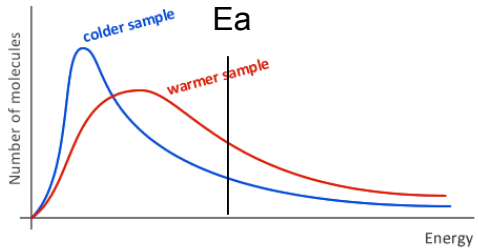


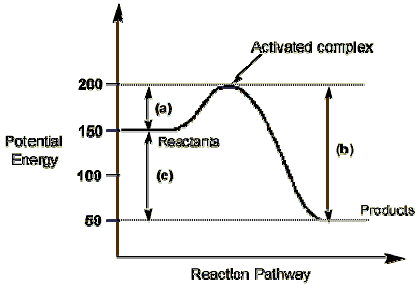
TRANSITION STATE THEORY

- looks at transition between reactants to products.
- i.e. K.E. is converted to potential energy as the reactants collide

POTENTIAL ENERGY DIAGRAM

- diagrammatic way of representing P.E. as a reaction progresses
  -
  -

Exothermic : reactants have higher energy level than products



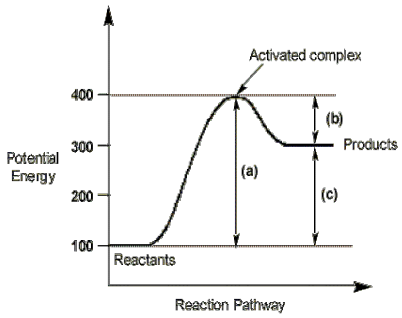
The activation energy (E_a) for the forward reaction is shown by **(a)**:

The activation energy (E_a) for the reverse reaction is shown by **(b)**:

The enthalpy change for the reaction is shown by **(c)**:

-
-
-

Endothermic: reactants energy is lower than products



The activation energy (E_a) for the forward reaction is shown by **(a)**:

The activation energy (E_a) for the reverse reaction is shown by **(b)**:

The enthalpy change for the reaction is shown by **(c)**:

- top of Ea:
- **activated complex** -

- Occurs during the **transition state** of the reaction

PRACTICE PROBLEMS P. 294 #13 - 16

CATALYSIS DEMONSTRATION

In this demonstration the reaction between rochelle salt (sodium potassium tartrate, $KNaC_4H_4O_6 \bullet 4H_2O$) and hydrogen peroxide produces carbon dioxide. The reaction can be qualitatively followed, by observing the rate of production of bubbles of gas. The reaction is catalysed by Co^{2+}, which forms a reaction intermediate.

Questions and Observations

1. Why was the solution of rochelle salt and hydrogen peroxide heated?

2. Why was the solution divided?

3. After the solution was divided, what evidence was there for a chemical change?

4. Describe the $CoCl_2$ solution catalyst.

5. Should the catalyst be added to the reaction solution or vice versa?

6. What did you observe after the catalyst was added?

7. In your own words, define the term catalyst.

8. Predict what will happen when the contents of the beaker are added to the "control" beaker

6.4 REACTION MECHANISMS AND CATALYSTS

- most chemical reactions proceed over a number of steps

ELEMENTARY REACTIONS

Reaction Mechanism

▪

Elementary reaction

▪

▪

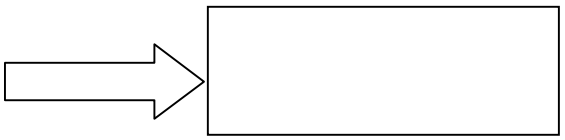
- ie. can involve formation of different molecules or ions or a change in energy or geometry of starting molecules.

e.g. $2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$

2 steps involved

(1) $NO_{(g)} + O_{2(g)} \longrightarrow NO_{3(g}$

(2) $NO_{3(g)} + NO_{(g)} \longrightarrow 2NO_{2(g)}$



▪

- Presence of intermediate would help explain the mechanism

Molecularity of Elementary Reactions

Molecularity ⇒

e.g. previous had 2 molecules colliding at each step
∴ <u>bimolecular</u> -
<u>unimolecular</u> - 1 particle reacts (Cl_2 light $\longrightarrow$ 2Cl)
<u>termolecular</u> -
(rare to have it happen)

RATE LAW EQUATIONS FOR ELEMENTARY REACTIONS

•

eg. A $\longrightarrow$ product Rate = K [A]
2A $\longrightarrow$ product Rate = $K[A]^2$

- Reaction mechanisms -

▪

- Look for a possible colour change if intermediate is present, and has that colour.

In order for a mechanism to be proposed it must fulfill the following criteria:

1.

2. .

3.

RATE DETERMINING STEP

ie. assembly line analogy - only as fast as the slowest guy

How does the rate determining step relate to rate law of overall?

Eg. $2NO_{2(g)} + Cl_{2(g)} \longrightarrow 2NO_2Cl_{(g)}$

Rate = $k[NO_2][Cl_2]$

Proposed mechanism:

1.

2.

reasonable

▪
▪

Does the mechanism support the experimentally determined rate law?

-

∴ rate of overall reaction depends on rate of slow step

▪

Step 1 $Rate_1 = k_1[NO_2][Cl_2]$

▪

∴

eg. $2NO_{(g)} + 2H_{2(g)} \longrightarrow N_{2(g)} + 2H_2O_{(g)}$

Rate law is $Rate = k[NO]^2[H_2]$

Proposed mechanism

Step 1 $2NO_{(g)} + H_{2(g)} \longrightarrow N_2O_{(g)} + H_2O_{(g)}$ slow

Step 2 $N_2O_{(g)} + H_{2(g)} \longrightarrow N_{2(g)} + H_2O_{(g)}$ fast

is the proposed mechanism reasonable?

(A)

(B)

Step 2 is bimolecular Step 1 is the molecular (rare by possible)

-

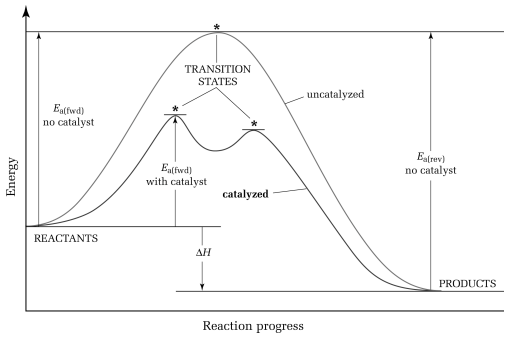
$\therefore$

▪

$\therefore$ seems reasonable

p.301 practice #17 - 20

CATALYSTS -



How a Catalyst works:

▪

▪

-

-

e.g. A + B ⟶ AB one step bimolecular reaction

Step 1 A + catalyst ⟶ A-catalyst

Step 2 A - catalyst + B ⟶ AB + catalyst

OVERALL A + B = AB

A - catalyst —>

- Catalyst - produced in step 1 —> consumed in step 2
  -
  -

Homogeneous Catalysts –

Heterogeneous Catalysts –