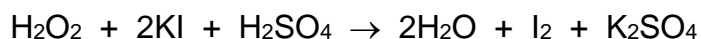


Practical question 1 (Paper 3 practice) 17 marks - 25 minutes

Hydrogen peroxide reacts with potassium iodide to produce iodine:



The rate of this reaction can be followed by using the *iodine clock* technique. A fixed amount of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) solution and a small amount of starch solution are added to the reaction mixture. The sodium thiosulfate reacts with the iodine as soon as it is formed but when all the sodium thiosulfate is used up the iodine reacts with the starch to produce a blue-black colour. The experiment thus measures the time taken for a fixed amount of iodine to be produced.

The equation for the reaction between thiosulfate ions and iodine is: $\text{I}_2 + 2\text{S}_2\text{O}_3^{2-} \rightarrow 2\text{I}^- + \text{S}_4\text{O}_6^{2-}$

A student carried out a series of experiments to investigate how changing the concentration of potassium iodide changes the rate of the reaction. They made up the reaction mixtures shown in the table below. The hydrogen peroxide solution was added last and the timer started. The timer was stopped when the reaction mixture became blue-black.

The student recorded the following data

Expt. No.	Volume 1.00 mol dm ⁻³ H ₂ SO ₄ /cm ³ ±0.1	Volume 0.100 mol dm ⁻³ KI /cm ³ ±0.1	Volume H ₂ O /cm ³ ±0.1	Volume of 0.00500 mol dm ⁻³ Na ₂ S ₂ O ₃ /cm ³ ±0.1	Volume of 1.2 volume hydrogen peroxide ±0.1	Time / s ±1
1	10.0	25.0	0.0	10.0	5.0	32
2	10.0	20.0	5.0	10.0	5.0	40
3	10.0	15.0	12.0	10.0	5.0	
4	10.0	10.0	15.0	10.0	5.0	80
5	10.0	5.0	20.0	10.0	5.0	160

1.0±0.1 cm³ of starch solution was added to each reaction mixture.

- (a) Other than the concentrations and volumes of the reactants explain one other variable that it is important to control in this experiment. [1]

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- (b) (i) Calculate the absolute uncertainty on the volume of the reaction mixture in experiment 1 [1]

- (ii) Calculate the concentration of potassium iodide in the reaction mixture in experiment 1. [2]

- (iii) Determine the absolute uncertainty of the concentration of potassium iodide in experiment 1 [2]

(c) (i) Calculate the number of moles of iodine required to react with the sodium thiosulfate present in experiment 1. [2]

(ii) Calculate the change in concentration of iodine required to cause the reaction mixture to become blue-black and hence the rate of reaction in experiment 1 [2]

(d) The student made a mistake in determining the volumes to use in experiment 3. Explain what the mistake is and the effect this would have on the time recorded. [2]

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(e) Use the data in the table to deduce the order of reaction with respect to potassium iodide. [2]

(f) Hydrogen peroxide decomposes to form water and oxygen.

(i) Write an equation for the decomposition of hydrogen peroxide. [1]

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(ii) The concentration of hydrogen peroxide solutions is often expressed as a volume concentration, where the number refers to the volume of oxygen gas (measured at STP) obtained when 1 cm³ of solution decomposes. Thus 1 cm³ of 20 volume hydrogen peroxide solution produces 20 cm³ of oxygen gas when it decomposes fully. Calculate the concentration in mol dm⁻³ of a 1.2 volume hydrogen peroxide solution. [2]