EXPERIMENT 5
CHEMICAL KINETICS II
Effects of Temperature and Catalysts

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$$2I^- (aq) + S_2O_8^{2-} (aq) \rightarrow I_2 (aq) + 2SO_4^{2-} (aq)$$

How is the rate of change of each reactant and each product related to each other?

We can express the rate of iodide consumption as

= 2 × [rate of peroxidisulfate consumption]
= 2 × [rate of iodine production]
= [rate of sulfate production]

THE RATE LAW/EQUATION

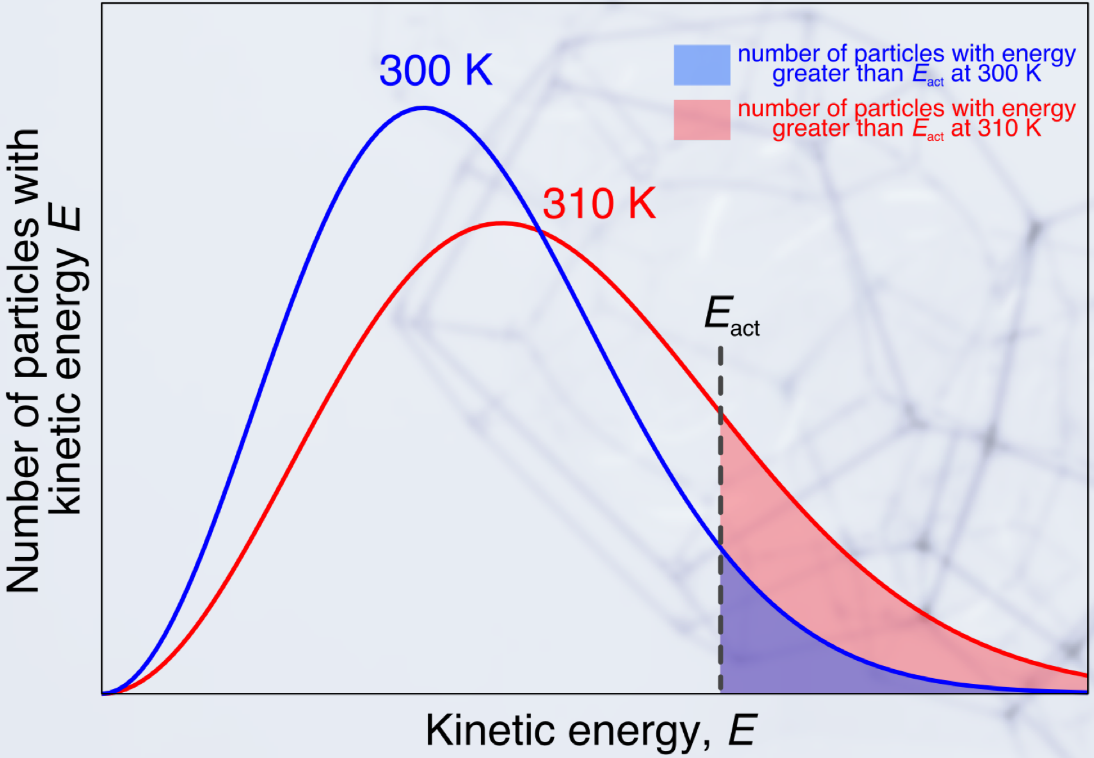
The reaction is 1st order with respects to both reactants: I^- and $S_2O_8^{2-}$

$$\text{Rate} = k[\text{I}^-][\text{S}_2\text{O}_8^{2-}]$$

$$k = \frac{\text{Rate}}{[\text{I}^-][\text{S}_2\text{O}_8^{2-}]}$$

If the "initial" rate of reaction can be measured/determine experimentally, the value of *k* can be calculated as:

$$k = \frac{\text{Initial Rate}}{[\text{I}^-]_0[\text{S}_2\text{O}_8^{2-}]_0}$$



PURPOSES:

1. Temperature dependence
2. Effect of catalyst (Cu^{2+})

Axiom:
Reaction rate doubles for a 10 °C rise.

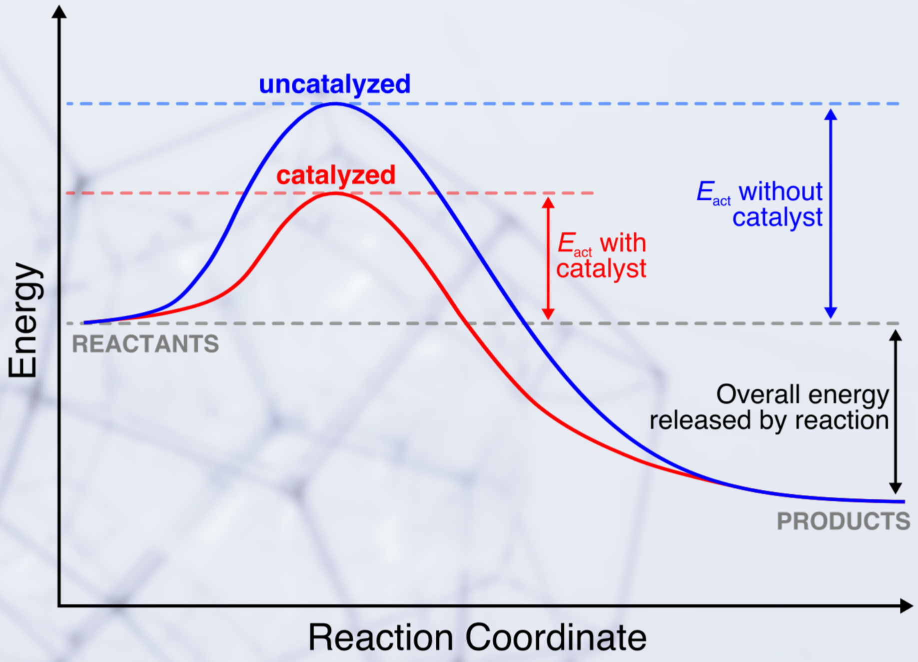
THE ARRHENIUS EQUATION

$$k = Ae^{-\frac{E_{\mathrm{act}}}{RT}} \qquad \ln k = \ln A - \frac{E_{\mathrm{act}}}{RT}$$

plot ln k vs. $1/T$

How does a catalyst increase the speed of a reaction?

1. It is not consumed in reaction.
2. It lowers the E_{act}.
3. It catalyzes both directions.
4. It speeds up attainment of equilibrium.



How do we measure the speed of our reaction?
What is the role of the thiosulfate ion ($S_2O_3^{2-}$)?

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I_2 *(aq)* + $2S_2O_3^{2-}$ *(aq)* → $2I^-$ *(aq)* + $S_4O_6^{2-}$ *(aq)*

This is an extremely fast reaction compared to our reaction of interest.

↓

As long as there is $S_2O_3^{2-}$ in the reaction mixture, $[I_2] = 0$

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When all $S_2O_3^{2-}$ is consumed, I_2 accumulates.
Reaction mixture turns **BLUE** (with starch indicator).

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

Then determine the rate:

$$\text{Rate} = -\frac{\Delta[\mathrm{I_2}]}{\Delta t} = -\frac{1}{2}\frac{\Delta[\mathrm{S_2O_3^{2-}}]}{\Delta t} = \frac{1}{2}\frac{[\mathrm{S_2O_3^{2-}}]_0}{t_{\text{blue}}}$$

BECAUSE

$$\Delta[\mathrm{S_2O_3^{2-}}] = [\mathrm{S_2O_3^{2-}}]_{\text{blue}} - [\mathrm{S_2O_3^{2-}}]_0$$
$$= 0 - [\mathrm{S_2O_3^{2-}}]_0$$