Chemistry 12

Reaction Kinetics II

Name:
Date:
Block:

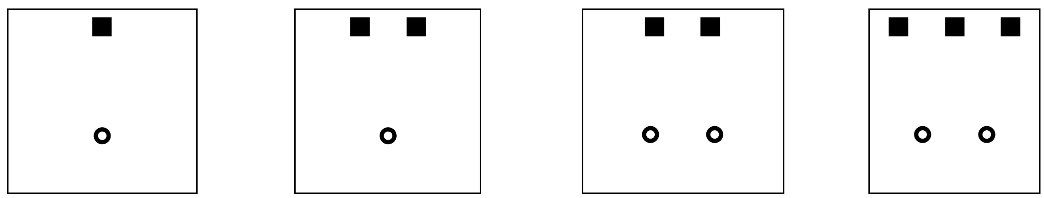
1. **Collision Theory**
2. **Activation Energy**
3. **Potential Energy Diagrams**

Collision Theory (Kinetic Molecular Theory)

- In order for two molecules to react, they must ________________ with each other.
- When they collide they transfer ______________ among themselves.

Consider a hypothetical reaction between two gas particles, A and B, to form AB according to the reaction:

$$A_{(g)} + B_{(g)} \rightarrow AB_{(g)}$$



Total possible collisions: ____________ ____________ ____________ ____________

The rate of reaction is directly proportional to the product of the concentrations of the reactants.

- When two variables are directly proportional to one another, there is a constant that relates the two, called a proportionality constant, represented by the letter *k.*
- Rate Law:

Reaction rate =

- The proportionality constant is called a rate-constant. Each reaction has its own unique rate law and its own unique rate constant.
- **For many reactions, x and y are equal to 1, and are called reactant orders. We will only be dealing with reactions with an order of 1.**

1. Assume a reaction occurs by this rate law: rate = k[A]. How would the rate be affected by each of the following changes in concentration?
   a) [A] is doubled.

   b) [A] is halved.

2. Assume a gaseous reaction occurs by this rate law: rate = k[A][B]. How would the rate be affected if the volume of the container were halved?

3. We also know that **temperature** changes the rate.
    a) Considering the rate law, rate = k[A], how is the rate of a reaction affected by increasing temperature?

    b) What part of the rate law must be affected by changing temperature?

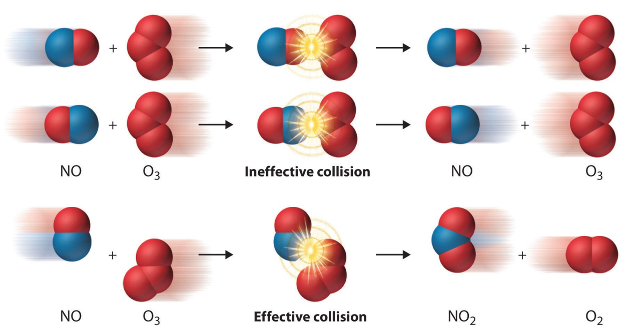
Activation Energy (E_a)

Most collisions are not "successful" and do not result in a reaction.

A **successful collision** requires the following:

1.

2.

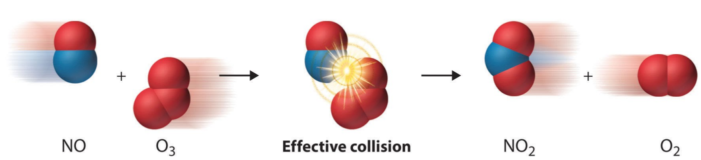


Which of the following reaction is fastest?

a. $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$
b. $Ag^{+}_{(aq)} + I^{-}_{(aq)} \rightarrow AgI_{(s)}$
c. $C_6H_{12}O_{6\,(s)} + 6\,O_{2(g)} \rightarrow 6\,CO_{2(g)} + 6\,H_2O_{(g)}$
d. $5C_2O_4^{2-}{}_{(aq)} + 2MnO_4^{2-}{}_{(aq)} + 16H^{+}_{(aq)} \rightarrow 10CO_{2(g)} + 2Mn^{2+}{}_{(aq)} + 8H_2O_{(l)}$

Activation Energy:

- Must overcome:
    - Repulsive forces between electron clouds of the reacting molecules
    - Weaken or break bonds



Transition State Theory:

When molecules have enough kinetic energy to react collide, their electron clouds initially repel one another to form an unstable transitory configuration of atoms.

- Because they have sufficient kinetic energy to overcome this, the unstable complex will form the desired products.

Bond *breaking* requires energy _______________, while bond *forming* results in energy _________________.

Example:

$H_{2\,(g)} + Br_{2\,(g)} \rightarrow 2\ HBr_{(g)}$

Potential Energy Diagrams

As bonds are broken/formed, there is energy gained and lost. The total energy in the system depending on the position of the particles is called the ___________________ energy. As bonds are broken and formed, the change in the total energy is represented as a Potential Energy Diagram.

Potential Energy Diagrams: Graphical representation of the energy changes that take place during a chemical reaction.

The activation energy, Ea, is the difference between the potential energy of the activated complex and the potential energy of the reactant molecules.

- It represents the amount of energy the reactant molecules must gain to form an activated complex.

E_a =

The enthalpy change (**Δ**H) is the difference between the total potential energy of the products and the total potential energy of the reactants.

ΔH =

Calorimetry – the science of measuring the change in heat associated with a chemical reaction

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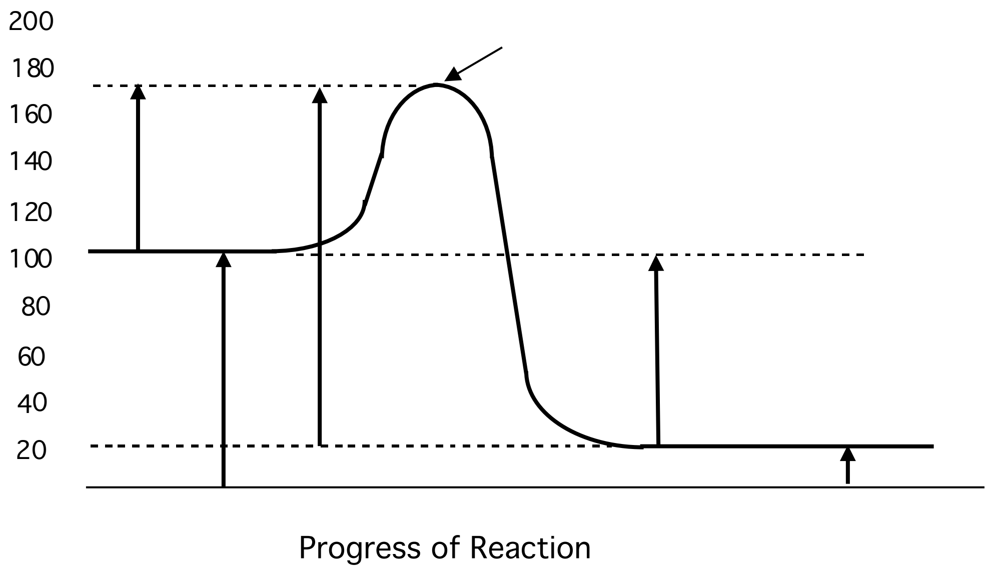
1. Label each arrow in the following diagram:



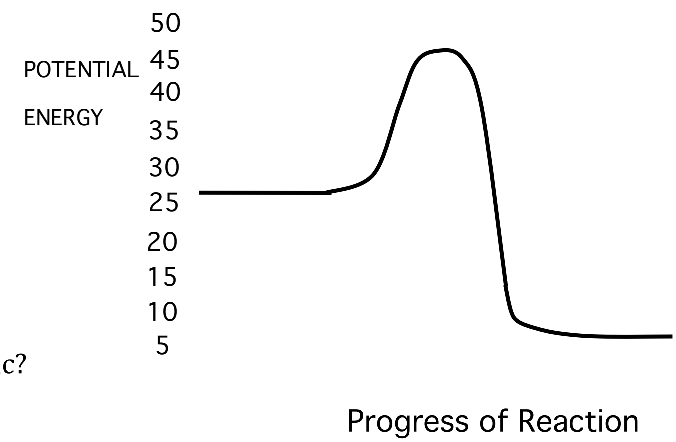
2. Consider the following graph on the right.

a) What is the potential energy of the activated complex?

b) What is the activation energy of the reaction?

c) What is the ΔH for this reaction?

d) Is the reaction endothermic or exothermic?



Many chemical reactions are **reversible** under certain conditions.

The first potential energy diagram could be read in reverse to give the same measurements provided by the second diagram.

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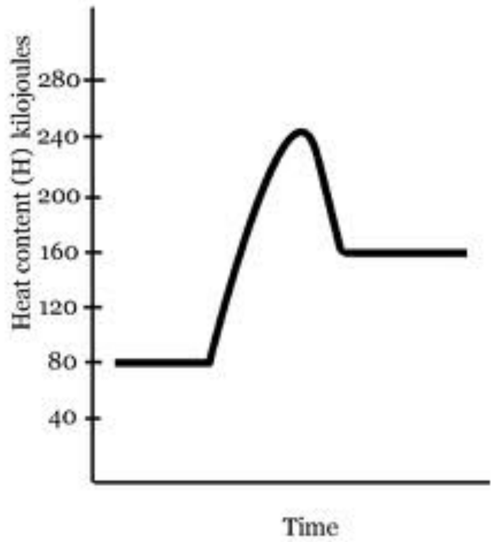
3. Answer the following questions about this potential energy diagram:



a) Give ΔH for the forward reaction. Is this reaction exothermic or endothermic?

b) Give ΔH for the reverse reaction. Is this reaction exothermic or endothermic?

c) Give E_a for the forward reaction.

d) Give E_a for the reverse reaction.

e) Which is faster, the forward or reverse rate?

f) Give the potential energy for the activated complex. How does this value compare for the forward and reverse reactions?

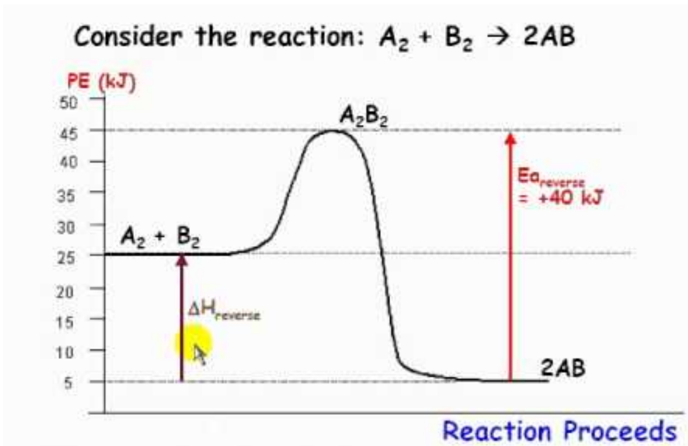
4. Consider the graph and equation on the right:
   a) What species represents the transition state?

   b) Which is faster, the forward or reverse rate?

   c) Circle the specie(s) that has the *strongest* bonds:

      $A_2 + B_2$ OR AB

   d) Explain your answer to the question above.



Hebden Workbook: Pg. 23 #34, 37 Pg. 25 #41-45

Potential Energy Diagrams Worksheet