Determine the activation energy for a reaction

Education in Chemistry
October 2018
rsc.li/2OM1O0Z
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Determine the activation energy for the reaction between bromide ions and bromate(V) ions

Objective: Use the Arrhenius equation to determine the activation energy of a reaction

Safety

- Wear a lab coat and gloves, and use eye protection.
- Phenol is corrosive and toxic.
- Sulfuric acid solution is an irritant.
- Potassium bromate(V) is oxidising.

Preliminary testing

Trial	Instructions	Observations	Inferences
1	Pipette 10 cm^3 of phenol solution and 10 cm^3 of bromide and bromate(V) solution into a boiling tube. Place into a water bath at approximately 70ºC.		
2	Pipette 10 cm^3 of phenol solution and 10 cm^3 of bromide and bromate(V) solution into a boiling tube. Place into a water bath at approximately 70ºC. Pipette 5 cm^3 of sulfuric acid solution into a boiling tube. Place into the water bath. When warm, pour the sulfuric acid into the other boiling tube.		
3	Pipette 10 cm^3 of phenol solution and 10 cm^3 of bromide and bromate(V) solution into a boiling tube. Add 4 drops of methyl red indicator. Place into a water bath at approximately 70ºC. Pipette 5 cm^3 of sulfuric acid solution into a boiling tube. Place into the water bath. When warm, pour the sulfuric acid into the other boiling tube.		

Preliminary analysis

1. Write an equation for the reaction occurring in Trial 2 to form the white precipitate.

2. Write an equation for the redox reaction occurring between bromide ions and bromate(V) ions.

3. The methyl red indicator is decolourised by the reaction with bromine. Why does it not decolourise instantly?

Investigation

- Complete a number of experiments to study the rate of this redox reaction at a range of temperatures.
- Design a suitable table of results.
- Plot a graph of $\frac{1}{T}$ (with T in Kelvin) against $\ln t$ (with *t* in seconds).
- Starting from the Arrhenius equation, $k = Ae^{-\frac{E_a}{RT}}$, show mathematically that $-\frac{E_a}{RT}$ is the gradient of the line.

- The gradient of the line from your graph is $-\frac{E_a}{RT}$. Calculate the activation energy of the reaction.