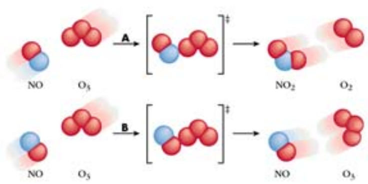
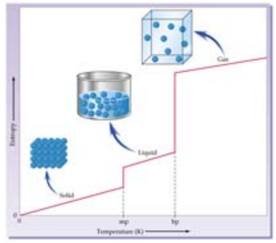
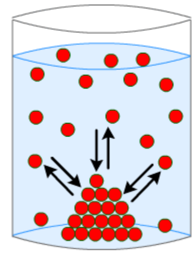
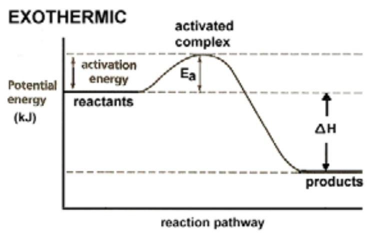
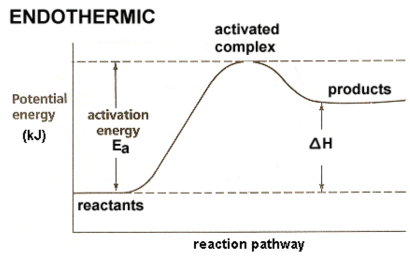






Kinetics/Equilibrium/Thermochemistry

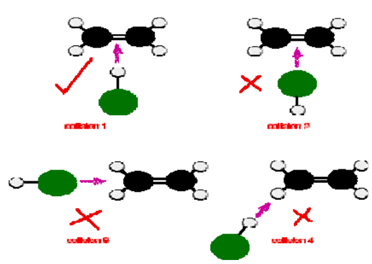


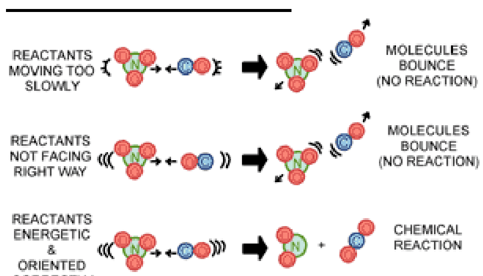


1

Kinetics

- study of the rates of chemical ____________
- Collision theory: in order for a reaction to occur, particles must _________ with proper ______________ and ____________





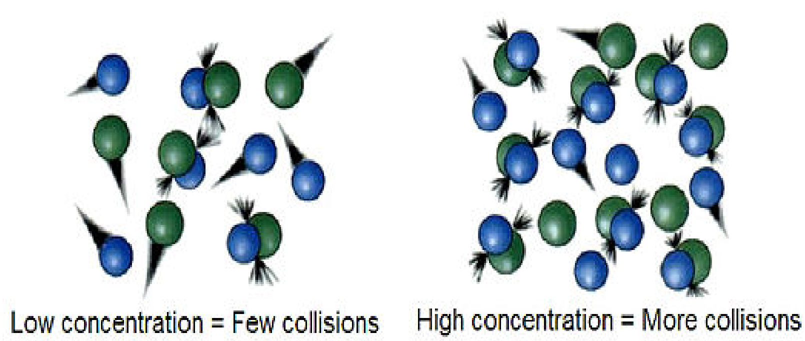
Factors affecting rate of reaction

- Type of reactant (covalent vs. ionic)
  - Covalent
    - _________ to break bond
    - _________ energy required
    - __________ bonds to break
    - Reacts ____________
  - Ionic
    - __________ to break bond
    - __________ energy needed
    - __________ bonds to break
    - Reacts _____________

3

Factors affecting rate of reaction

- Concentration: ___ in amount of reactants will ___ rate of rxn (more _____________ occurring when more is present)



4

Factors affecting rate of reaction

- Surface Area: ___ in surface area will ___ rate of rxn
  - Ex. clump of sugar; inner portions are _______ making _____________ with water (the other reactant)
  - Rxn is __________ than if material was crushed

5

Factors affecting rate of reaction

- Pressure: Specifically affects gases
  - ___ in pressure will ___ amount of collisions
  - In a closed system a volume ___ will lead to a pressure ___ and rxn rate ___
- Temperature: ___ in temp will ___ KE of particles which will result in more energy and more effective collisions
  - As collisions ___, rxn rate also ___
  - Temperature and Movement animation

6

Factors affecting rate of reaction

- Catalyst: Provides an _________________ for a reaction
  - ___ rate of rxn
  - Causes activation (___________) energy to be ___________, so rxn may start ___________
  - remains ______________ when rxn is complete

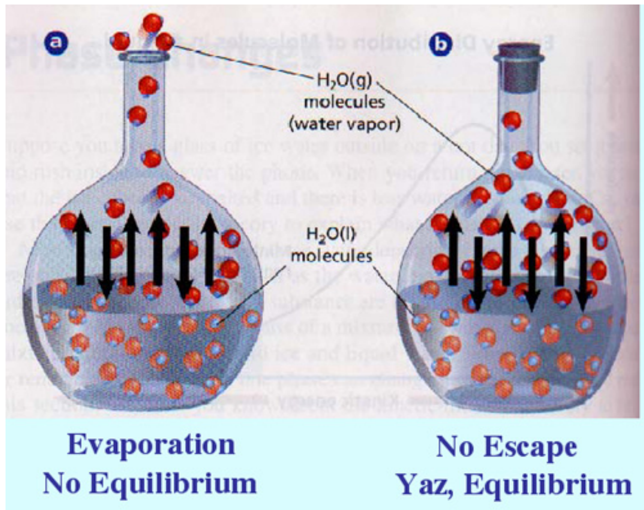
7

Equilibrium

- when both forward and reverse reactions occur at the __________________ (in a closed system)
- Ex. $H_2O(l) \Leftrightarrow H_2O(g)$ (represented by double arrow)
- ______________ of reactants and products do ___ have to be equal, but there of __________ or _____________ up are equal
  - Ex. rate of water ______________ is the same is water vapor _________________ back to liquid
  - Boiling water → steam rises and condenses back into the pot

8

Equilibrium



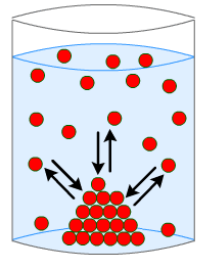
9

Physical Equilibrium

- Changing of ____________ occurs
- <u>Phase equilibrium</u>: between solid/liquid or melting/freezing
  - Water will _________ and ___________ at the same rate at O°C ($H_2O(s) \Leftrightarrow H_2O(l)$)
- <u>Solution Equilibrium</u>: solids in liquids
  - When ______________ = _______________ (at a constant temperature)

10

Physical Equilibrium



- Ex. sugar in a saturated tea solution→ some may _____________, but other molecules will _____________ ($C_{12}H_{22}O_{11}(s) \Leftrightarrow C_{12}H_{22}O_{11}(aq)$)

• Can also occur with a gas in a liquid
- CO_2 in soda ($CO_2(g) \Leftrightarrow CO_2(aq)$)
- If temperature ___, more gas will __________ then will be converted/dissolved to aqueous form

11

Chemical Equilibrium

- When reactants are 1st mixed, only the ________________ reaction will occur
- When reactant amount ___ and product ___ the ______________ reaction will be favored
- When forward = reverse, _________________ is achieved

12

Le Chatelier's Principle

- Systems will ________________________ due to changes in ________________, ________________ or _____________ so as to relieve stress on the system
  - May shift forward (to the ________)
  - May shift reverse (to the ________)

13

Le Chatelier's Principle

- **<u>Changes in Temperature</u>**: ex. $N_2 + 3H_2 \Leftrightarrow 2NH_3$ + Heat
  - If Heat ____, _____________ rxn favored
    - Easier to __________________ larger molecules into smaller ones with the addition of heat
    - Typically takes place with ________________ reactions (heat ___)
  - If Heat ____, _____________ rxn favored
    - Easier for smaller reactants to ___________ and form a ______________ product
    - Typically takes place with ________________ reactions (heat ___)

14

Le Chatelier's Principle

- **Changes in Concentration**:
  - _______________ of a _____________ will shift equilibrium to the _____________
    - More __________ is formed
    - _____________ rxn favored over _____________
    - _________________ will eventually be met
  - _________________________ of a reactant will shift equilibrium to the ___________
    - Less product can be formed
    - _______________ rxn favored over _______________
    - Equilibrium is eventually met

15

Concentration Shift

- Ex. $4NH_3(g)+5O_2(g) \Leftrightarrow 4NO(g) + 6H_2O(g)$ + Heat
- If ______(g) is removed from the __________, $NO(g)$ and $H_2O(g)$ would be impossible to ________

16

Le Chatelier's Principle

- **Changes in Pressure**: (typically with gases)
  - When only 1 gas present on both sides of a reaction; $CO_2(g)$ ⇔ $CO_2(aq)$
    - Pressure ___ will favor the ____________ rxn
    - More CO_2 (g) going ______ solution→ becoming CO_2 (aq)
    - Pressure ___ will favor the ___________ rxn
    - $CO_2(g)$ will come ________ solution (when you open a soda can

17

When # of gas molecules/moles is different on both sides of the reaction

- ex. $N_2(g)$ + $3H_2(g)$ ⇔ $2NH_3(g)$
  - ___ moles of reactants⇔___ moles of products
- An ___in pressure will ___ concentration of reactants and products on ______ sides of equation
  - Molecules move closer together so reactants _______ to make _________ product
  - Will favor the ____________ rxn towards the side with the ___________ gas moles (_________(g) above)
- A ___ in pressure will favor the _________ direction.
  - ________ product made as molecules are farther apart and will ____________ as successful as under high pressure

18

Le Chatlier's Priciple: Pressure continued

- When # of gas molecules/moles is the ________ on both sides, a pressure change will have _____ affect on the system reaction rate
  - $H_2(g) + Cl_2(g) \Leftrightarrow 2HCl(g)$
  - ___ molecules⇔ ___ molecules in above example

19

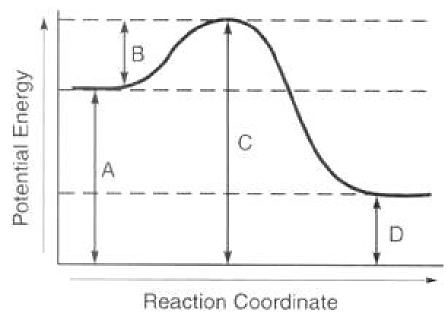
Le Chatelier's Principle

- **Catalyst**: Introduction of a catalyst will change the rate of reaction in ______ directions
  - may cause equilibrium to be met ___________
  - has no affect on _________________

20

Potential Energy Diagrams (PED's)

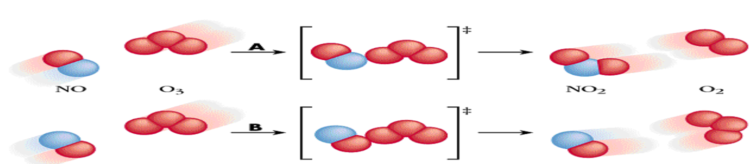
- Used to illustrate the Potential Energy changes that occur during a chemical reaction
- A= Potential Energy of ________________
- B= _________________
- C= Potential Energy of ____________________
- D= Potential Energy of ______________



21

Activated Complex

- For a reaction to occur, reactants need an effective ________ with proper ___________ and _______________
- As they collide/bond, their ________ energy is ____________ to stored ______________ energy

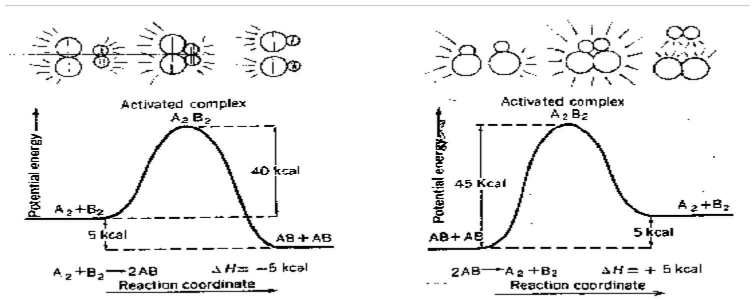


- ____________ → _____________ → ___________

22

Activated Complex

- Occurs when colliding particles form a ___________ intermediate product that may break apart and _____________________ or make a new _________

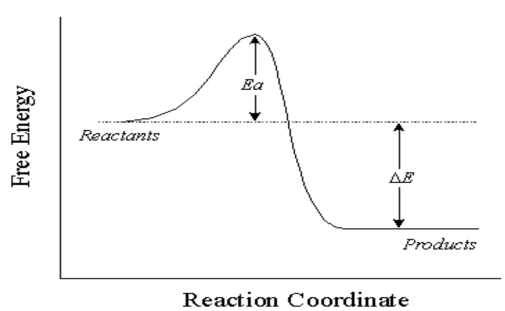


On the left is a potential energy diagram for the changes occurring in a chemical system during an exothermic reaction. On the right is the same type of diagram for an system undergoing an endothermic reaction.

23

Activation Energy

- To form the activated complex, the reactants must collide with enough ______________________
  - Measured as the distance between ______________ and the ____________________________ (sometimes listed as ___)



  - May be measured in _________________

24

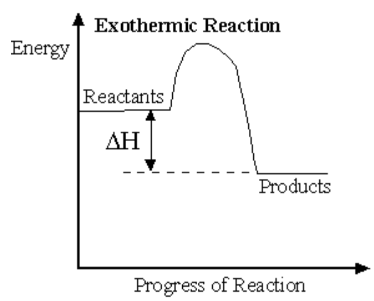
Heat of Reaction: (ΔH)

- = Difference between PE of ___________ and PE of ___________
- ΔH is the quantity of heat __________ or _____________ in a chemical Rxn
- ΔH = H_______ –H_________
  - ( ) values indicate a _______ of heat and therefore an ______________ reaction
  - See Table ___ for common reactions

25

Exothermic Reactions

- when PE of product is _________ than PE of reactant
  - A+B→ C+D + Energy
  - Heat given _____
  - ΔH is _________

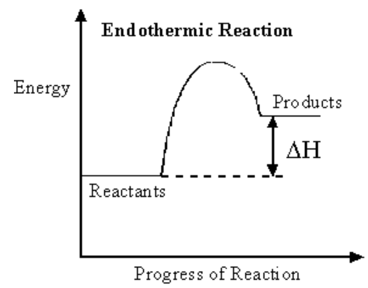


  - The ___________ the (-) value for ΔH, the more ____________ the material

26

Endothermic Reactions

- when PE of reactant is _________ than PE of product
  - A+B+ Energy → C+D
  - Heat _____________
  - ΔH is ___________

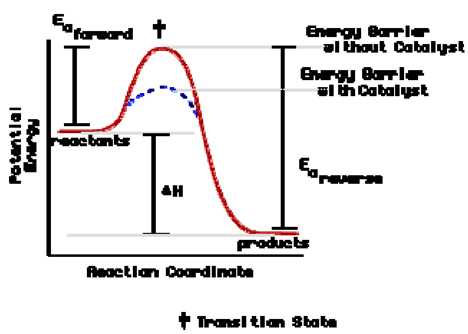


  - If a rxn is Exothermic in the ___________ direction, it will be endothermic in the _________ (and vice versa)

27

Catalysts

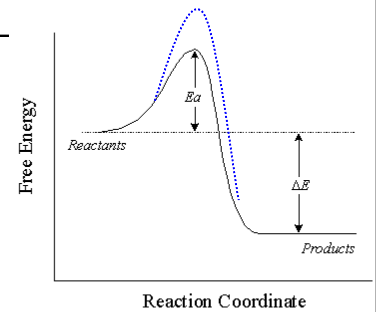
- cause a reaction to reach equilibrium ________ as they _________________________
  - Reactant and product values remain _________
  - Catalyst remains __________ and can be __________



28

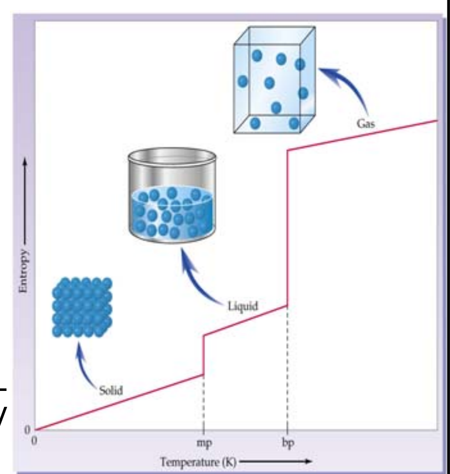
Inhibitor

- causes a Rxn to _____________ (opposite of ___________) or take _________ to reach equilibrium
  - Reactant and product values remain _________
  - Activation energy _________
  - Activation Energy with Inhibitor



Entropy

- going to a state of _________
  - ____________or chaos/lack of regularity
  - Systems will tend to go from __________ (great order) to ___________ (great disorder)
    - Due to particle ___________
  - Ex. _____ → _____ → _____ would be the trend in entropy for molecular arrangement



Enthalpy

- Tendency to change to a lower __________
  - Associated with Heat of Reaction (ΔH)
  - Exothermic Rxn's→____________ energy, thus products will have less PE than the reactants
  - Systems tend to move towards _________ energy (___________) and greater disorder (____________)

31