acidic.

H^+ OH^- F^-

(1)

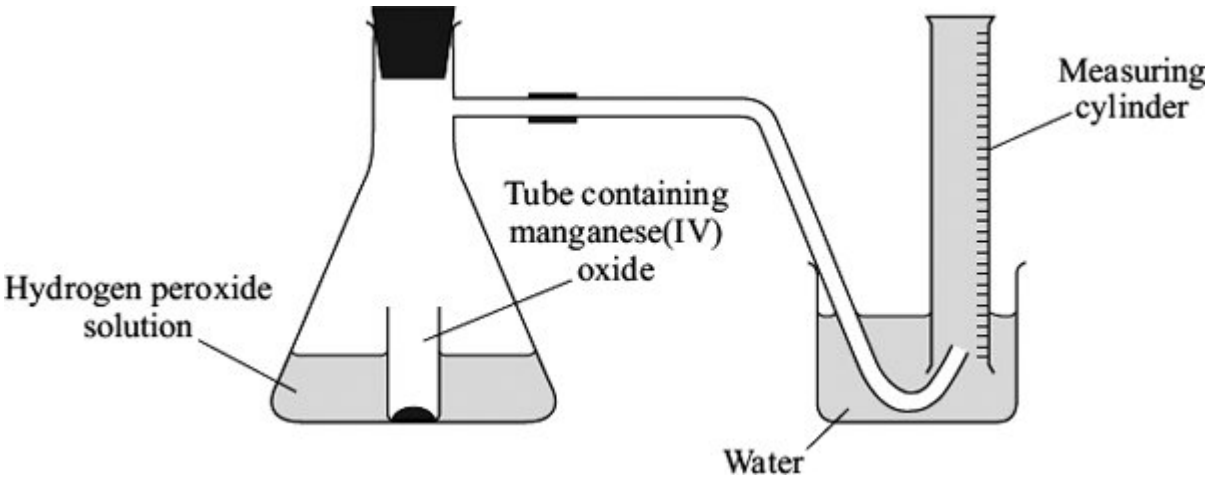
(Total 6 marks)

Q15.

A student investigated the effect of temperature on the decomposition of hydrogen peroxide.
Hydrogen peroxide decomposes to oxygen and water when a manganese(IV) oxide catalyst is added.

The student measured the time taken to collect 5 cm^3 of oxygen gas.

The apparatus shown below was used for the investigation. The reaction was started by shaking the flask so that the manganese(IV) oxide and hydrogen peroxide were mixed.



The student did the investigation at two different temperatures. All the other variables were kept constant.

The student's results are shown in the table.

Temperature of the hydrogen peroxide solution in °C	Volume of oxygen collected in cm^3	Time taken to collect the oxygen in seconds	Rate of reaction in cm^3 per second
20	5	40	0.125
25	5	25	

(a) (i) Calculate the rate of reaction at 25 °C.

_____

Rate of reaction = _____ cm^3 per second

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(2)

(ii) The teacher said that the student should repeat the investigation to get more results.

Suggest why.

_____

_____

(1)

(b) The student concluded that:

'the rate of reaction increases when the temperature is increased'.

Explain, in terms of particles, why the rate of reaction increases.

_____

_____

_____

_____

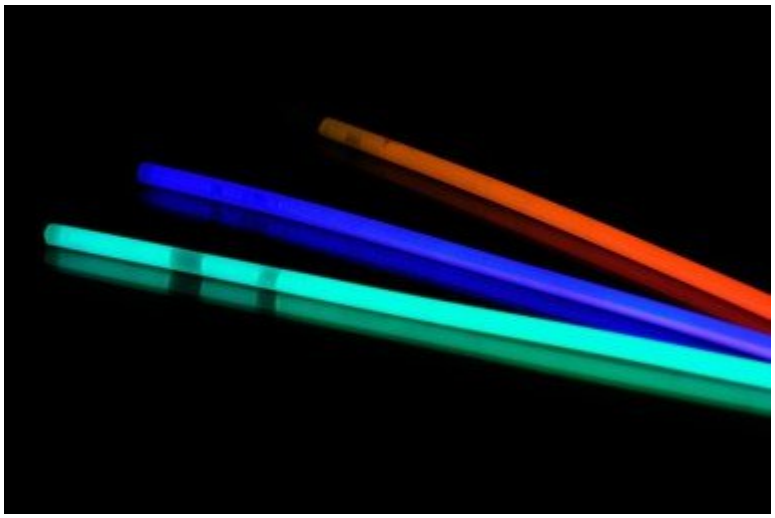
_____

(2)

(Total 5 marks)

Q16.

The picture shows three glowsticks.



Photograph supplied by iStockphoto/Thinktsock

Glow sticks contain several chemicals. When a glow stick is bent the chemicals mix. A chemical reaction takes place which causes light to be given out.

A student investigated three glow sticks. One was placed in water at 5 °C, one in water at 40 °C and one in water at 70 °C.

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The results are shown in the table.

Temperature in °C	Effect on glow stick	
	Brightness of light	Time it gave out light, in hours
5	dim	7
40	bright	3
70	very bright	1

(a) How did increasing the temperature affect the brightness of the glow stick?

_____

_____

(1)

(b) How did increasing the temperature affect the time it gave out light?

_____

_____

(1)

(c) The student was asked why an **increase** in temperature changes the rate of the chemical reaction. The student listed five ideas. Only **three** of them are correct.

Put ticks (✓) next to the **three** correct ideas.

Ideas	Ticks (✓)
The particles will collide more often.	
The particles will be more concentrated.	
The particles will move faster.	
The particles will have more energy.	
The particles will get bigger.	

(3)

(d) Suggest **one** way the student could improve this investigation.

_____

_____

(1)

(Total 6 marks)

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Q17.

The equation for a reaction to produce hydrogen is:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

(a) Explain why changing the pressure does **not** affect the yield of hydrogen at equilibrium.

_____

_____

(1)

(b) Suggest why the best yield of hydrogen at equilibrium is obtained at **low** temperatures.

_____

_____

(1)

(c) The temperature used in industry needs to be high enough for the reaction to take place quickly. Explain, in terms of particles, why the rate of reaction increases when the temperature is increased.

_____

_____

_____

_____

_____

_____

(3)

(d) Scientists have developed catalysts which allow the reaction to take place quickly at lower temperatures. How could this be good for the manufacturer and for the environment?

_____

_____

_____

_____

(2)

(Total 7 marks)

Q18.

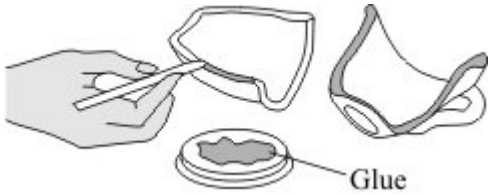
The following steps show how to use a type of glue.

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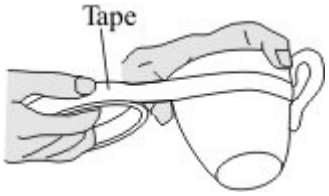
Step 1 Measure out equal amounts of the liquids from tubes **A** and **B**.



Step 2 Mix the liquids to make the glue.
Put a thin layer of the glue onto each of the surfaces to be joined.



Step 3 Assemble the pieces to be joined and then hold them together with tape.



Step 4 Leave the glue to set.

(a) When liquids **A** and **B** are mixed a chemical reaction takes place.

(i) This reaction is exothermic.

Complete the sentence below using a word or phrase from the box.

decrease	**increase**	**stay the same**

During the reaction the temperature of the mixture will _____ .

(1)

(ii) When the glue sets it forms a giant covalent structure.

Draw a ring around **one** property that you would expect the set glue to have.

good conductor of electricity **low melting point** **high melting point**

(1)

(b) The time taken for the glue to set at different temperatures is given in the table below.

Temperature in °C	Time taken for the glue to set
20	3 days

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60	6 hours
90	1 hour

(i) Complete the sentences below using words or phrases from the box.

decrease	**increase**	**stay the same**

When the temperature is increased the time taken for the glue to set

_____

When the temperature is increased the rate of the setting reaction

_____

(2)

(ii) Put a tick (✓) next to the **two** reasons why an increase in temperature affects the rate of reaction.

Reason	(✓)
It gives the particles more energy.	
It increases the concentration of the particles.	
It increases the surface area of the particles.	
It makes the particles move faster.	

(2)
(Total 6 marks)

Q19.

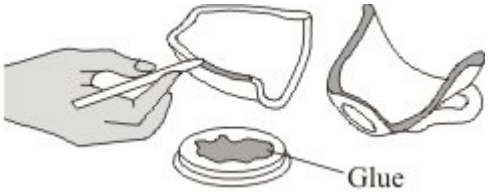
The following steps show how to use a type of glue.

Step 1 Measure out equal amounts of the liquids from tubes **A** and **B**.

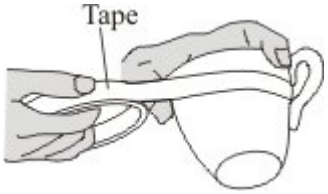


Step 2 Mix the liquids to make the glue.
Put a thin layer of the glue onto each of the surfaces to be joined.

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Step 3 Assemble the pieces to be joined and then hold them together with tape.



Step 4 Leave the glue to set.

(a) When liquids **A** and **B** are mixed a chemical reaction takes place.

(i) This reaction is exothermic.

State how the temperature of the mixture will change as the glue is mixed.

_____

_____

(1)

(ii) When the glue sets it forms a giant covalent structure.

Explain why substances with giant covalent structures have high melting points.

_____

_____

_____

_____

(2)

(b) The time taken for the glue to set at different temperatures is given in the table below.

Temperature in °C	Time taken for the glue to set
20	3 days
60	6 hours
90	1 hour

Explain, in terms of particles, why increasing the temperature changes the rate of the reaction which causes the glue to set.

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_____

_____

_____

_____

_____

(2)

(Total 5 marks)

Q20.

Aspirin tablets have important medical uses.



A student carried out an experiment to make aspirin. The method is given below.

1. Weigh 2.00 g of salicylic acid.
2. Add 4 cm^3 of ethanoic anhydride (an excess).
3. Add 5 drops of concentrated sulfuric acid.
4. Warm the mixture for 15 minutes.
5. Add ice cold water to remove the excess ethanoic anhydride.
6. Cool the mixture until a precipitate of aspirin is formed.
7. Collect the precipitate and wash it with cold water.
8. The precipitate of aspirin is dried and weighed.

(a) The equation for this reaction is shown below.

$C_7H_6O_3$ + $C_4H_6O_3$ → $C_9H_8O_4$ + CH_3COOH

salicylic acid — aspirin

Calculate the maximum mass of aspirin that could be made from 2.00 g of salicylic acid.

The relative formula mass (M_r) of salicylic acid, $C_7H_6O_3$, is 138

The relative formula mass (M_r) of aspirin, $C_9H_8O_4$, is 180

_____

_____

_____

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_____

Maximum mass of aspirin = _____ g

(2)

(b) The student made 1.10 g of aspirin from 2.00 g of salicylic acid.

Calculate the percentage yield of aspirin for this experiment.

(If you did not answer part (a), assume that the maximum mass of aspirin that can be made from 2.00 g of salicylic acid is 2.50 g. This is **not** the correct answer to part (a).)

_____

_____

_____

_____

Percentage yield of aspirin = _____ %

(2)

(c) Suggest **one** possible reason why this method does **not** give the maximum amount of aspirin.

_____

_____

(1)

(d) Concentrated sulfuric acid is a catalyst in this reaction.

Suggest how the use of a catalyst might reduce costs in the industrial production of aspirin.

_____

_____

(1)

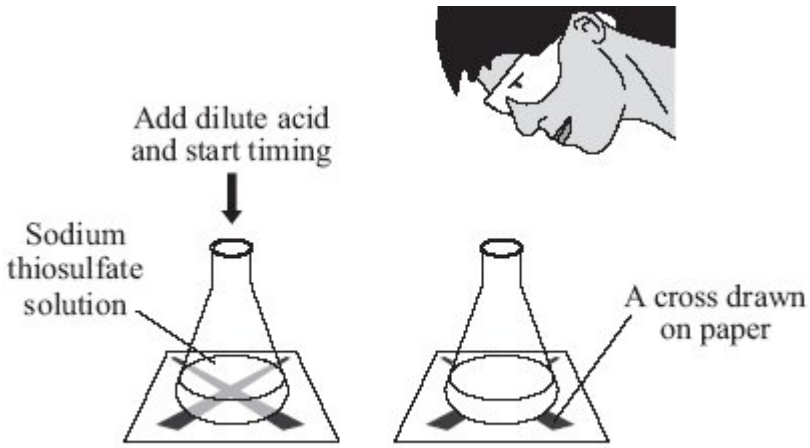
(Total 6 marks)

Q21.

Sodium thiosulfate solution reacts with hydrochloric acid. As the reaction takes place the solution slowly turns cloudy.

The diagram shows a method of measuring the rate of this reaction.

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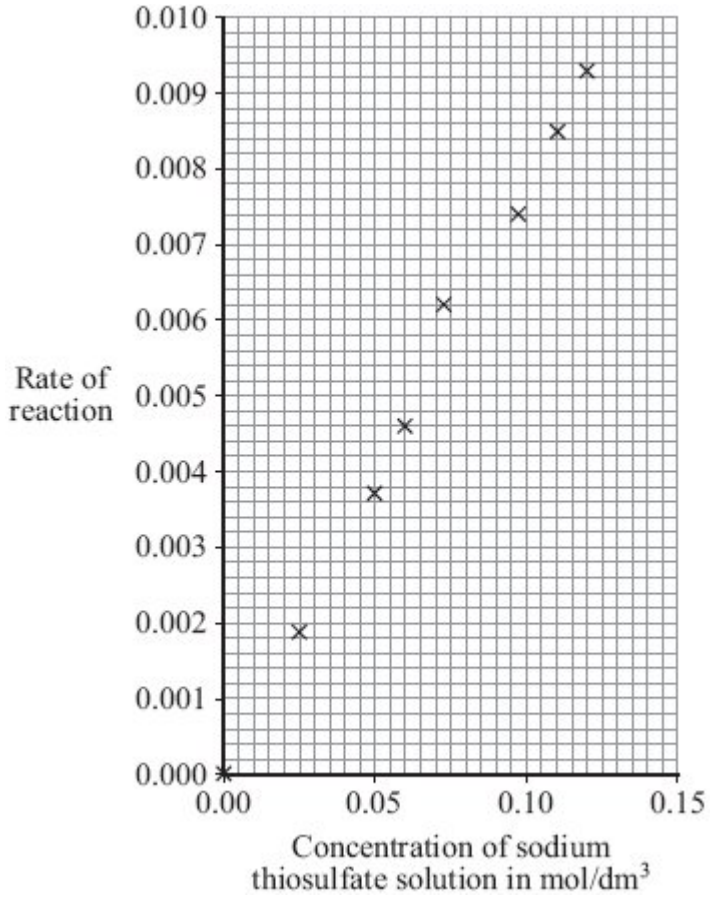


Time how long it takes for the cross to disappear

A student used this method to investigate how changing the concentration of the sodium thiosulfate solution affects the rate of this reaction.

The student used different concentrations of sodium thiosulfate solution. All the other variables were kept the same.

The results are shown on the graph below.



(a) (i) Draw a line of best fit on the graph.

(1)

(ii) Suggest **two** reasons why all of the points do not lie on the line of best fit.

1. _____

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_____

2. _____

_____

(2)

(b) (i) In a conclusion to the investigation the student stated that:

'The rate of this reaction is directly proportional to the concentration of the sodium thiosulfate solution.'

How does the graph support this conclusion?

_____

_____

(1)

(ii) Explain, in terms of particles, why the rate of reaction increases when the concentration of sodium thiosulfate is increased.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q22.



An airship caught fire when it was coming in to land in 1937. The airship was filled with hydrogen. A spark or flame ignited the hydrogen. The hydrogen reacted with oxygen in the air to produce water.

(a) The equation for the reaction can be represented using structural formulae for the chemicals.

$$2\ H – H + O = O \rightarrow 2\ H – O – H$$

Use the bond energies given in the table to help you to calculate the energy change for this reaction.

Bond	Bond energy in kJ per mole
H – H	436

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O = O	498
O – H	464

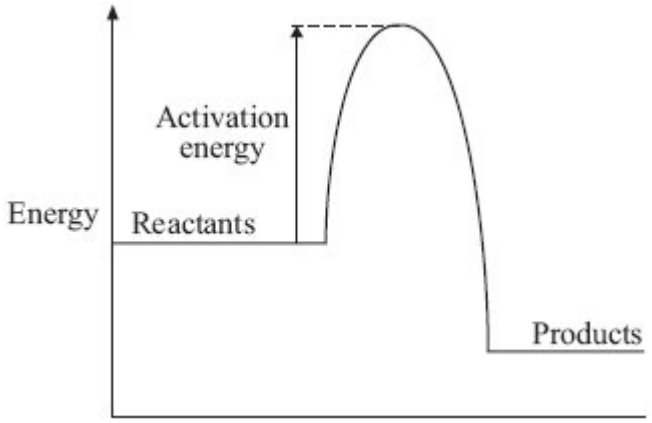
Energy change = _____ kJ

(3)

(b) Explain, in terms of making and breaking bonds, why this reaction is exothermic.

(1)

(c) Use the energy level diagram for this reaction to help you to answer these questions.



(i) The hydrogen did **not** burn until ignited by a spark or flame.

Explain why.

(1)

(ii) Platinum, a transition metal, causes hydrogen to ignite **without** using a spark or flame.

Explain why.

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_____

_____

_____

_____

(2)

(Total 7 marks)

Q23.

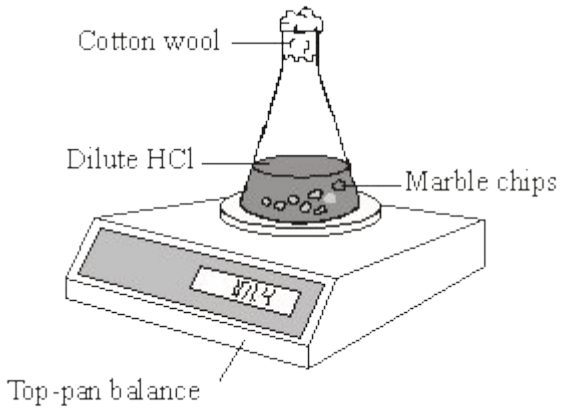
A student investigated the rate of reaction between marble and hydrochloric acid.

The student used an excess of marble.

The reaction can be represented by this equation.

$CaCO_3$ (s) + 2HC1 (aq) → $CaC1_2$ (aq) + H_2O (l) + CO_2 (g)

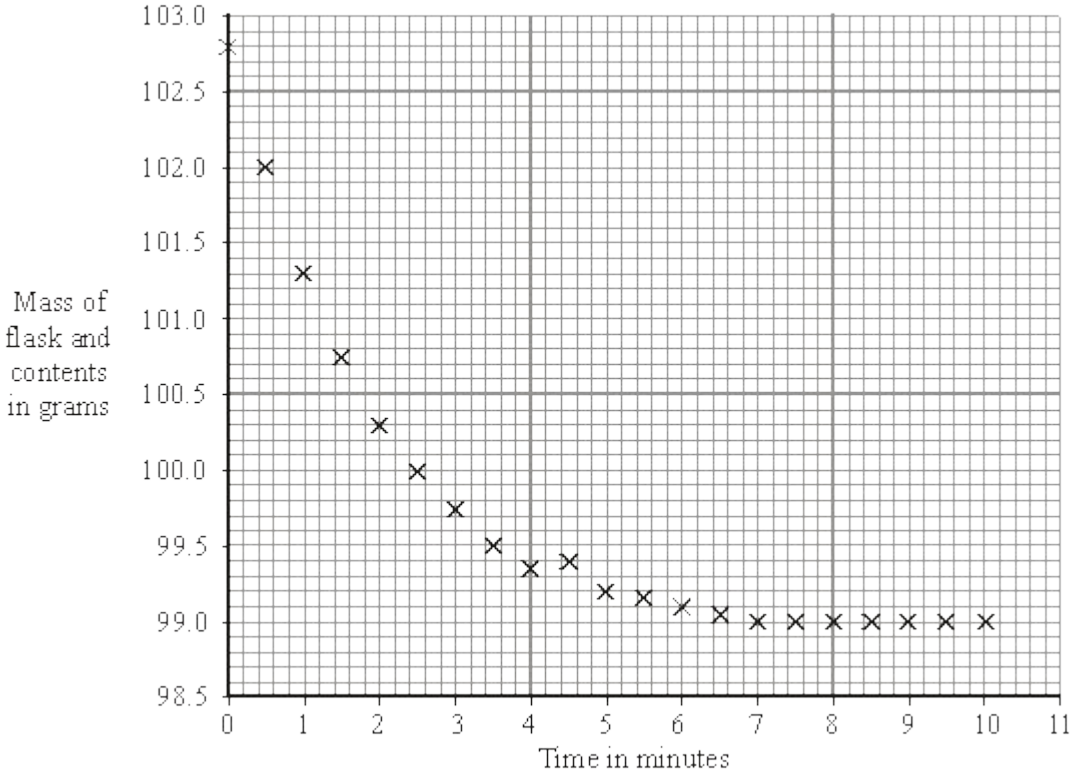
The student used the apparatus shown in the diagram.



The student measured the mass of the flask and contents every half minute for ten minutes.

The results are shown on the graph. Use the graph to answer the questions.

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(a) **Complete the graph** opposite by drawing a line of best fit.

(1)

(b) Why did the mass of the flask and contents decrease with time?

_____

_____

(1)

(c) After how many minutes had all the acid been used up?

_____ minutes

(1)

(d) The student repeated the experiment at a higher temperature. All other variables were kept the same as in the first experiment. The rate of reaction was much faster.

(i) Draw a line **on the graph** to show what the results for this second experiment might look like.

(2)

(ii) Why does an increase in temperature increase the rate of reaction?

_____

_____

_____

_____

_____

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_____

(3)

(Total 8 marks)

Q24.

This label was taken from a cola drink.



The pH of this drink is 2.5.

(a) (i) Which **one** of the ingredients in the cola drink causes the low pH?

_____

(1)

(ii) Draw a ring around the name of the ion that gives the cola drink its low pH.

chloride **hydrogen** **hydroxide** **sodium**

(1)

(b) The preservative used in the cola drink is sodium benzoate.
Sodium benzoate is made using two chemical reactions.

Reaction 1
Methylbenzene is reacted with oxygen, with the help of a catalyst, to form benzoic acid.

Reaction 2
Benzoic acid is neutralised by sodium hydroxide solution to form sodium benzoate and water.

(i) How does the catalyst help **reaction 1**?

_____

_____

(1)

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(ii) **Reaction 1** has a high atom economy.

The table lists several statements. Put a tick (✓) next to the **one** statement which best describes a high atom economy.

Statement	(✓)
All the atoms used are cheap.	
Most of the starting materials end up as useful products.	
Only a small number of atoms are used in the reaction.	

(1)

(iii) **Reaction 2** is a neutralisation reaction.

Complete the equation by writing the formula of the product.

$H^+ + OH^- \rightarrow$ _____

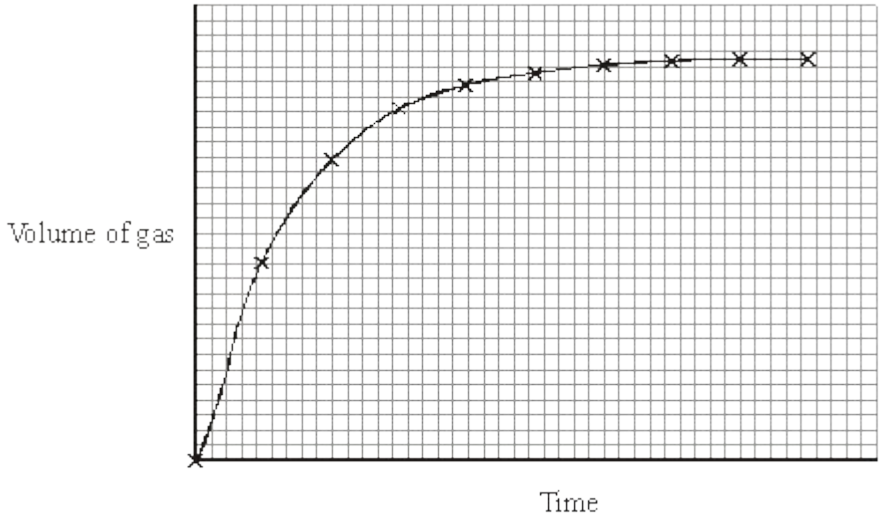
(1)

(Total 5 marks)

Q25.

Pieces of zinc react with dilute acid to form hydrogen gas.

The graph shows how the volume of hydrogen gas produced changes with time.



(a) Describe, as fully as you can, how the volume of gas produced changes with time.

_____

_____

_____

_____

(2)

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(b) A student wants to make the reaction take place faster.

Some suggestions are given in the table.

Put ticks (✓) next to the **two** suggestions that would make the reaction take place faster.

Suggestions	(✓)
Use bigger pieces of zinc.	
Use a more concentrated acid.	
Use zinc powder.	
Decrease the temperature of the acid.	

(2)

(Total 4 marks)

Q26.

Copper sulfate ($CuSO_4$) is a salt that has many uses.

An aqueous solution of copper sulfate can be made by reacting copper oxide (CuO) with an acid.

(a) (i) Name this acid. _____

(1)

(ii) Write a balanced symbol equation, including state symbols, for this reaction.

_____

(2)

(b) Copper oxide reacts much faster with acid at 40 °C than at 20 °C.

Explain why in terms of particles.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q27.

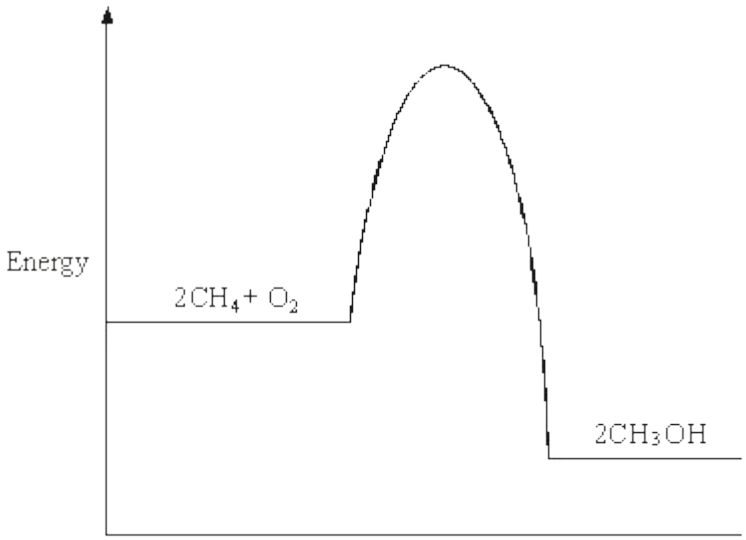
Methanol (CH_3OH) can be made by reacting methane (CH_4) and oxygen (O_2) in the presence of a platinum catalyst. The reaction is exothermic.

An equation that represents the reaction is:

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$$2CH_4 + O_2 \rightarrow 2CH_3OH$$

(a) The energy level diagram for this reaction is given below.



(i) Use the diagram to explain how you know that this reaction is exothermic.

_____

_____

_____

(1)

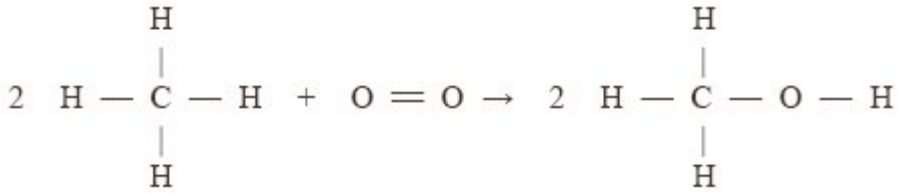
(ii) Explain, in terms of the energy level diagram, how the platinum catalyst increases the rate of this reaction.

_____

_____

(1)

(b) The equation can also be written showing the structural formulae of the reactants and the product.



(i) Use the bond energies given in the table to help you to calculate the energy change for this reaction.

Bond	Bond energy in kJ
C — H	435
O = O	498

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C — O	805
O — H	464

_____

_____

_____

_____

_____

Energy change = _____ kJ

(3)

(ii) In terms of the bond energies, explain why this reaction is exothermic.

_____

_____

(1)

(Total 6 marks)

Q28.

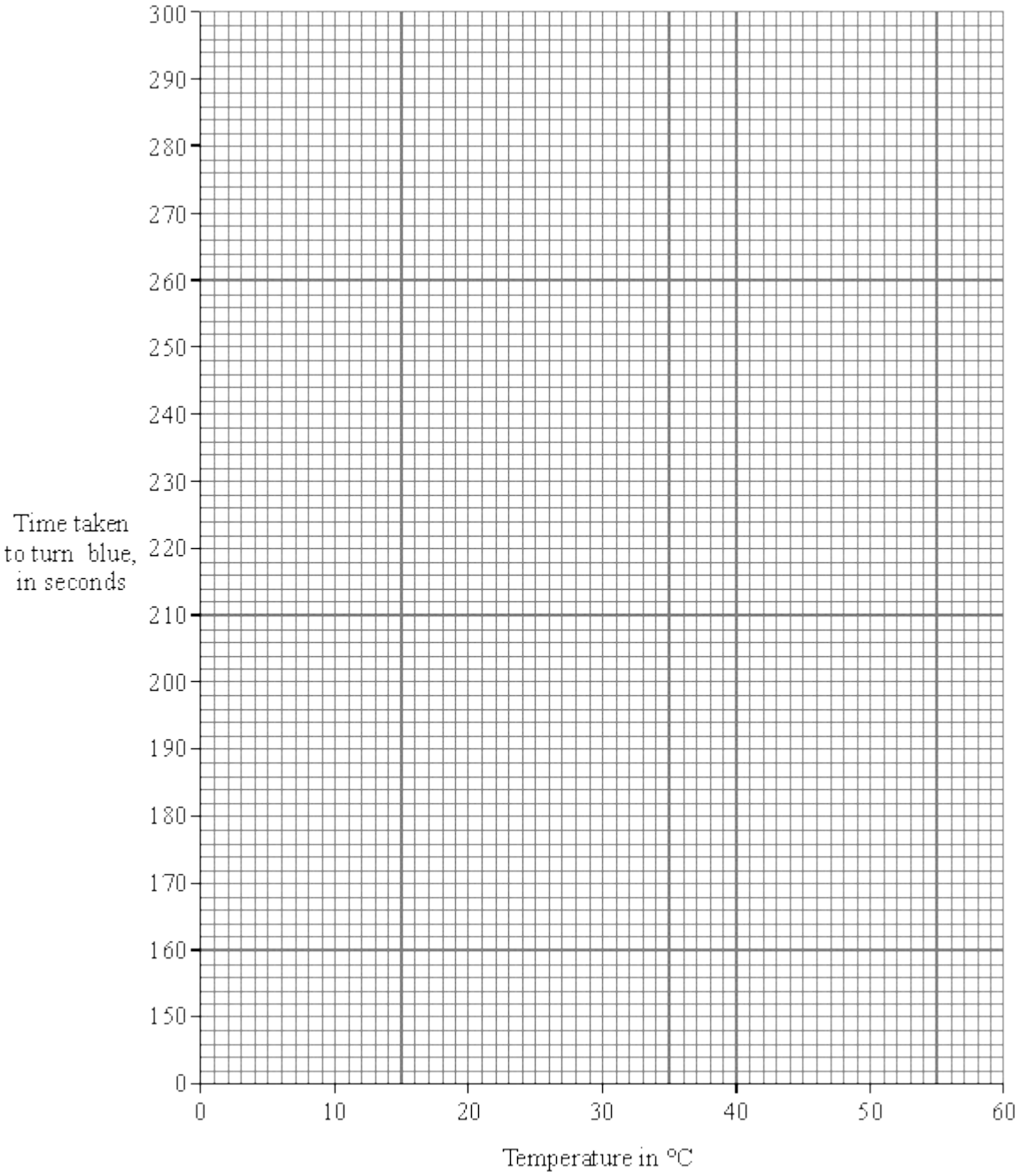
Solutions **A** and **B** are colourless. When they are mixed, they react and turn blue after a period of time. A student investigated how temperature affected the rate of reaction between solutions **A** and **B**. The rate was measured by timing how long the mixture took to turn blue.

The results are shown in the table.

Temperature in °C	22	25	34	45	51
Time taken to turn blue, in seconds	290	250	200	170	160

(a) (i) Draw a graph for these results.

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(3)

(ii) Use your graph to find how long it takes the solution to turn blue at 40°C.

Time = _____ s

(1)

(b) (i) How does the rate of reaction change as the temperature is increased?

_____

_____

(1)

(ii) Explain, in terms of particles, why temperature has this effect on the rate of reaction.

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To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

_____

_____

_____

_____

_____

_____

(3)

(c) State **one** variable that must be kept constant to make this experiment a fair test.

_____

(1)

(Total 9 marks)

Q29.

This label was on a bottle of stain remover.



When 'Simply Amazing' is mixed with water a reaction takes place which produces bubbles of oxygen gas.

(i) Suggest a method that you could use to measure how quickly this reaction takes place.

_____

_____

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_____

_____

_____

_____

(2)

(ii) Read the instructions on the label and then suggest how increasing the temperature of the water affects the rate of this reaction.

_____

_____

(1)

(iii) Suggest **one** other way in which the rate of a reaction can be changed.

_____

_____

(1)

(Total 4 marks)

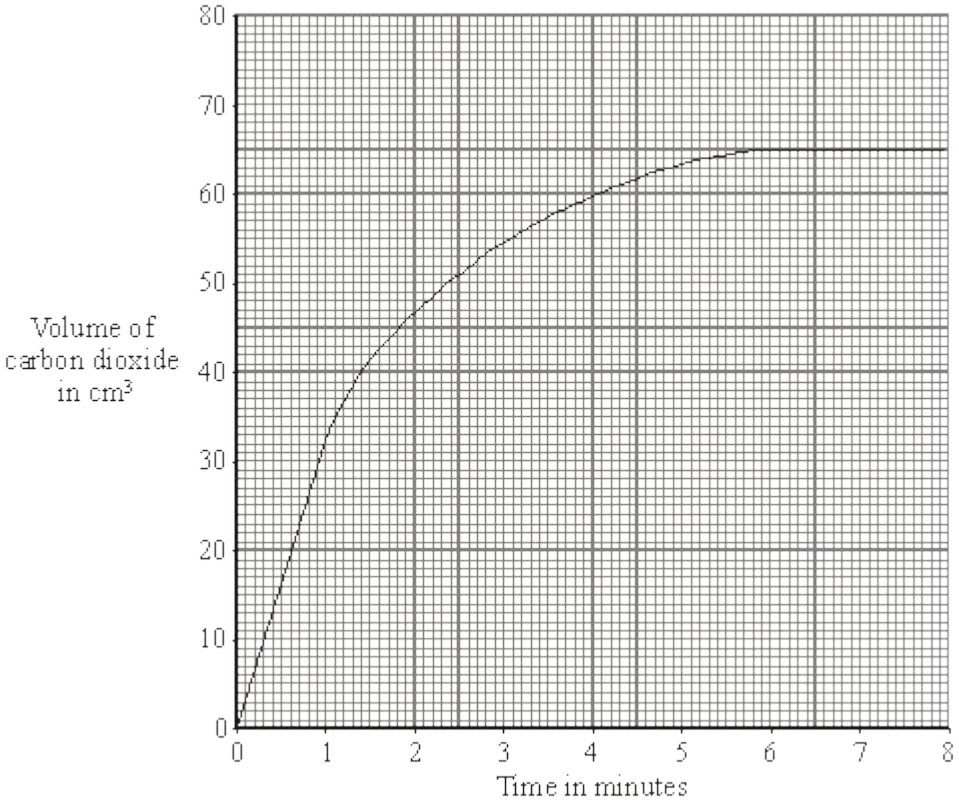
Q30.

A student studied the reaction between dilute hydrochloric acid and an **excess** of calcium carbonate.

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

The student measured the volume of carbon dioxide produced in the experiment. The results are shown on the graph.

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(a) After how many minutes had all the acid been used up?

_____ minutes

(1)

(b) The student wrote this conclusion for the experiment:

'The reaction gets slower and slower as the time increases.'

Explain why the reaction gets slower. Your answer should be in terms of particles.

_____

_____

_____

_____

(2)

(c) A second experiment was carried out at a higher temperature. All other factors were the same.

Draw a line on the graph above to show the results that you would expect.

(2)

(Total 5 marks)

Q31.

The monomer chloroethene is made from ethene in a two-stage process,

(a) The first stage is to convert ethene to 1,2-dichloroethane.

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$$2C_2H_4(g) + 4HC1(g) + O_2(g) \rightleftharpoons 2C_2H_4Cl_2(g) + 2H_2O(g)$$
ethene 1,2-dichloroethane

State and explain the effect of increasing the pressure on:

(i) the yield of 1,2-dichloroethane;

_____

_____

(2)

(ii) the rate of reaction.

_____

_____

(2)

(b) In the second stage 1,2-dichloroethane is converted into chloroethene.

$C_2H_4C1_2 \rightarrow C_2H_3C1 + HCl$

This reaction is a thermal decomposition.

Suggest what would need to be done to decompose 1,2-dichloroethane.

_____

_____

(1)

(Total 5 marks)

Q32.

(a) Indigestion tablets called antacids can be taken to react with excess hydrochloric acid in the stomach. A student investigated two different antacid tablets labelled **X** and **Y**.

(i) Both tablets, **X** and **Y**, contained calcium carbonate. Give the chemical symbol for each of the three elements in calcium carbonate.

_____

_____

(3)

(ii) Name the gas formed when calcium carbonate reacts with hydrochloric acid.

_____

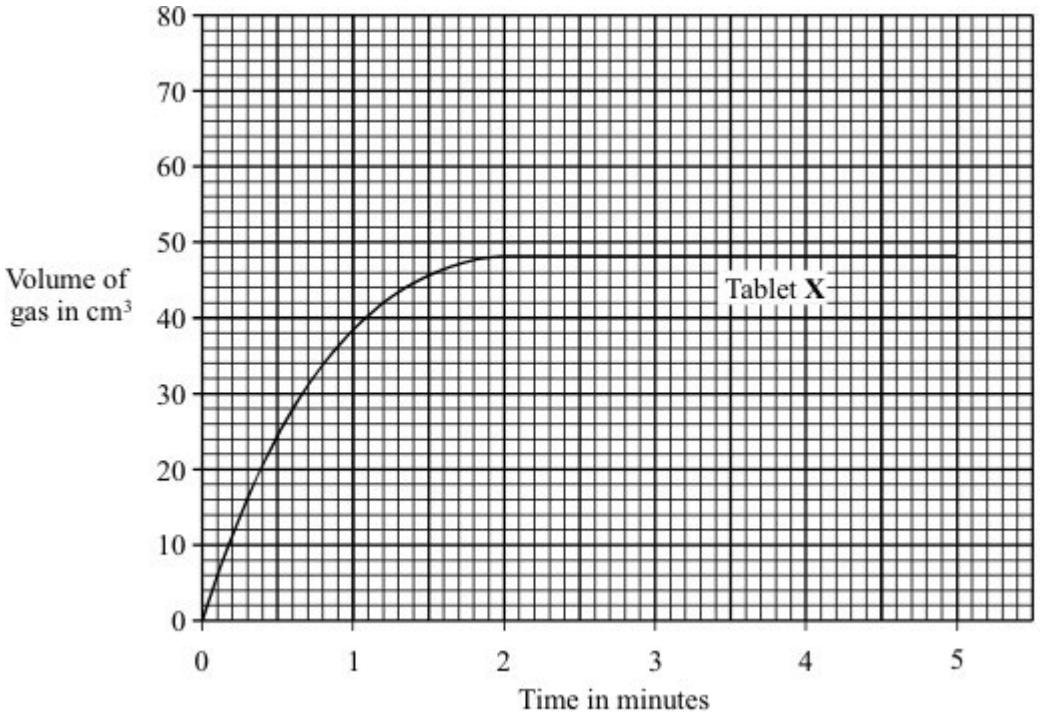
(1)

(b) The student first reacted tablet **X** and then tablet **Y**, with 100 cm^3 of a hydrochloric acid solution. The student measured the volume of gas produced during the first five minutes. The results are shown in the table.

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Time in minutes	0	1	2	3	4	5
Volume of gas in cm^3 Tablet X	0	38	48	48	48	48
Volume of gas in cm^3 Tablet Y	0	31	54	67	72	72

(i) Draw a graph of the results for tablet **Y**. (A graph of the results for tablet **X** has been drawn for you.)



(3)

(ii) Tablet **X** contains less calcium carbonate than tablet **Y**. How do the results show this?

_____

_____

(1)

(iii) Explain why the rate of reaction slows down for both tablets.

_____

_____

_____

(2)

(Total 10 marks)

Q33.

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Hydrogen peroxide, H_2O_2, is often used as a bleach. It decomposes forming water and oxygen.

(a) (i) Write the balanced chemical equation for the decomposition of hydrogen peroxide.

_____

(3)

(ii) Give a test for oxygen.

Test _____

Result of test _____

_____

(2)

(b) The rate of decomposition of hydrogen peroxide at room temperature is very slow. Manganese oxide is a catalyst which can be used to speed up the decomposition. Complete the sentence.

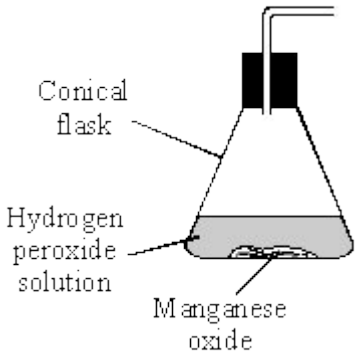
A catalyst is a substance which speeds up a chemical reaction. At the end of the

reaction, the catalyst is _____

(1)

(c) Two experiments were carried out to test if the amount of manganese oxide, MnO_2 affected the rate at which the hydrogen peroxide decomposed.

(i) Complete the diagram to show how you could measure the volume of oxygen formed during the decomposition.



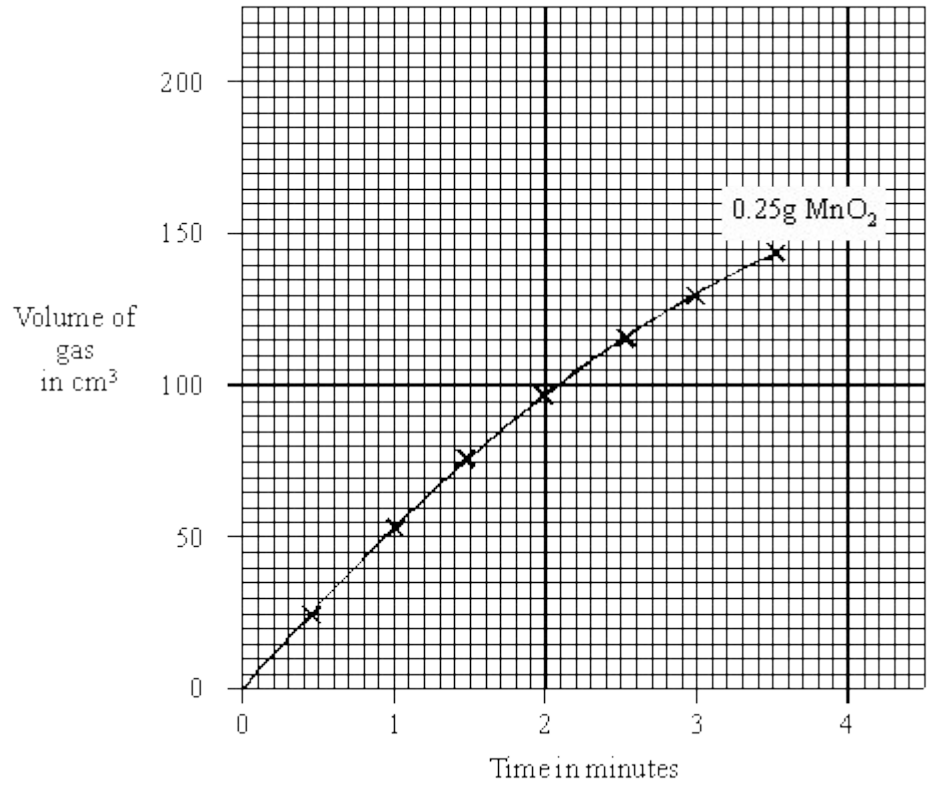
(2)

(ii) The results are shown in the table.

Time in minutes	0	0.5	1	1.5	2	2.5	3	3.5
Volume of gas in cm^3 using 0.25 g MnO_2	0	29	55	77	98	116	132	144
Volume of gas in cm^3 using 2.5 g MnO_2	0	45	84	118	145	162	174	182

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Draw a graph of these results. The graph for 0.25 g MnO_2 has been drawn for you.



(3)

(iii) Explain why the slopes of the graphs become less steep during the reaction.

_____

_____

_____

(2)

(iv) The same volume and concentration of hydrogen peroxide solution was used for both experiments. What **two** other factors must be kept the same to make it a fair test?

1. _____

_____

2. _____

_____

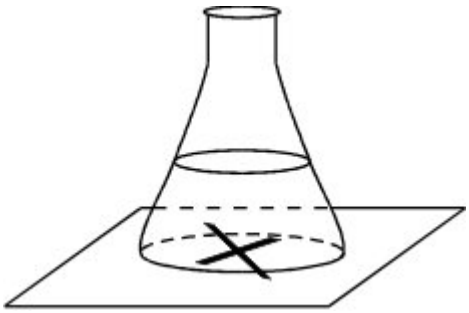
(2)

(Total 15 marks)

Q34.

A student studied the effect of temperature on the rate of reaction between hydrochloric acid and sodium thiosulphate.

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- The student mixed 50 cm^3 of a sodium thiosulphate solution and 5 cm^3 of hydrochloric acid in a flask.
- The flask was placed over a cross.
- The student timed how long after mixing the cross could no longer be seen.

(a) (i) Balance the chemical equation for this reaction.

$$Na_2S_2O_3(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$$

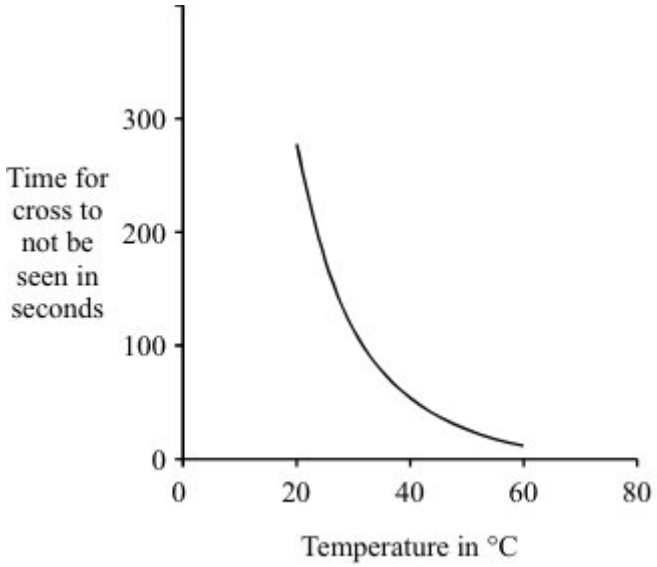
(1)

(ii) What causes the cross to be seen no longer?

_____

(1)

(b) A graph of the results is shown.



(i) What effect does temperature have on the rate of this reaction?

_____

(1)

(ii) Explain why temperature has this effect on the rate of reaction.

_____

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_____

_____

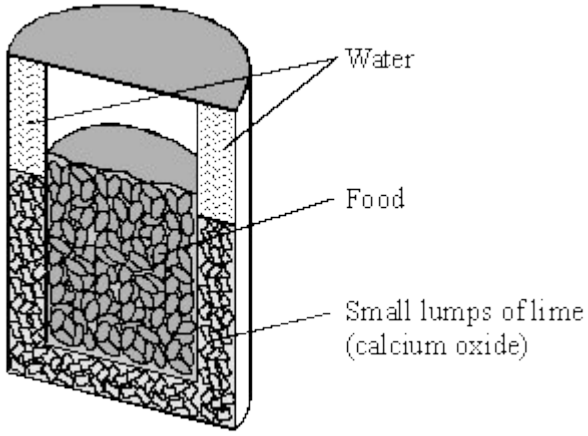
_____

(2)

(Total 5 marks)

Q35.

Mountaineers can warm their food in self-heating, sealed containers.



(a) The water is allowed to react with the lime. The heat from the reaction warms the food. What type of reaction causes a rise in temperature?

_____

(1)

(b) Some students investigated the effect of adding different sized lumps of lime to water. The results of their investigation are shown.

Time in minutes	Temperature in °C		
	Large lumps of lime	Small lumps of lime	Powdered lime
0	18	18	18
1	19	20	28
2	21	23	43
3	24	27	63
4	28	32	88
5	33	38	100

What do these results show? Give an explanation for your answer.

_____

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_____

_____

_____

(2)

(c) Suggest and explain **one** disadvantage of using powdered lime to heat food.

_____

_____

_____

(2)

(Total 5 marks)

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