New Document 1

Name: _____

Class: _____

Date: _____

Time: **41 minutes**

Marks: **41 marks**

Comments:

Q1.

A student investigates how the concentration of an acid affects the rate of a reaction.

This is the method used.

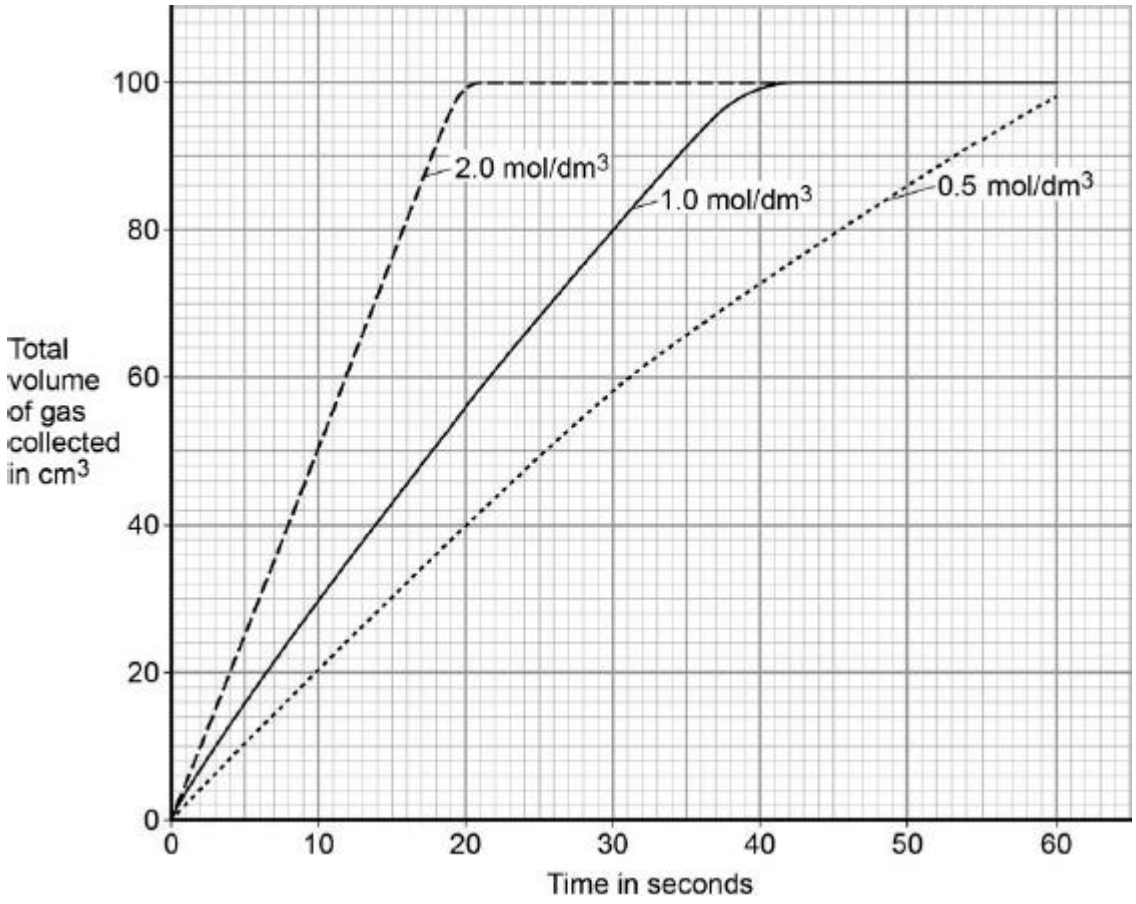
1. Put a 3 cm piece of magnesium ribbon into a conical flask.

2. Add 50 cm^3 of 0.5 mol / dm^3 hydrochloric acid to the flask.

3. Collect and measure the volume of gas produced at 10 second intervals.

4. Repeat with different concentrations of hydrochloric acid using the same length of magnesium ribbon and volume of acid.

The student's results are shown in the figure below.



(a) How do the results show that increasing the concentration of acid increases the rate of reaction?

You **must** use data from the graph in your answer.

_____

_____

_____

_____

_____

(2)

(b) Explain why the rate of reaction changes as the concentration of the acid increases.

You should answer in terms of particles.

(3)

(c) Student **A** said that the final volume of gas collected was lower for a concentration of 0.5 mol dm^3 because the reaction had not finished.

Student **B** said it was because all the acid had reacted.

Describe further experimental work the students could do to find out which student was correct.

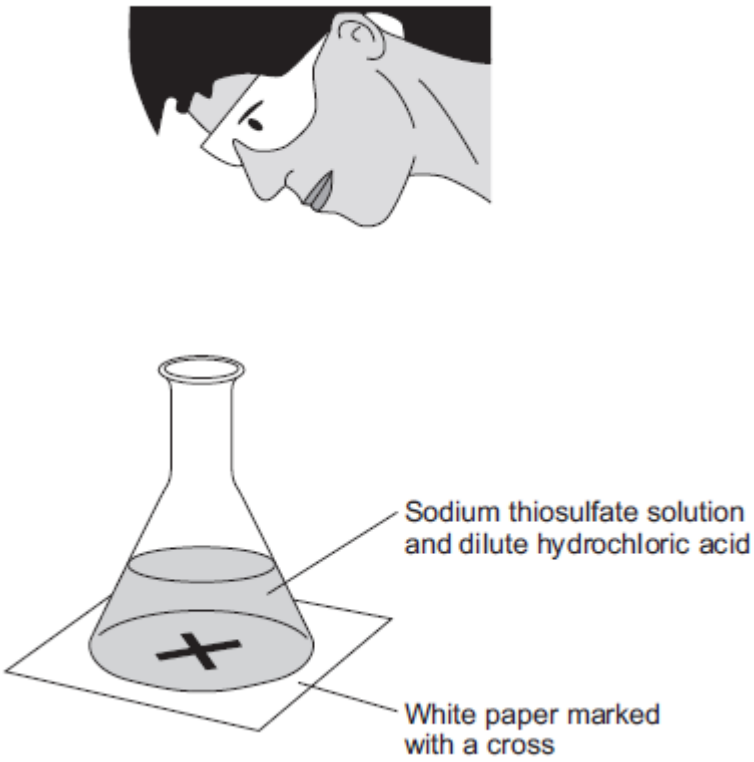
(2)

(Total 7 marks)

Q2.

A student investigated the rate of reaction between sodium thiosulfate solution and dilute hydrochloric acid, as shown in **Figure 1**.

Figure 1



The reaction produced a precipitate, which made the mixture turn cloudy.

The student timed how long it took until she could no longer see the cross.

She calculated the rate of the reaction.

(a) The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2\ HCl(aq) \longrightarrow 2\ NaCl(aq) + S(s) + SO_2(g) + H_2O(l)$$

Name the product that made the mixture go cloudy.

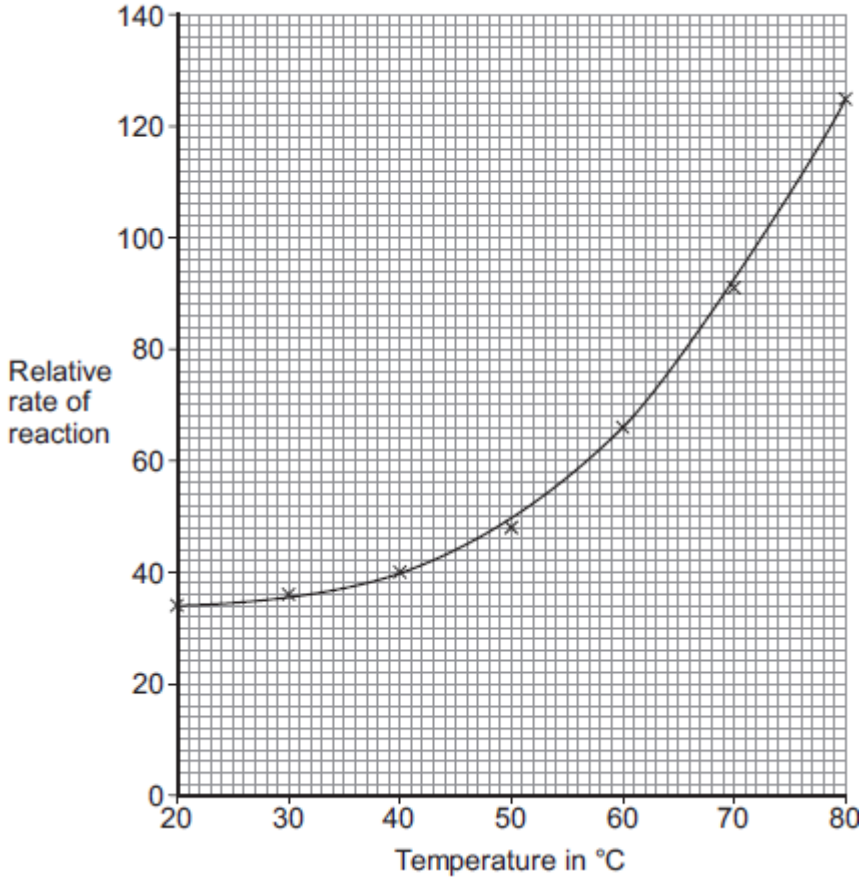
_____

(1)

(b) The student investigated the effect of changing the temperature of the sodium thiosulfate solution on the rate of reaction.

She plotted her results on a graph, as shown in **Figure 2**.

Figure 2



Describe the trends shown in the student's results.

_____

_____

_____

_____

_____

(2)

(c) The student then investigated the effect of changing the concentration of sodium thiosulfate solution on the rate of the reaction.

(i) Suggest **two** variables the student would need to control to make sure that her results were valid.

_____

_____

_____

_____

(2)

(ii) From this investigation the student correctly concluded:

'As the concentration of sodium thiosulfate solution doubles, the rate of

reaction doubles.'

Explain the student's conclusion in terms of particles.

_____

_____

_____

_____

_____

_____

_____

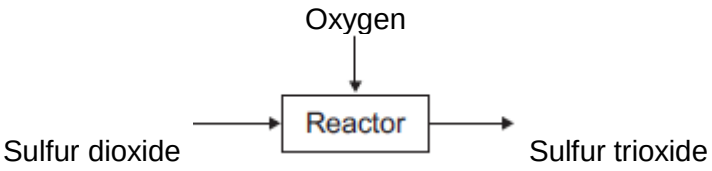
(3)

(Total 8 marks)

Q3.

Figure 1 represents a reaction in the production of sulfuric acid.

Figure 1



(a) Complete and balance the equation for the reaction.

_____ $SO_2(g)$ + _____ (g) ⇌ _____ $SO_3(g)$

(2)

(b) The conditions can affect the rate of the reaction.

(i) The pressure of the reacting gases was increased.

State the effect of increasing the pressure on the rate of reaction.

Explain your answer in terms of particles.

_____

_____

_____

_____

_____

_____

(3)

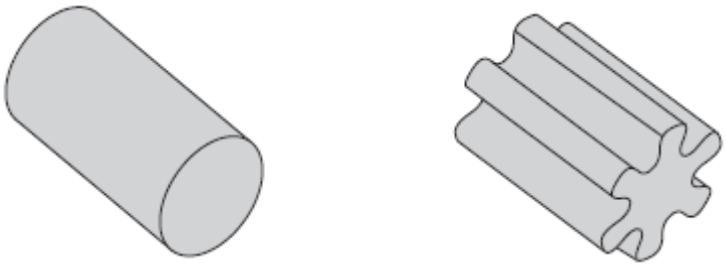
(ii) A catalyst is used for the reaction.

The gases pass through a layer containing pieces of the catalyst.

Figure 2 shows the shapes of pieces of catalyst.

Figure 2

A **B**



Suggest and explain why shape **B** is more effective as a catalyst than shape **A**.

_____

_____

_____

_____

(2)

(c) The reaction is carried out at a high temperature to provide the reactants with the **activation energy**.

What is meant by the **activation energy**?

_____

_____

_____

(1)

(d) Sulfuric acid reacts with metals to produce salts.

(i) A student concluded that potassium would **not** be a suitable metal to react with sulfuric acid.

Explain why.

_____

_____

_____

_____

(2)

(ii) A student reacted zinc metal with sulfuric acid to produce a salt and another product.

Complete the equation for this reaction.

$Zn + H_2SO_4 \longrightarrow$ _____ + _____

(2)

(iii) The student wanted to increase the rate of the reaction between the zinc and sulfuric acid.

State **one** way, other than using a catalyst, that the student could increase the rate of the reaction.

_____

_____

(1)

(Total 13 marks)

Q4.

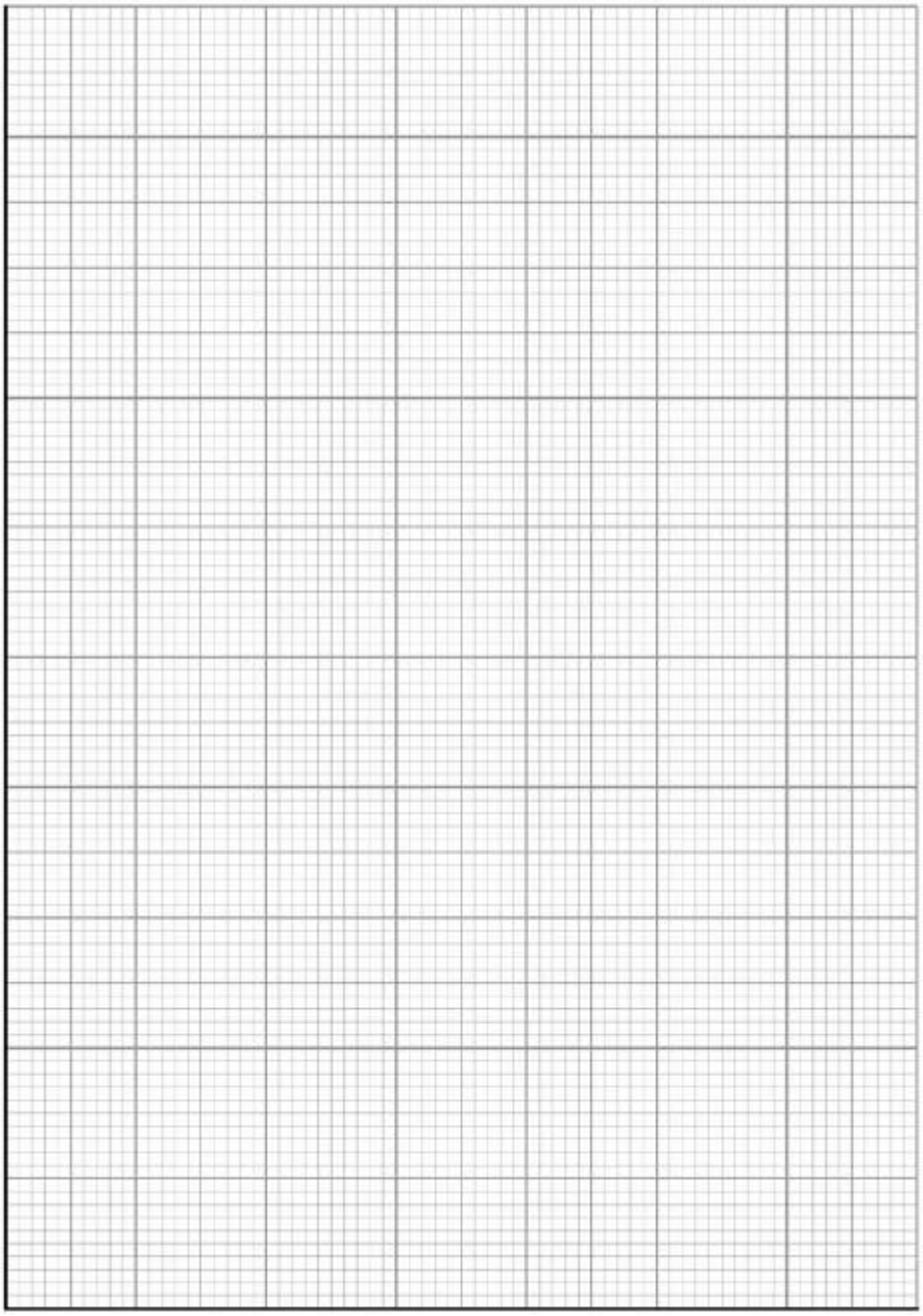
Ammonium nitrate (NH_4NO_3) is produced by reacting ammonia with nitric acid.

A student measured the mass of ammonium nitrate that dissolves in 100 cm^3 of water at different temperatures.

The table below shows the student's results.

Temperature in °C	0	20	40	60	80	100
Mass of ammonium nitrate in g that dissolves in 100 cm^3 water	119	190	286	321	630	1 024

(a) Use the table above to plot a graph of the solubility of ammonium nitrate on the figure below.



(4)

(b) At 20 °C, 190 g of ammonium nitrate dissolves in 100 cm^3 of water.

Calculate the amount of ammonium nitrate (in moles) that dissolves in 1 dm^3 of water at 20 °C.

Relative atomic masses (A_r): H = 1; N = 14; O = 16

_____

_____

_____

_____

Amount of dissolved ammonium nitrate = _____ mol

(3)

(c) Farmers use ammonium nitrate as a fertiliser.

Farmers want to slow down the rate at which ammonium nitrate fertiliser dissolves in the water in the soil.

Suggest why they spread the fertiliser in the form of small beads instead of a fine powder.

(2)

(d) Ammonia is needed to make ammonium nitrate.

The reaction used to make ammonia is:

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

The forward reaction is exothermic.

At equilibrium, about 35% of the nitrogen and hydrogen are converted to ammonia at 450 °C and 200 atmospheres pressure.

Explain the effects of increasing the temperature, or increasing the pressure, on the amount of ammonia produced at equilibrium.

(4)

(Total 13 marks)

Mark schemes

Q1.

(a) (as concentration increases)

*answers **must** refer to data from graph to gain full marks*

relationship identified from the graph

*eg the same volume of gas is collected in a shorter time **or** more gas is collected in the same time **or** reaction reaches completion in a shorter time*

1

reference to relevant data to evidence relationship

eg 20 ml collected in 10 seconds at 0.5 mol / dm^3 in 6.5 s at 1.0 mol / dm^3 and in 4 s at 2.0 mol / dm^3

or

at 10 seconds volume collected is 20 cm^3 with 0.5 mol / dm^3, 30 cm^3 with 1.0 mol / dm^3, 50 cm^3 with 2.0 mol / dm^3

or

total volume collected reaches maximum of 100ml in 20 seconds at 2.0 mol / dm^3 but takes twice as long at 1.0 mol / dm^3 and at 0.5 mol / dm^3

1

(b) reactions occur when particles collide

1

increasing concentration means there are more particles in the same volume

1

so there are more collisions

1

(c) leave for longer

1

if gas continues to be produced student A is right

1

or

repeat with more acid (1)

if more gas is produced student B is right (1)

[7]

Q2.

(a) sulfur / sulphur / S / S(s)

1

(b) as the temperature increases, the rate of reaction increases

allow two correct values for rate quoted (from graph) at different temperatures

1

the rate of increase increases **or** there is an exponential relationship

*accept the rate of reaction increases slowly (from 20 °C to 50 °C) then increases more rapidly for **2** marks*

answer MUST be based on rate / speed of reaction

1

(c) (i) any **two** from:

- temperature (of the reactants)
- concentration of hydrochloric acid
- volume of hydrochloric acid
- volume of sodium thiosulfate
- the (size / darkness / thickness of the) cross
- total volume of solution.

*if no other marks gained, allow **1** mark for:*

rate of stirring

OR

amount of hydrochloric acid / sodium thiosulfate

OR

volume of solution

2

(ii) (because as the concentration increases) the number of particles per unit volume increases **or** particles are closer together.

idea of more particles in a given space is required for the first mark.

ignore references to area.

1

(therefore) the frequency of (successful) collisions increases

allow increased chance / probability of collisions

number of collisions increases is insufficient here.

***must** mention per unit time or frequency.*

ignore speed of collisions.

if reference to space and time missing from M1 and M2 but they are otherwise correct, then award 1 mark.

1

so the number of particles (per unit volume) doubles **or** (the frequency of) collisions doubles.

*students can score **2** marks for a qualitative explanation; the third mark is for a quantitative explanation.*

1

[8]

Q3.

(a) O_2 in correct space

1

correct balancing

accept multiples

1

(b) (i) rate increases

*incorrect reference to energy = max **2***

ignore references to equilibrium

1

because particles are closer together

accept because there are more particles (per unit volume)

allow particles have less space / room to move around

1

so frequency of collisions increases

accept particles are more likely to collide

ignore more collisions

ignore more successful collisions

1

(ii) has a greater surface area

1

so the reaction is faster

accept so more frequent collisions

1

(c) the (minimum) amount of energy (particles must have) to react ***or*** *to start a reaction*

accept the energy needed to break bonds

ignore references to heat

1

(d) (i) (potassium is) too / *very* reactive

ignore potassium is a Group 1 / alkali metal

1

so dangerous / *violent reaction*

accept hydrogen produced rapidly

1

(ii) $ZnSO_4$

accept products in either order

ignore names of substances

1

H_2

*do **not** accept brackets or charges in the formulae*

1

(iii) any **one** from:

- increase concentration (of sulfuric acid)
- increase temperature **or** heat it
- increase surface area of zinc

1

[13]

Q4.

(a) *x* axis scale correct

1

y axis scale correct

1

all points plotted correctly

± ½ small square

1

curve correct, omitting the anomalous point

1

(b) relative formula mass of NH_4NO_3 = 14 + (4 × 1) + 14 + (3 × 16) = 80

1

mass of ammonium nitrate in 1 dm^3 at 20 °C = 190 × 10 = 1 900 g

1

number of moles of ammonium nitrate in 1 900 g = 1 900 / 80 = 23.75 mol

1

(c) small beads would dissolve slower than fine powder

1

because the surface area of the bead is less than fine powder

1

(d) increasing the temperature at equilibrium will reduce the amount of ammonia produced

1

because the reaction is exothermic

1

increasing the pressure at equilibrium will increase the amount of ammonia produced

1

because the equilibrium will shift towards the smaller number of molecules in the equation (which is ammonia)

1

[13]