

**A. Definition:** Rate =

Chemistry Rate =

Units:

**B. Four Factors Affecting Rates of Chemical Reactions**1. ConcentrationFor the Reaction:  $A + B \rightarrow C + D$ 

## a. Relative Rates

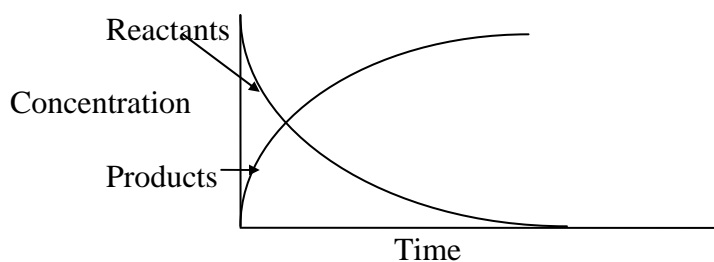
Start with 2.0 M A and 4.0 M B, then trial 2 with 1.0 M A and 2.0 M B. Faster reaction??

## b. Changes in concentrations over time

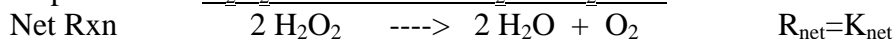
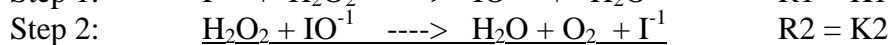
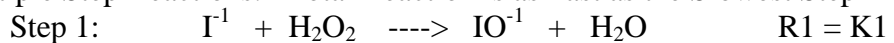
Start:

End:

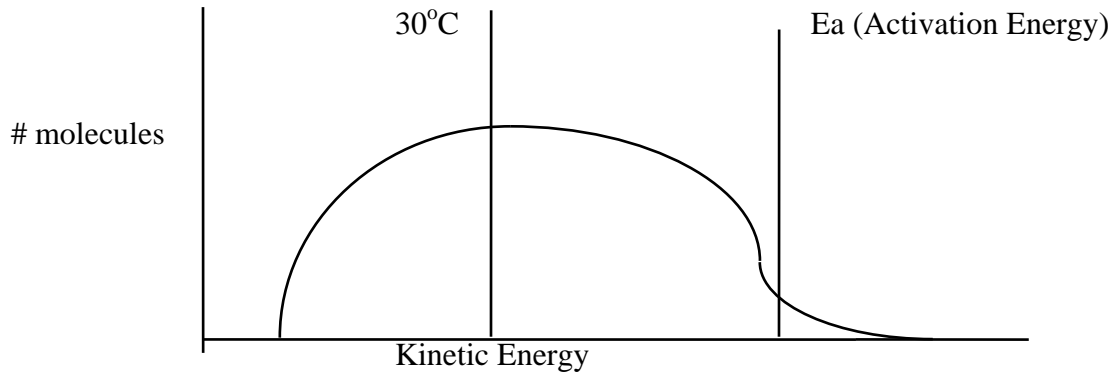
SLOPE OF LINE EQUALS THE RATE OF THE REACTION



## c. Multiple Step Reactions: Total Reaction is as Fast as the Slowest Step

2. Surface Area:

3. Temperature: 10°C rule:



Example: Let a rate = "1" at 20°C

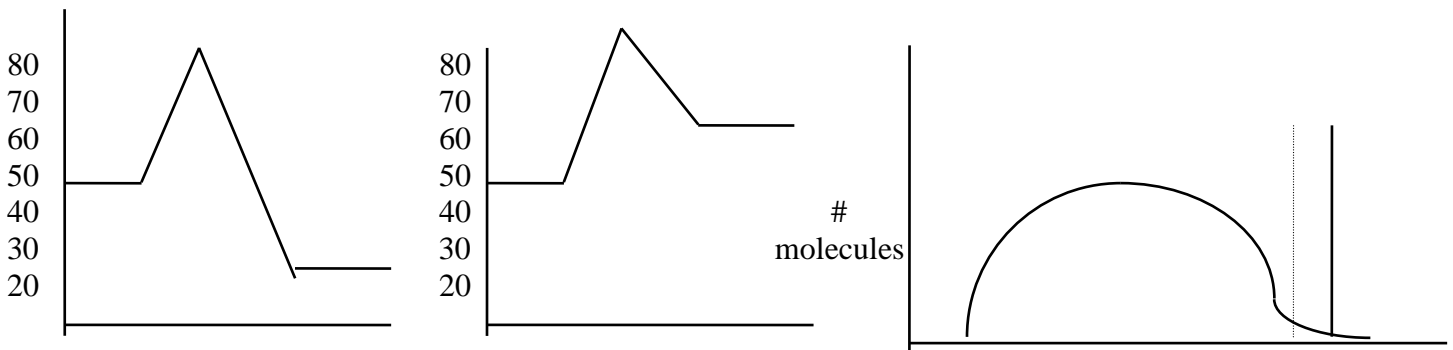
Temp.      Rate  
 20 C      1

4. Effect of Catalysts

Catalysts: 1.

2.

a. Descriptions of Lowering Ea      Ea normal ←→      Ea with Catalyst ←.....→



Ea is the energy from the Reactants to the Top of the Hill

$\Delta H$  is the energy from the Reactants to the Products (beginning to end ignoring the height of the hill)

At the top is the **Activated Complex**---an intermediate form which has:    **1.**

**2.**

b. Methods of Lowering the Ea of a reaction

i) React with Reactants Ex:

ii) Offer Substrate for Reaction:

## AR CHEMISTRY: REACTION RATES NOTES

### A. Definition: Rate = Performance / Time

Chemistry Rate =  $\Delta$ Concentration / Time

Units: M/sec, M/Lsec

### B. Four Factors Affecting Rates of Chemical Reactions

#### 1. Concentration

For the Reaction:  $A + B \rightarrow C + D$

Rate =  $K [A] [B]$  Brackets indicate MOLARITY

##### a. Relative Rates

Start with 2.0 M A and 4.0 M B, then trial 2 with 1.0 M and 2.0 M B. Faster reaction??

$$R1 = K [2.0] [4.0] = 8.0 K$$

$$R2 = K [1.0] [2.0] = 2.0 K$$

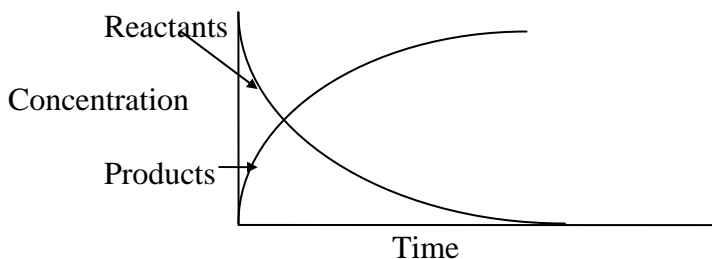
$$\text{Relative Rate} = \text{Fast} / \text{Slow} = R1/R2 = 8.0 K / 2.0 K = 4$$

Rate 1 is 4 times faster than Rate 2

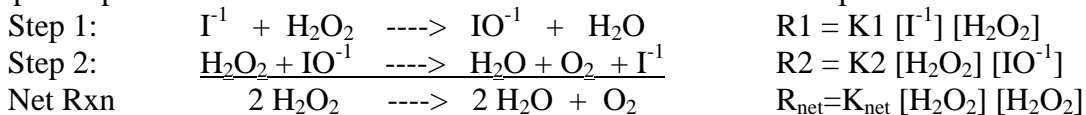
##### b. Changes in concentrations over time

Start:	Lots of Reactants	No Products
	Lose Reactants Fast	Gain Products Fast
	Lose Reactants Medium	Gain Products Medium
	Lose Reactants Slowly	Gain Products Slowly
End:	No Reactants	Lots of Product

SLOPE OF LINE EQUALS THE RATE OF THE REACTION



##### c. Multiple Step Reactions: Total Reaction is as Fast as the Slowest Step



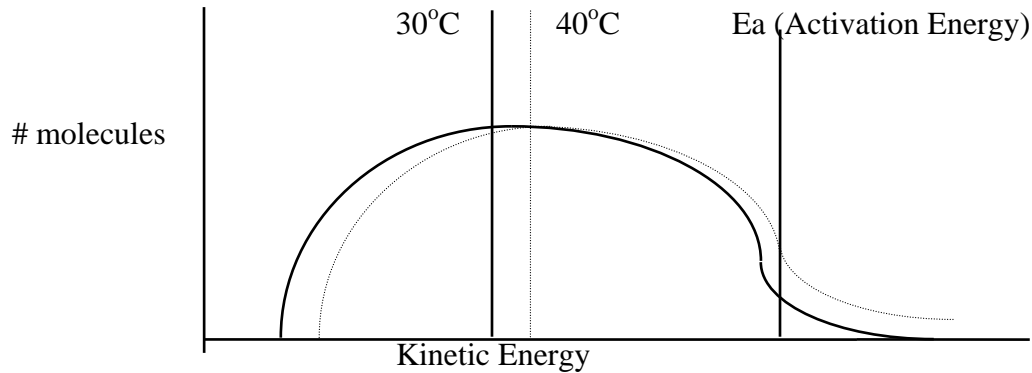
Net Reaction is made by canceling chemicals which are the same on both sides.

#### 2. Surface Area: Increasing the surface area increases the rate of reaction

Make the particles twice as small----double the rate

Make the particles three times smaller---triple the rate

3. Temperature: 10°C rule: For each change of temperature of 10°C, the rate doubles (or is cut in half)  
 Why: The Poisson “whale” shifts to allow twice as many particles past the  $E_a$  line.



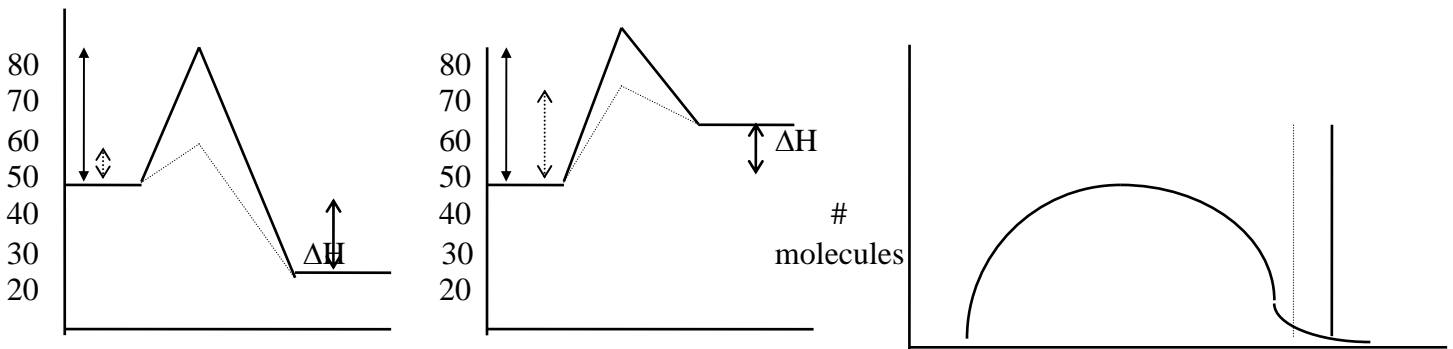
Example: Let a rate = “1” at 20°C

Temp.	Rate
50 C	8
40 C	4
30 C	2
<b>20 C</b>	<b>1</b>
10 C	1/2
0 C	1/4
-10 C	1/8

4. Effect of Catalysts

- Catalysts: 1. Speed up reaction without changing the identity of the catalyst  
 2. Lowers the activation energy ( $E_a$ )

a. Descriptions of Lowering  $E_a$        $E_a$  normal  $\longleftrightarrow$        $E_a$  with Catalyst  $\longleftrightarrow$



$E_a$  is the energy from the Reactants to the Top of the Hill

$\Delta H$  is the energy from the Reactants to the Products (beginning to end ignoring the height of the hill)

- At the top is the **Activated Complex**---an intermediate form which has: **1. Correct alignment**  
**2.  $E_a$  (enough energy)**

b. Methods of Lowering the  $E_a$  of a reaction

- i) React with Reactants Ex:  $I^-$  with  $H_2O_2$  (see section 1c)
- ii) Offer Substrate for Reaction: Ex: Pt in catalytic converter  
 Enzymes in biochemical reactions