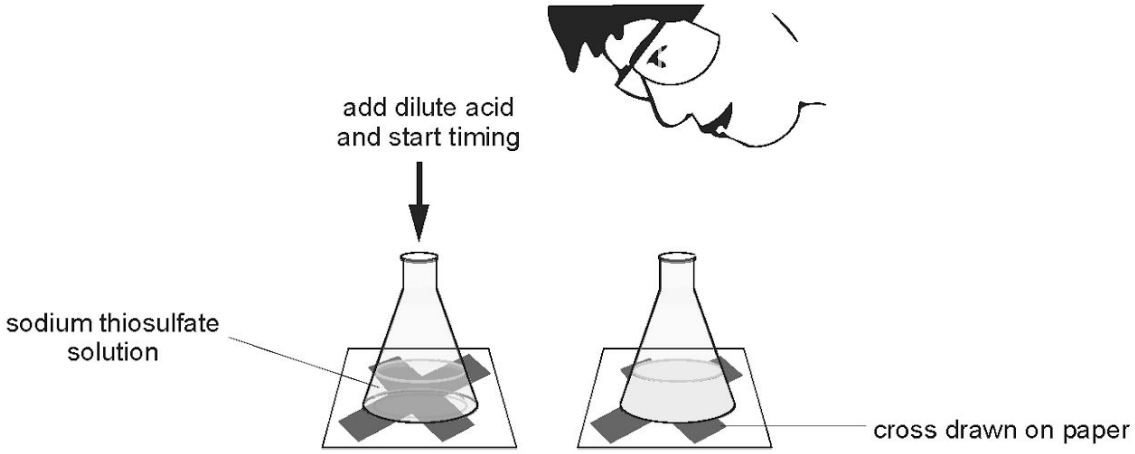
WJEC Chemistry GCSE

9: Rate of Chemical Change and Dynamic Equilibrium

Practice Questions

England Specification

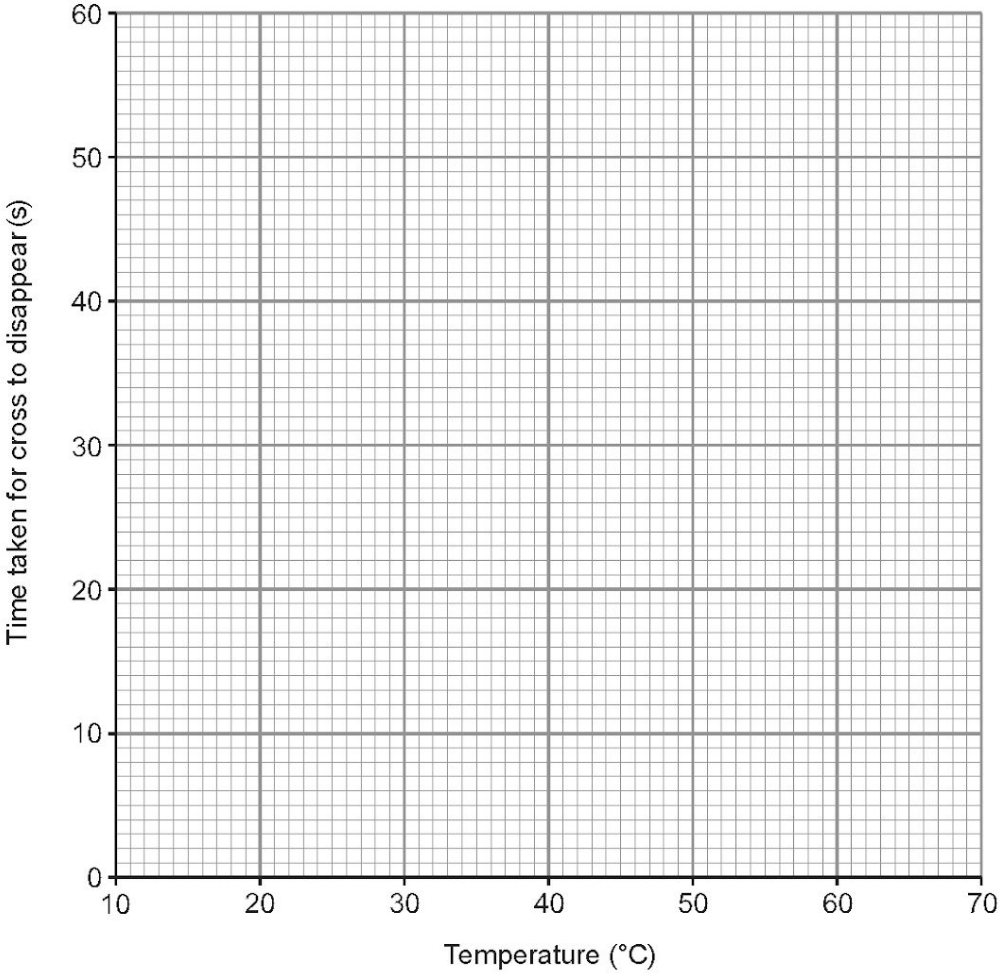
1. When sodium thiosulfate solution reacts with dilute acid, sulfur forms as a precipitate. The precipitate causes the solution to go cloudy. The rate of reaction can be measured by placing a cross beneath the flask and measuring the time taken for the cross to disappear.



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]

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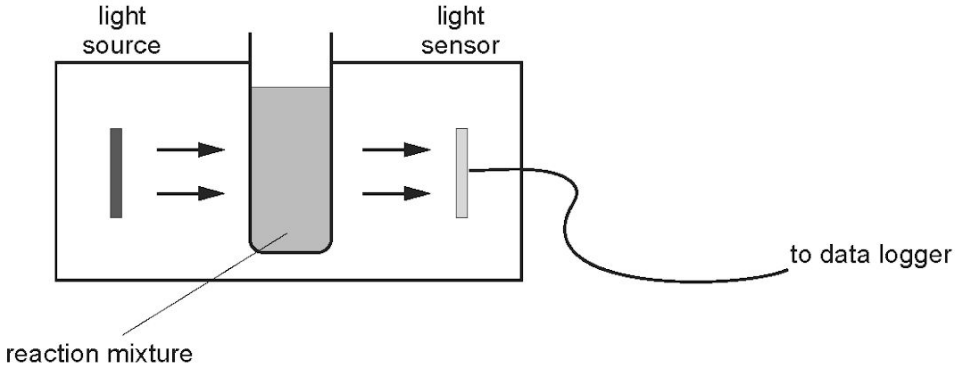
(iii) A second student carried out the same experiment using a higher concentration of acid. Draw the line you would expect him to obtain on the same grid. [1]

(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]

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2. Explain, using particle theory, how the rate of a chemical reaction depends on concentration and temperature. [6 QWC]

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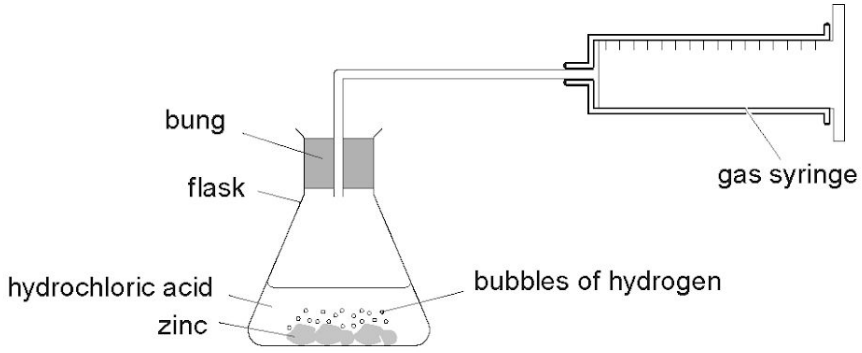
3.

(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]

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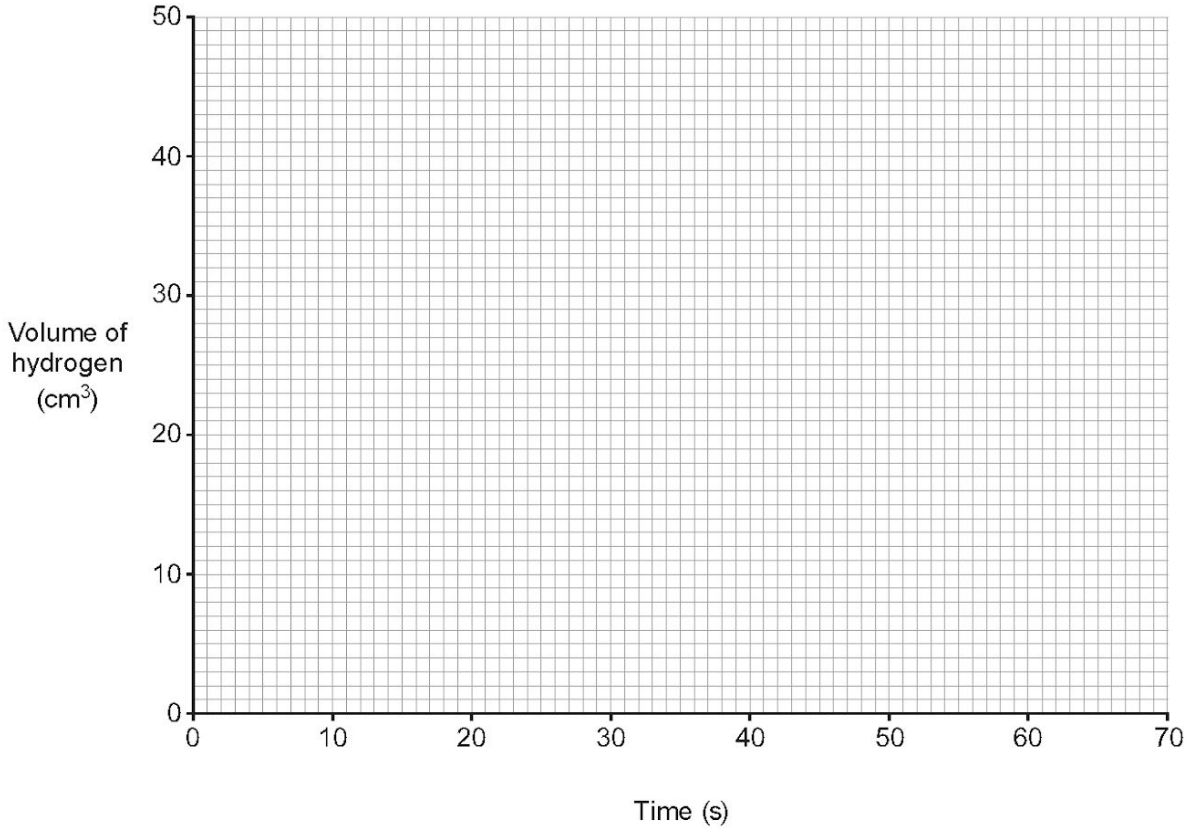
(ii) Plot **all** the results from the table on the grid below and draw a suitable line. [3]



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

..... cm^3

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

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(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]

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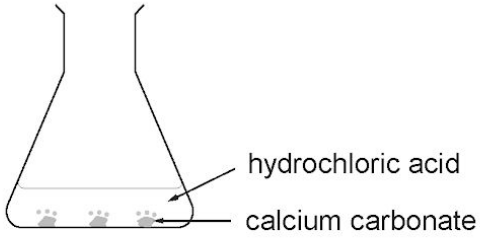
4. An investigation was carried out to find the effect of different factors on the rate of reaction of calcium carbonate and hydrochloric acid.



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]

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

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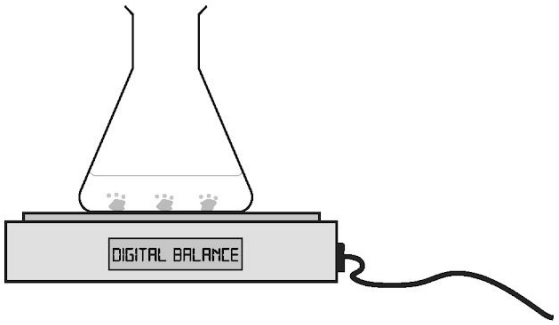
(iii) State **two** *other* factors that should be kept the same in order to make this investigation a fair test. [2]

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]

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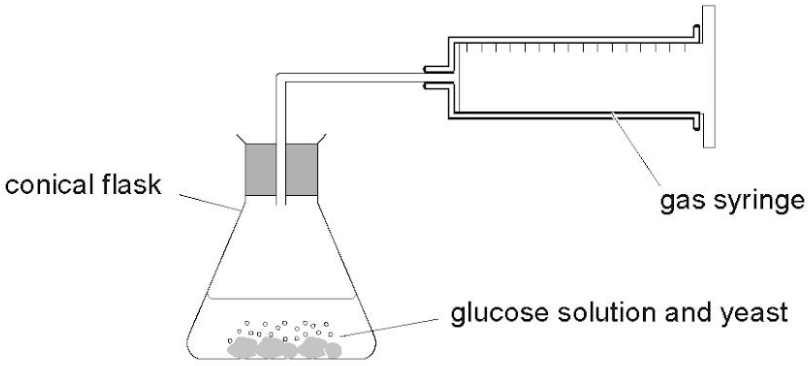
5.

A pupil investigated the effect of temperature on the rate of fermentation using the apparatus shown below.



The experiment was carried out three times at five different temperatures. The volume of gas collected after 10 minutes was recorded each time. The results are shown below.

Temperature (°C)	Volume of gas collected after 10 minutes (cm^3)			
	1	2	3	Mean
20	9	8	7	8
30	38	40	32	39
40	52	53	54	53
50	35	32	33	33
60	12	11	12	12

(a) Suggest why the circled value is considered to be anomalous. [1]

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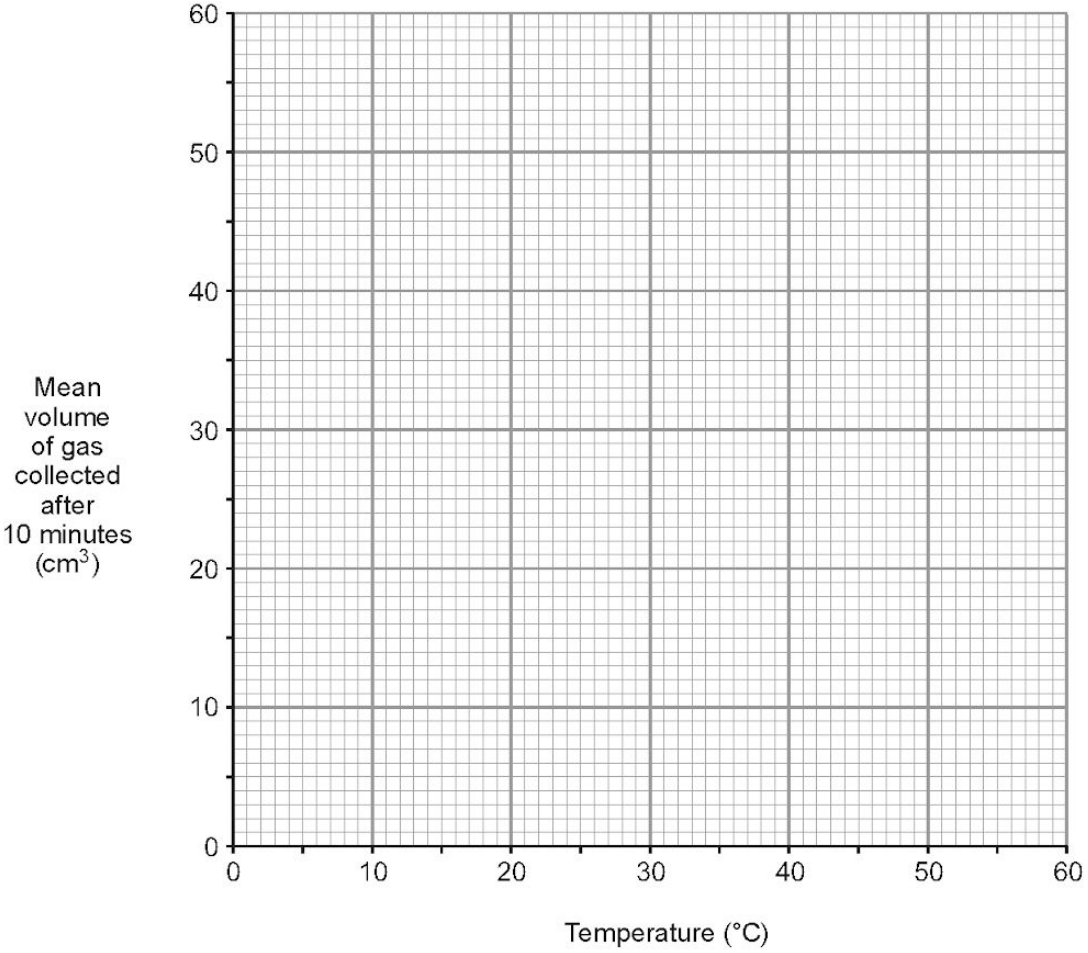
(b) Plot a graph of the **mean** volume of gas collected against temperature on the grid opposite. [2]



(c) State what conclusions can be drawn from the graph. [2]

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(d) Write a **word** equation for the reaction taking place. [2]

..... ⟶ ..... + ...

(e) Yeast produces a catalyst that allows this reaction to take place. Name the **type** of catalyst produced by yeast. [1]

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6.

(a) One of the main dangers in the coal mining industry is that coal dust can form an explosive mixture with air.

Explain why an explosion is more likely to occur with coal dust than with lumps of coal. [2]

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(b) A chemical reaction goes twice as fast if the temperature is increased by 10 °C.

At 5 °C, milk undergoes a chemical reaction that makes it go sour in 8 days.

Calculate how long it will take milk to go sour at 35 °C. [2]

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7.

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

zinc + hydrochloric acid ⟶ zinc chloride + hydrogen

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]

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

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

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(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]

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

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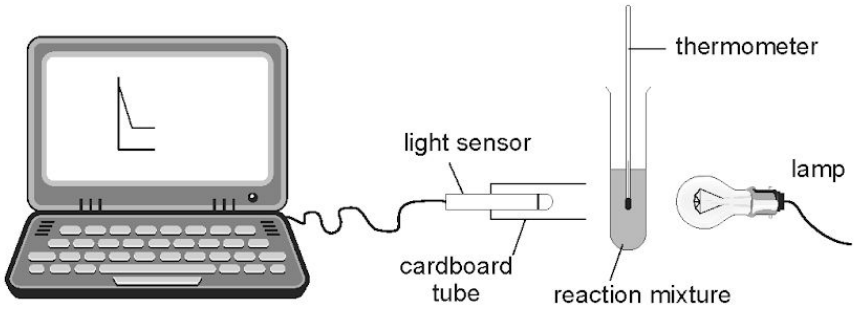
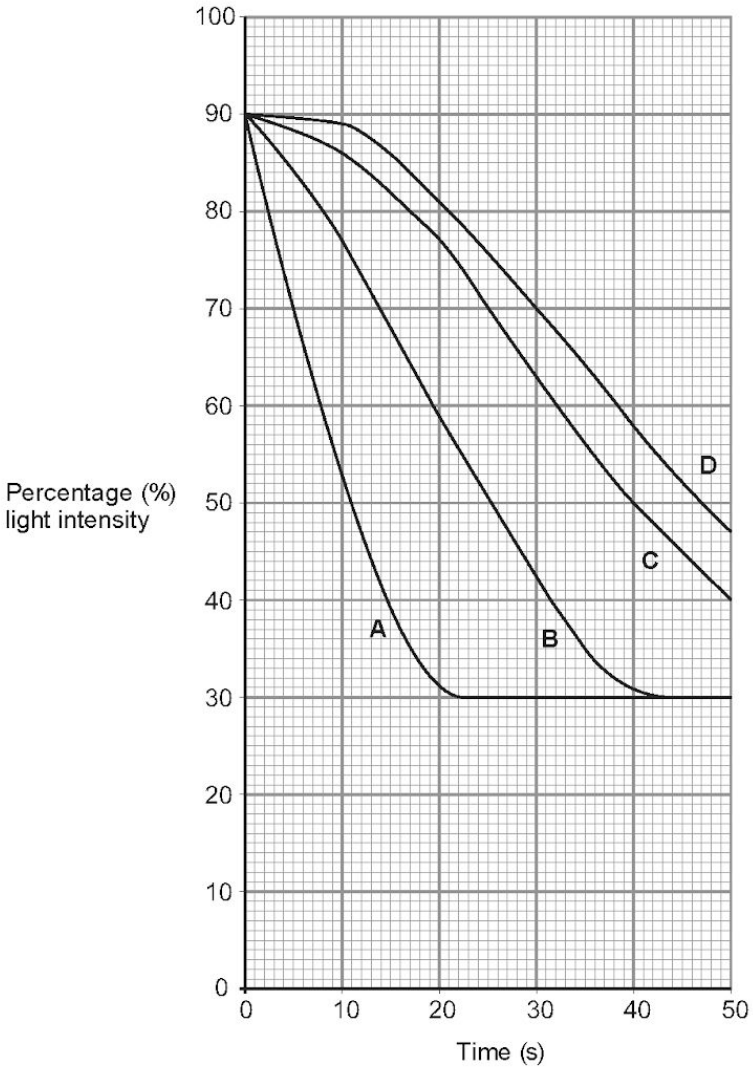
8.

Sodium thiosulfate solution reacts with dilute hydrochloric acid forming a yellow precipitate. This reaction can be investigated using the equipment below. The yellow precipitate formed during the reaction causes a reduction in the amount of light reaching the light sensor.



5 cm^3 of dilute hydrochloric acid was added separately to 10 cm^3 sodium thiosulfate solutions at four different temperatures. All other factors were kept the same. The results are shown on the grid below.



(a) Give the letter **A**, **B**, **C** or **D** of the graph which represents the reaction carried out at the highest temperature and give the reason for your choice. [1]

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(b) The rate of reaction can be calculated using the formula:

$$\text{rate} = \frac{1}{\text{time}}$$

The reaction is considered to be complete when the percentage light intensity reaches 30 %. Use the formula to find the mean rate for experiment **A**. [2]

Rate = ... / s

(c) State and explain, using particle theory, the conclusion you draw from the investigation. [3]

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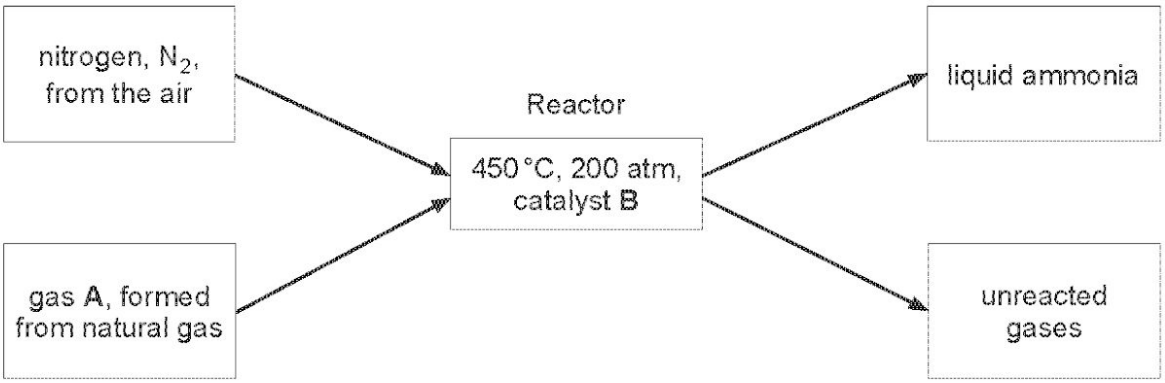
9.

Ammonia is produced during the Haber process. The reaction is summarised in the diagram below.



(a) Give the name of gas **A**. ..... [1]

(b) Name catalyst **B** and state why it is used. [2]

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(c) The yield of ammonia is only 28 % therefore 72 % of the gases remain unreacted.

Describe what happens to these unreacted gases and state why this is important. [2]

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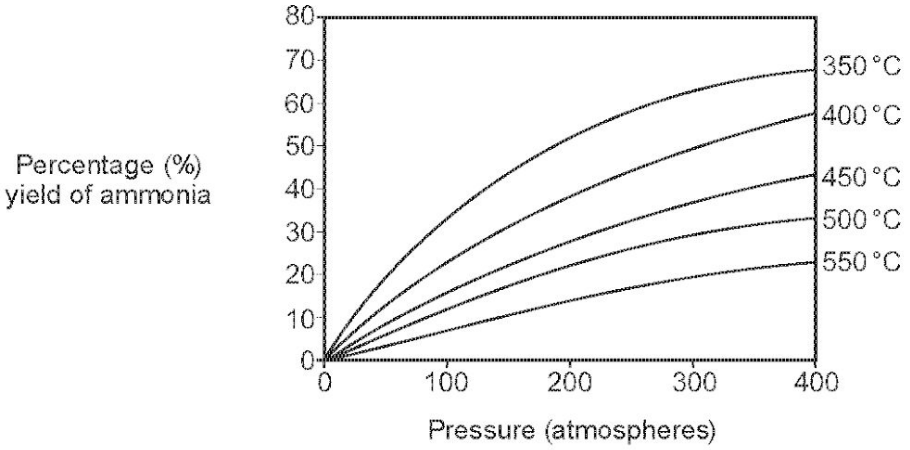
(d) The following graph shows the effect of temperature and pressure on the yield of ammonia during the Haber process.



Describe how the yield of ammonia varies with temperature and pressure. [2]

Temperature

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Pressure

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(e) Write a balanced **symbol** equation for the production of ammonia. [3]

..... + ... ⇌ .....

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10.

Ammonia is manufactured from nitrogen and hydrogen using the Haber process.

(a) The equation below shows the formation of ammonia.

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

(i) State the numbers of nitrogen atoms and hydrogen atoms on the **left** hand side of the equation. Use these numbers to show that the equation is balanced. [2]

Number of nitrogen atoms ..... *Number of hydrogen atoms* .....

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(ii) Give the meaning of (g) in the equation. [1]

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(b) The box below shows some of the conditions and terms used when describing the Haber process.

ammonia	**hydrogen**	**450 °C**	**iron**	**cooling**
nitrogen	**reversible**	**200 atmospheres**		**recycling**

(i) Choose from the box

I. the process used to remove the product from the reaction mixture, [1]

.....

II. the method used to reduce the waste of reactants. [1]

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(ii) Choose from the box the catalyst used in the reaction. State the purpose of a catalyst. [2]

Catalyst .....

Purpose .....

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11.

(a) Ammonia is made industrially from nitrogen and hydrogen by the Haber process.

The table below shows the yield of ammonia under different pressure and temperature conditions.

Pressure (atmospheres)	Temperature (°C)				
	100	200	300	400	500
	Yield of ammonia (%)				
10	88.2	50.7	14.7	3.9	1.2
50	94.5	75.0	39.5	15.3	5.6
100	96.7	81.7	52.5	25.2	10.6
200	98.4	89.0	66.7	40.0	18.3
400	99.4	94.6	79.7	55.4	31.9
1000	99.9	98.3	92.6	79.8	57.5

(i) Using **only** the data in the table suggest the conditions that should be chosen for the process. [1]

Pressure ..... atmospheres *Temperature* ..... °C

(ii) Give the disadvantage of using a low temperature in the process and state how this problem is overcome. [2]

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(iii) The actual pressure used in the process is 200 atmospheres. Apart from safety issues, suggest a disadvantage of using a higher pressure. [1]

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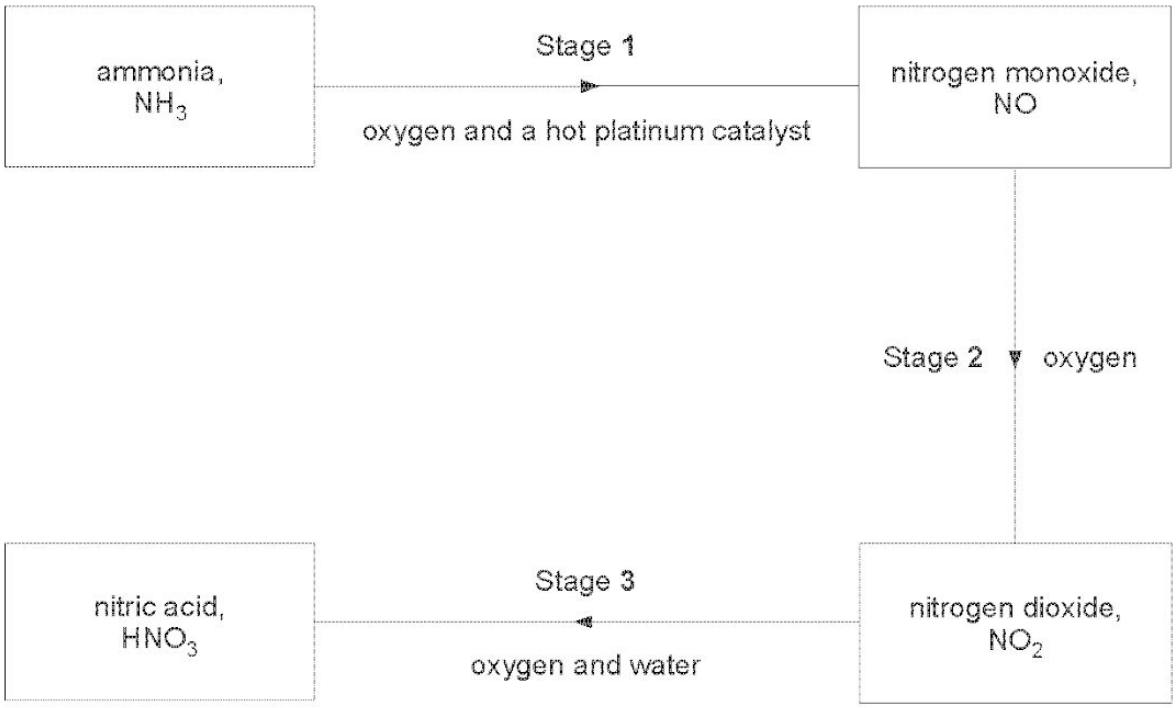
(b) Ammonia is used to form nitric acid in a three-stage reaction.



(i) Once the reaction in stage 1 has started there is sufficient heat to maintain the reaction. Give the term used to describe a reaction that produces heat. [1]

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(ii) Balance the symbol equation below that represents the reaction taking place in stage 3. [1]

$$\square\ NO_2 + O_2 + 2H_2O \longrightarrow \square\ HNO_3$$

(iii) Write a balanced symbol equation for the reaction that occurs when nitric acid is added to copper(II) carbonate. [2]

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