

Name: Key
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**Chemistry 12
 REACTION KINETICS**

Lesson # 9/10 REACTION MECHANISMS WITH ENERGY DIAGRAMS

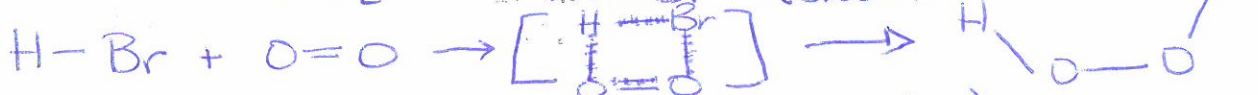
Because the PROBABILITY of more than TWO particles colliding SIMULTANEOUSLY is highly UNLIKELY, reactions involving more than TWO PARTICLES must involve a MULTIPLE - STEP reaction mechanism.

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

**you will NEVER be required to Predict a specific rxn mechanism*

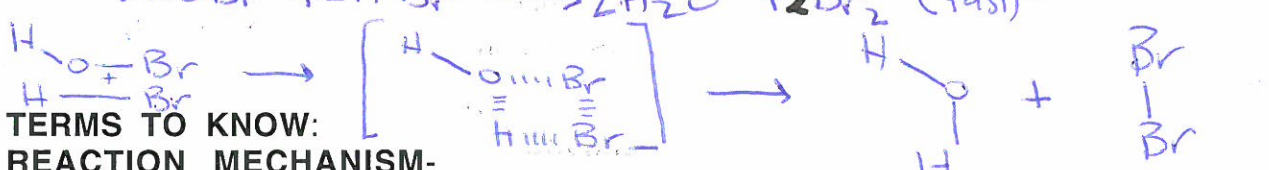
Step 1: $\text{HBr} + \text{O}_2 \rightarrow \text{HOBr}$ (slow)



Step 2: $\text{HOBr} + \text{HBr} \rightarrow 2 \text{H}_2\text{O}$ (fast)



Step 3: $2 \text{HOBr} + 2 \text{HBr} \rightarrow 2 \text{H}_2\text{O} + 2 \text{Br}_2$ (fast)



**TERMS TO KNOW:
 REACTION MECHANISM-**

The actual sequence of steps which makes up an overall rxn.

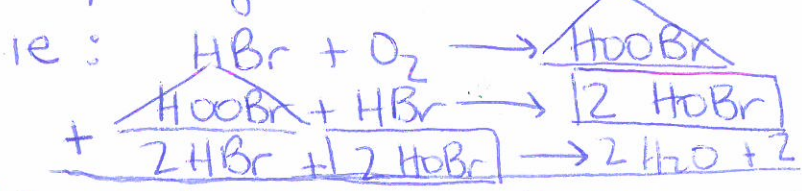
ELEMENTARY PROCESS-

an individual step in a rxn mechanism

∴ the above has THREE ELEMENTARY PROCESSES

RATE DETERMINING STEP- (is experimentally determined) is the SLOWEST STEP in the rxn mechanism (ie step 1).

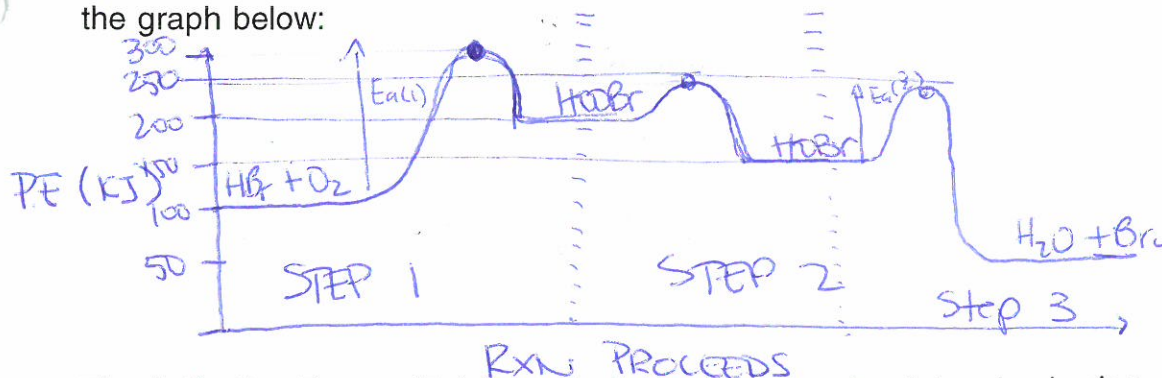
REACTION INTERMEDIATE- ↑ Stable molecules that can exist indefinitely on their own but happen to react quickly in the rxn mechanism. Not present in overall rxn!



∴ rxn intermediates:
 $\text{HOBr} + \text{HOBr}$



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:



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.

Step 1 (highest AC)

b. Calculate the activation energies for each step in the reaction mechanism

E_a (step 1) = $(300 \text{ kJ}) - (100 \text{ kJ}) = 200 \text{ kJ}$

E_a (step 2) = $(250 \text{ kJ}) - (200 \text{ kJ}) = 50 \text{ kJ}$

E_a (step 3) = $(250 \text{ kJ}) - (150 \text{ kJ}) = 100 \text{ kJ}$

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:

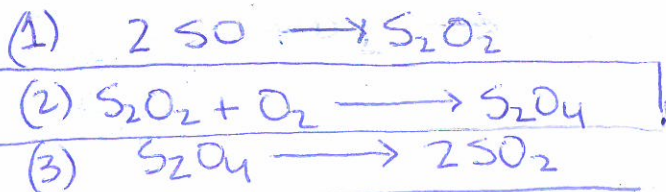
$2 \text{SO} \rightarrow \text{S}_2\text{O}_2$ (first) and $\text{S}_2\text{O}_4 \rightarrow 2 \text{SO}_2$ (third)

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)



b) S_2O_2 and S_2O_4

c) S_2O_4

