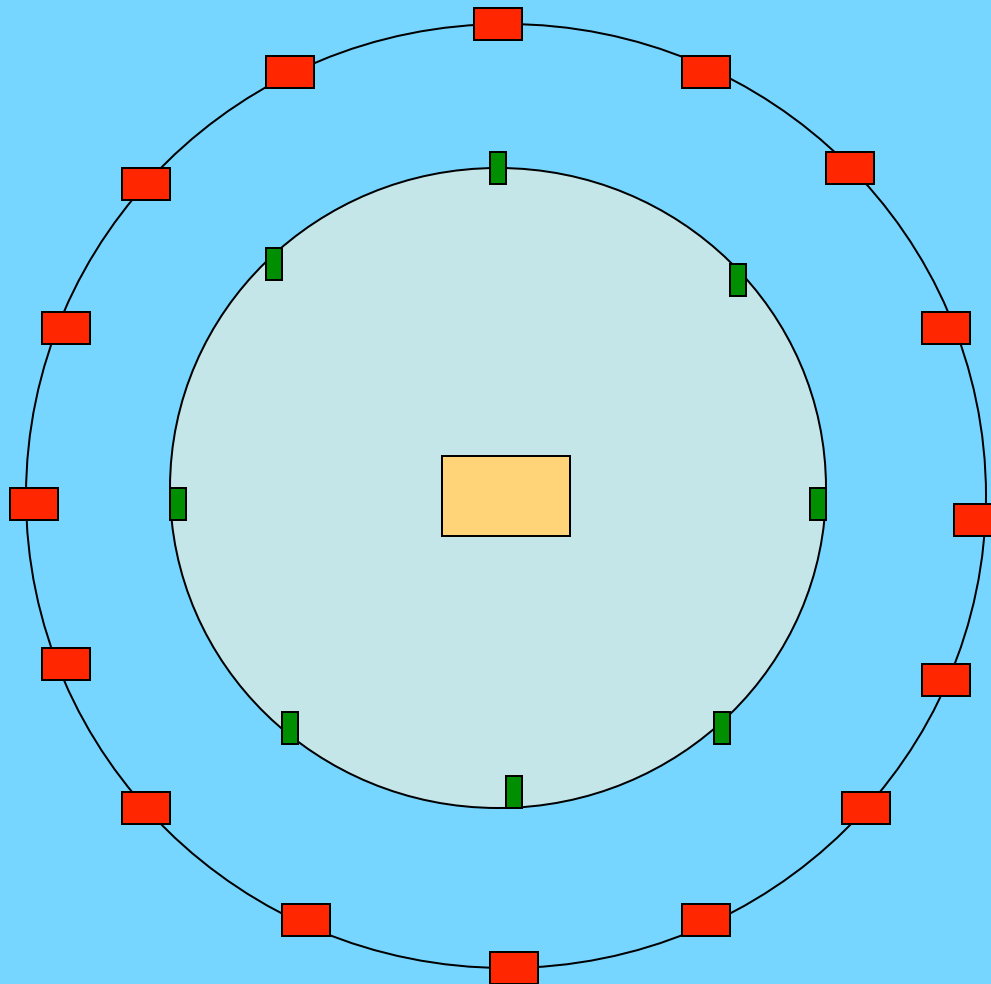


Reaction Mechanisms

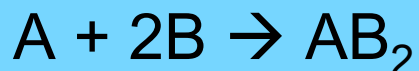
Many reactions occur in steps...!

Rate Limiting Step – An Analogy!!

- Consider the Assembly Hall at the U. of I.



- $A + 2B \rightarrow AB_2$ $\text{Rate} = k[A][B]$
- A “reaction mechanism” is a series of steps by which the reaction occurs, and the steps can occur at different rates:
- Step 1 $A + B \rightarrow AB$ (Slow)
- Step 2 $AB + B \rightarrow AB_2$ (Fast)
- Overall $A + 2B \rightarrow AB_2$
- Each step is called an “elementary step”
- AB is an “intermediate” – a substance that is part of the mechanism but doesn’t show up in the balanced equation



$$\text{Rate} = k[A][B]$$

- Step 1 $A + B \rightarrow AB$ (Slow)
- Step 2 $AB + B \rightarrow AB_2$ (Fast)
- Overall $A + 2B \rightarrow AB_2$

- The rate law for an elementary step can be written from the coefficients in the elementary step

- For Step 1 the rate law is: $\text{Rate} = k[A][B]$

- For Step 2 the rate law is: $\text{Rate} = k[AB][B]$

- Key Concept – the slow step is the rate determining step
- The rate of the slow step is the rate of the overall reaction
- The rate law of the slow step is consistent with the rate law of the overall reaction

Reaction Mechanisms...Another Example

- Step 1 $2A \rightarrow A_2$ (SLOOOOOOOOOOOOW!)
- Step 2 $A_2 + X \rightarrow A_2X$ (Fast!)
- Step 3 $A_2X + B \rightarrow A_2B + X$ (Fast!)

- What would the overall reaction be (balanced equation)?
- Overall $2A + B \rightarrow A_2B$
- What would the rate law be??
- Rate = $k[A]^2$
- What are A_2 and A_2X ?
- Intermediates!!
- What is X?
- A Catalyst!!
- Note – intermediates do not appear in the rate law

Reaction Mechanisms...Practice Problem 1

- For the reaction $3X+2Y\rightarrow X_3Y_2$ the rate law is $\text{Rate}=k[X]^2[Y]$
- The following mechanism is proposed:
 - Step 1: $X+Y\rightarrow XY$
 - Step 2: $2X+Y\rightarrow X_2Y$
 - Step 3: $XY+X_2Y\rightarrow X_3Y_2$
- Which is the rate limiting step?
- What is (are) the intermediates?

Reaction Mechanisms...Practice Problem 2

- For the reaction $2A + 2B \rightarrow A_2B_2$ the rate law is $\text{Rate} = k[A]^2$
- Two proposed mechanisms are:
 - Mechanism 1:

Step 1	$2A + B \rightarrow A_2B$	Slow
Step 2	$A_2B + B \rightarrow A_2B_2$	Fast
 - Mechanism 2:

Step 1	$2A \rightarrow A_2$	Slow
Step 2	$A_2 + B \rightarrow A_2B$	Fast
Step 3	$A_2B + B \rightarrow A_2B_2$	Fast
- Which mechanism is consistent with the rate law?