Candidate 6 evidence

Investigating Rate and Concentration

Aim,

To investigate the effect of the concentration of Potassium iodide on the rate of reaction.

Underlying Chemistry,

collision theory:

in order for a chemical reaction to occur particles must successfully collide. For a collision to be successful, particles must collide with enough energy to overcome the activation energy (Ea) and with the correct collision geometry. if particles collide with enough energy to overcome the activation energy and the correct collision geometry then an activated complex is formed. An activated complex is an unstable arrangement of atoms. This then breaks down to form the products or original reactants of the reaction.

H Br → H - - - Br → H - Br
H Br → H - - - Br → H - Br

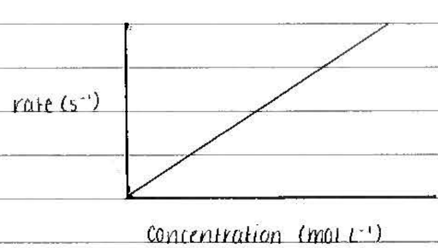
(activated complex)

if particles don't collide with the correct collision geometry then an activated complex cannot be formed and therefore no reaction takes place.

H-H Br-Br → H - - - H - - - Br - - - Br

relative rate:

relative rate is used to calculate the rate of reaction at one point when no gas is formed or there is no change in mass. Relative rate can be determined from a concentration - rate graph using the line of best fit. Typically, in these graphs the line of best fit is a straight line. This means that the concentration and rate are directly proportionate. This means that if you doubled the concentration, you also double the rate of reaction. Relative rate can also be calculated using the formula: relative rate = $\frac{1}{t}$



Concentration:

when the concentration is increased, the number of reactant particles also increases. this causes more collisions and leads to more successful collisions. This will increase the rate of reaction. Alternatively, if the concentration is decreased then the number of reactant particles also decreases. This means that there are fewer collisions and therefore fewer successful collisions and so the rate decreases.

REDOX Reactions:

A reduction reaction involves the gaining ~~for~~ of electrons whereas an oxidation reaction results in the loss of electrons. A REDOX reaction is a balanced equation where an oxidation and reduction reaction occur at the same time. An oxidising agent causes the oxidation of another atom ~~whereas~~ and is itself reduced and so it gains electrons. whereas a reducing agent causes the reduction of another atom and is itself oxidised and so it loses electrons.

In this experiment, 2 REDOX reactions occured:

1. $H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \rightarrow 2H_2O(l) + I_2(aq)$

oxidation = $2I^-(aq) \rightarrow I_2(aq) + 2e^-$

reduction = ~~2~~ $H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(l)$

In this reaction $2I^-(aq)$ is being oxidised and so it is the reducing agent causing the reduction of $H_2O_2(aq) + 2H^+(aq)$ and it loses electrons.

$H_2O_2(aq) + 2H^+(aq)$ is being reduced and so it is the oxidising agent and causes the oxidation of $2I^-(aq)$ and so it gains electrons.

2. $I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$

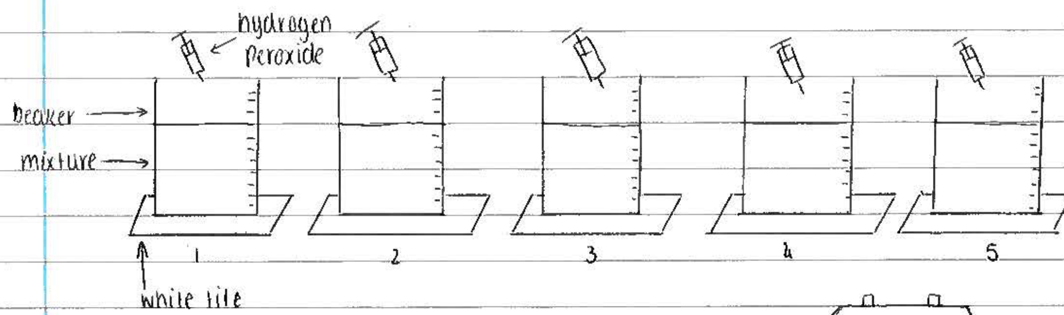
Oxidation = $2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2e^-$

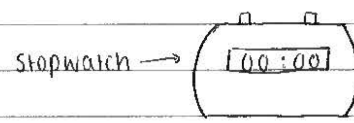
reduction = $I_2(aq) + 2e^- \rightarrow 2I^-(aq)$

In this reaction $2S_2O_3^{2-}(aq)$ is being oxidised this means that it is the reducing agent and causes the reduction of $I_2(aq)$ and loses electrons.

$I_2(aq)$ is being reduced and so it is the oxidising agent meaning it causes the ~~reduction~~ oxidation of $2S_2O_3^{2-}(aq)$ and gains electrons.

Method,





mixture = 10cm^3 Sulfuric acid
10cm^3 Sodium thiosulfate
1cm^3 Starch solution
Varying volumes of potassium iodide and deionised water (25, 0 / 20, 5 / 15, 10 / 10, 15 / 5, 20) (cm^3)

The apparatus was set up as shown in the diagram. The volumes of all reactants were measured using syringes prior to each repeat of the experiment and remained constant with the exception of the potassium iodide and deionised water solution which ~~ramar~~ varied to reduce the concentration. Hydrogen peroxide was added and a timer was started. The timer was stopped when the mixture became coloured. Standard lab safety procedures were followed and the experiment was repeated three times for each of the five concentrations.

Results

Volume of KI (0.1 mol l⁻¹)(cm³)	Volume of H_2O (cm³)	Concentration of KI(aq) (mol l⁻¹)	Time (s)		
			1	2	3
25	0	0.05	24	29	27
20	5	0.04	30	33	32
15	10	0.03	40	44	43
10	15	0.02	61	67	78
5	20	0.01	133	144	130

concentration of KI(aq) (mol l⁻¹)	average time (s)	relative rate (s⁻¹)
0.05	26.7	0.0375
0.04	31.7	0.0315
0.03	42.3	0.0236
0.02	68.7	0.0146
0.01	135.7	0.0074

example calculation ⇒ concentration = 0.05 mol l⁻¹

average time = $\frac{t_1 + t_2 + t_3}{3} = \frac{24 + 29 + 27}{3} = 26.7\,s$

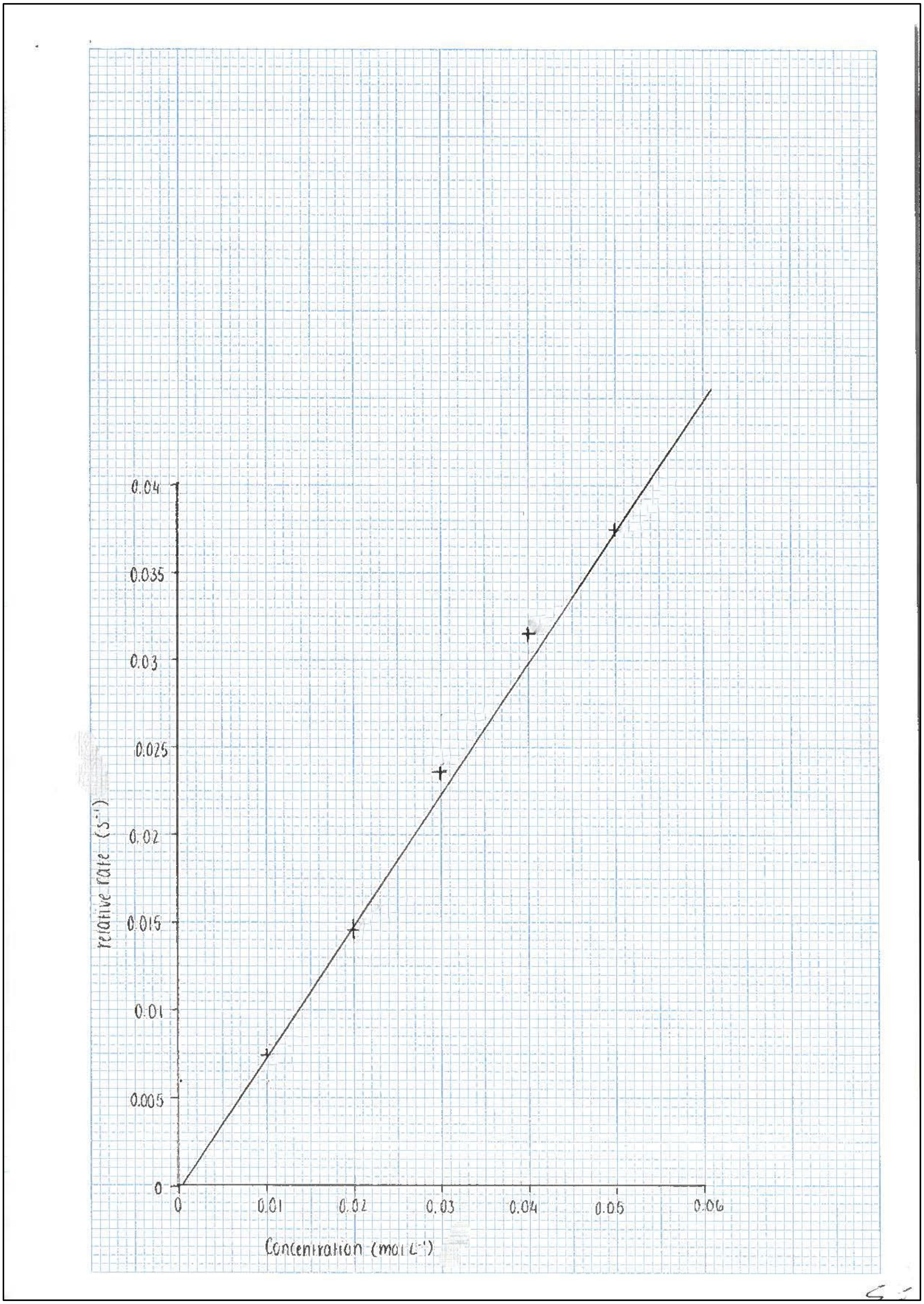
relative rate = $\frac{1}{t} = \frac{1}{26.7} = 0.0375\,s^{-1}$

↑ average time

Source Results

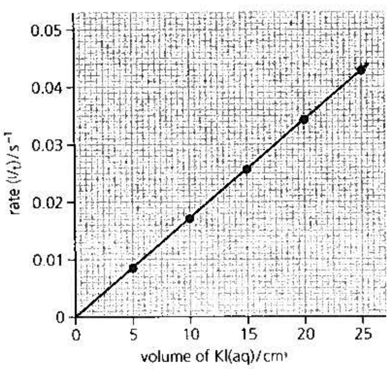
Volume of KI(aq)/cm³	Volume of H_2O/cm³	Time (t)/s	Rate (1/t)/s⁻¹
25	0	23	0.043
20	5	29	0.034
15	10	39	0.026
10	15	60	0.017
5	20	111	0.009

(1)


0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
relative rate (s⁻¹)
0
0.01
0.02
0.03
0.04
0.05
0.06
Concentration (mol L⁻¹)

Source Volume - Rate Graph/

(1)



Analysis/

Both my results and the secondary source ~~show~~ show an increasing trend in rate of reaction when the concentration of Potassium iodide is increased. Both my graph and the source graph display a directly proportionate relationship between the rate of reaction and the concentration ~~of potassium iodide~~ (or volume) of potassium iodide as they both feature a straight line as their line of best fit.

Conclusion/

In conclusion, when the concentration of potassium iodide is increased the rate of reaction also increases and when the concentration is decreased the rate of reaction decreases. This is demonstrated by my results, my graph and the secondary source.

Evaluation,

My secondary source is an SQA endorsed textbook. It was written by scientists and is approved by the SQA making it trustworthy and valid for comparison with my results. This supports the accuracy of my results as my calculated results are similar ~~and follow~~ to the source and follow the same trend.

When completing the experiment, the bottle of potassium iodide that we were using ran out before the experiment could be fully completed. This meant that we had to use a new bottle. This may slightly affect the accuracy of my results as there may be a slight discrepancy between the concentrations of the different bottles. This could have been avoided by ensuring that the required volume of reactants to complete all of the experiment repeats was available prior to conducting the experiment so it could be completed in one batch.

When timing the experiment, it was agreed that the timer would be stopped when the mixture turned a deep blue/black colour. This ensured that the timer was stopped at the same point in the reaction everytime to guarentee the most precise and accurate results were recorded.

References/

(1) Book: Higher Chemistry for CfE ; John Anderson, Eric Allan and John Harris ; Pages 9/10
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