

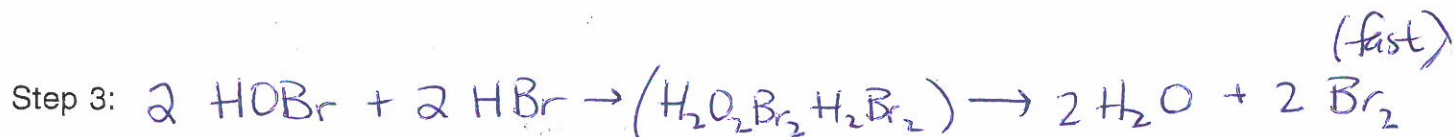
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Chemistry 12
REACTION KINETICS

Lesson # 9/10 REACTION MECHANISMS WITH ENERGY DIAGRAMS

Because the PROBABILITY of more than TWO particles colliding SIMULTANEOUSLY is highly UNLIKELY, reactions involving more than TWO PARTICLES must involve a multiple step reaction mechanism.

Example 1: For the chemical reaction : $4 \text{HBr} + \text{O}_2 \rightarrow 2 \text{H}_2\text{O} + 2 \text{Br}_2$
it has been experimentally determined that the reaction occurs in a THREE STEP REACTION MECHANISM



TERMS TO KNOW:

REACTION MECHANISM- the actual sequence of steps required to form the products.

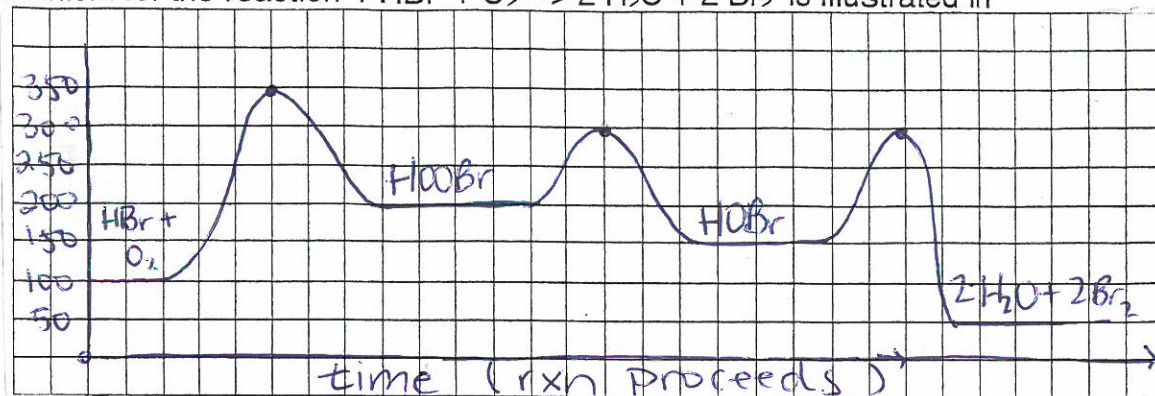
ELEMENTARY PROCESS- an individual step in the reaction mechanism.

RATE DETERMINING STEP- (experimentally determined) the SLOWEST step in the reaction mechanism.

REACTION INTERMEDIATE- a very stable molecule that is first formed and then used in the reaction mechanism. It does not appear in the overall reaction.

The reaction mechanism for the reaction $4 \text{HBr} + \text{O}_2 \rightarrow 2 \text{H}_2\text{O} + 2 \text{Br}_2$ is illustrated in the graph below:

Potential Energy (kJ)



The Activation Energy (E_a) for an individual step can be determined using
 E_a (individual step) = PE(activated complex) - PE (Reactants for the step)

Example 2:

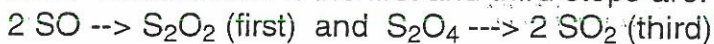
- a. Use the graph to identify the RATE DETERMINING STEP in the reaction mechanism. *The step with the Activated Complex with the highest Potential Energy (Step 1)*
- b. Calculate the activation energies for each step in the reaction mechanism

E_a (step 1) = $350 \text{ kJ} - 100 \text{ kJ} = 250 \text{ kJ}$

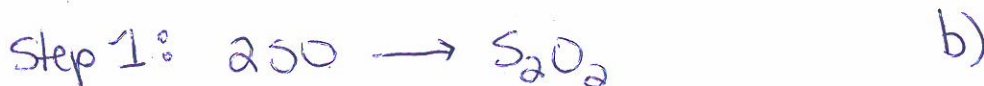
E_a (step 2) = $300 \text{ kJ} - 200 \text{ kJ} = 100 \text{ kJ}$

E_a (step 3) = $300 \text{ kJ} - 150 \text{ kJ} = 150 \text{ kJ}$

Example 3. A chemist suggests that the reaction $2 \text{SO} + \text{O}_2 \rightarrow 2 \text{SO}_2$ has a THREE STEP mechanism. If the first and third steps are:



- a. What is the Second Step in the proposed reaction?
 b. List all of the Reaction Intermediates present in the reaction mechanism
 c. What is the formula of the Activated Complex for the second step?



a) Step 2:



overall: