

Name: _____

Period: _____

Unit 13: Rates and Equilibrium- Guided Notes Part 1

What is a Chemical Reaction and how do they occur?

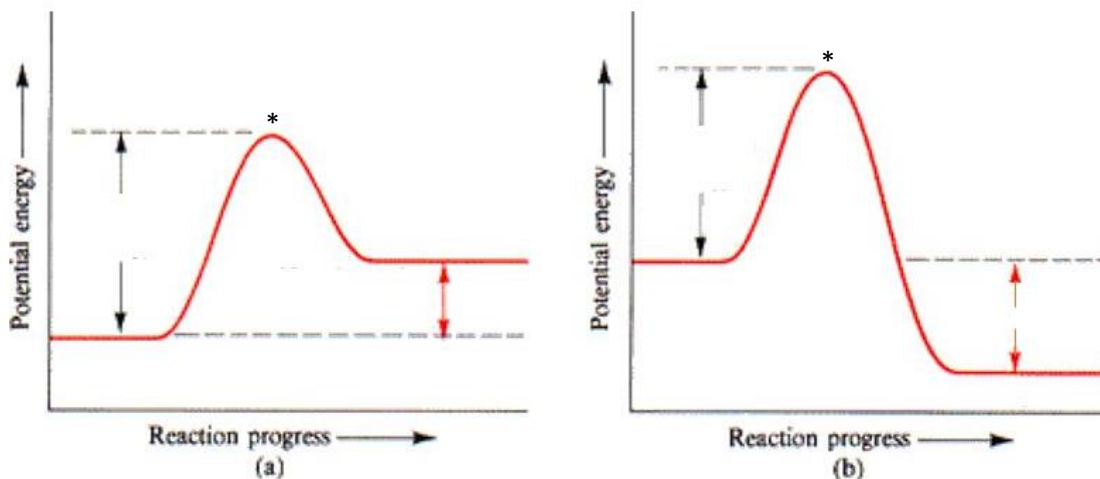
- A chemical reaction is a process that involves _____ of atoms
- Law of Conservation of _____: Mass is neither created or destroyed
- Balance and model the following reaction: $\text{H}_2 + \text{O}_2 \rightleftharpoons \text{H}_2\text{O}$

- Explain how the atoms are rearranged
- Why are there double arrows in the reaction?
- Collision Theory: molecules must _____ with enough _____ and in the proper _____ in order to react
- Do all reactions require energy to occur?
- _____ Energy- The minimum energy required in for a chemical reaction to occur
- What do we call a reaction that absorbs energy? _____
- What do we call a reaction that releases energy? _____

Energy in Reactions

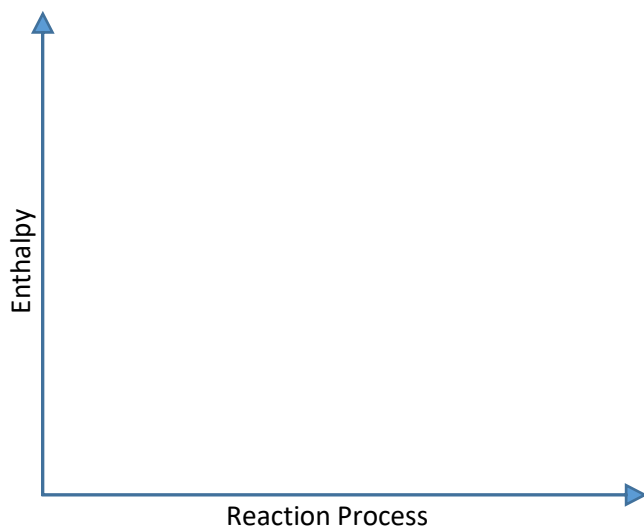
- Once the reactants have gained enough energy (the _____ energy), they are considered to be the _____
 - In other words the activated complex is the reactants with a lot of _____
- After the activated complex state, the reactants _____ to form the products
- _____: The change in energy in a reaction
- Represented by _____
- _____ reactions have a $+\Delta H$
- _____ reactions have a $-\Delta H$

Reaction Coordinate Diagrams



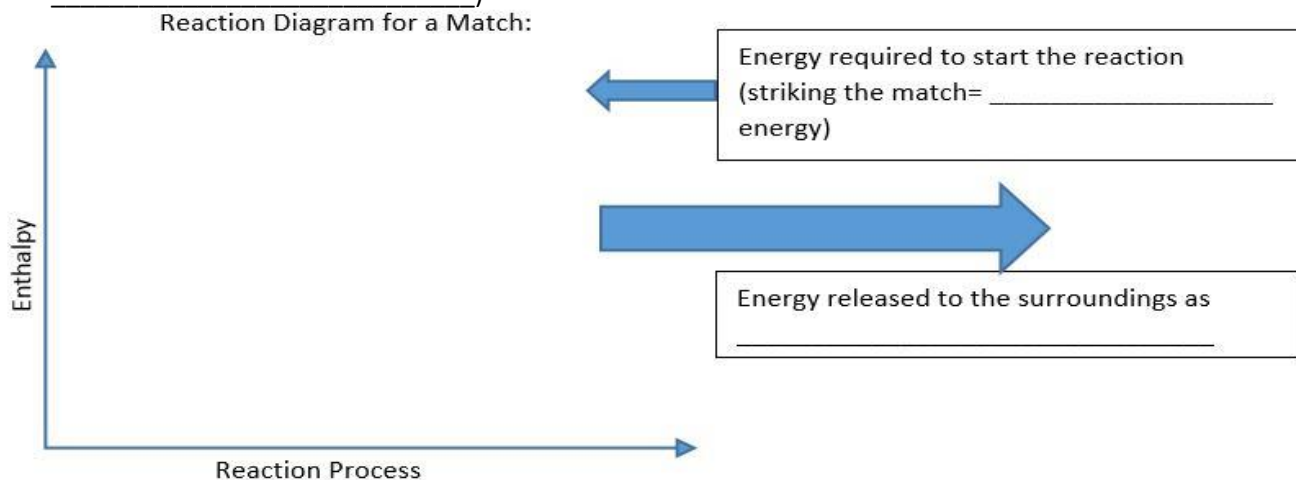
Catalyst and Inhibitors

- _____: a substance that speeds up a reaction without being consumed (_____ part of the reaction)
- How do catalysts work?
 - They lower the _____ energy (Now less energy is required for the reaction to take place)
 - They increase the rate of the _____ AND the _____ reaction
- An example of a catalyst is an _____
 - Enzyme: a large molecule, usually a protein, which catalyzes biological reactions (reactions in your body)
- _____: a substance that slows down a reaction without being consumed (_____ part of the reaction)
 - Decreases the rate of the _____ AND _____ reaction
 - Draw a Reaction Diagram with and without a catalyst:



Enthalpy

- The amount of energy transferred between the _____ (the reaction) and the _____
- $\Delta H = H_{\text{products}} - H_{\text{reactants}}$
- $\Delta H = +$ (_____)
 - More heat goes from _____ into system
- $\Delta H = -$ (_____)
 - More heat leaves _____ and goes into surroundings
- Energy is not created or destroyed just transferred between system and surroundings (Law of Conservation of _____)



Hess's Law

- _____ states that the enthalpy of a whole reaction is equivalent to the sum of its steps.
- All reactions have a _____
- Most substances have a known _____
- ΔH is usually measured in units of _____
- The change in enthalpy is caused by _____ breaking and forming
- Another way to calculate Hess's Law:
 - $\Delta H = \sum \Delta H_f (\text{products}) - \sum \Delta H_f (\text{reactants})$
 - What does this mean?
 - $\Delta H = (\text{the sum of the enthalpy of formation of the products}) - (\text{the sum of the enthalpy of formation of the reactants})$
 - Be careful adding and subtracting negative numbers
- **Hess's Law Example #1:** When methane is burned in oxygen, carbon dioxide and water are produced.
 $\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}$
- Calculate the ΔH when methane is burned using the following:

Substance	ΔH_f
CH ₄	-74.80 kJ
O ₂	0 kJ
CO ₂	-393.50 kJ
H ₂ O	-285.83 kJ

- **Hess's Law Example #2:** Use the standard enthalpies of formation table to determine the change in enthalpy for the following: $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

Substance	ΔH_f
NaOH	-426.70 kJ
HCl	-92.30 kJ
NaCl	-411.00 kJ
H ₂ O	-285.83 kJ

Unit 13: Rates and Equilibrium- Guided Notes Part 2

Equilibrium

- _____ reaction: reaction involving reactants and products in the same state
- _____ reaction: reaction involving reactants and products in different states
- _____: the exact balance of two processes, one of which is the opposite of the other
- _____: is when the **rate** of the forward reaction is the same as the **rate** of the reverse reaction
- At equilibrium concentrations of all reactants and products remain _____
- Chemical Equilibrium is _____ equilibrium (constantly changing)
- Does NOT mean same _____ of reactants and products
- $\text{H}_2\text{O} + \text{CO} \leftrightarrow \text{H}_2 + \text{CO}_2$
 - Equilibrium will occur when...
 - _____ of the forward rxn= _____ of reverse rxn
 - When concentration of all reactants and products remain _____
 - Does NOT mean concentration of reactants and products are _____
 - It is a *dynamic state* (reactants constantly _____ to products and products constantly _____ to reactants)

Equilibrium Expression

- Reactions are given the following general format: $aA + bB \leftrightarrow cC + dD$
- Where A, B, C, D are chemical _____
- a, b, c, d are _____
- Equilibrium expression: $K = \frac{[C]^c [D]^d}{[A]^a [B]^b}$ (Products over reactants)
- Remember [] indicate _____ in M
- _____ is a constant called the equilibrium constant
- Used to _____ the equilibrium of a reaction
- Solids and Liquids are _____ included in the equilibrium expression
 - The concentration of solids and liquids cannot change, so we ignore them
- Practice: Write the equilibrium expression for the following reactions:
 - 1) $\text{NH}_4\text{NO}_3 (\text{aq}) + \leftrightarrow \text{N}_2\text{O} (\text{g}) + 2\text{H}_2\text{O} (\text{g})$
 - 2) $2\text{KClO}_3 (\text{s}) \leftrightarrow 2\text{KCl} (\text{s}) + 3\text{O}_2 (\text{g})$
 - 3) $\text{CO}_2 (\text{g}) + \text{MgO} (\text{s}) \leftrightarrow \text{MgCO}_3 (\text{s})$
 - 4) Suppose that for the reaction below it is determined that the equilibrium concentrations are $[\text{N}_2] = 0.000104 \text{ M}$, $[\text{Cl}_2] = 0.000201 \text{ M}$, and $[\text{NCl}_3] = 0.141 \text{ M}$. Write the equilibrium expression and solve for the equilibrium constant. $\text{N}_2 (\text{g}) + 3\text{Cl}_2 (\text{g}) \leftrightarrow 2\text{NCl}_3 (\text{g})$

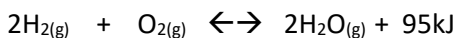
- Change in Pressure

- A change in pressure will only effect a reaction with _____
- If the pressure is _____ the reaction will shift to the side with _____ moles of gas
- _____ are used to determine # of moles
 - _____ pressure allows more space for gas
- If the pressure is _____ the reaction will shift to the side with _____ moles of gas
 - _____ pressure, allows less space for gas
- Example: $N_2(g) + 3 H_2(g) \leftrightarrow 2 NH_3(g)$
 - 1) What happens if I increase the pressure?

- 2) What happens if I decrease the pressure?

- Practice:

- 1) Which way would the reaction shift if the more pure liquid is added to the reactants? _____
- 2) Which way would the reaction shift if a catalyst was added to the reactants? _____
- 3) Using the reaction below determine which way the reaction will shift with the following stressors:



- a. Add O_2 _____
 - b. Remove H_2 _____
 - c. Decrease Pressure _____
 - d. Increase temperature _____
- 4) Using the reaction below determine which way the reaction will shift with the following stressors: (remember pure solids and liquids do NOT effect equilibrium): $87.6cal + 2KClO_{3(s)} \leftrightarrow 2KCl_{(aq)} + 3O_{2(g)}$
 - a. Add $KClO_3$ _____
 - b. Remove O_2 _____
 - c. Increase pressure _____
 - d. Increase temperature _____
 - 5) Using the reaction below determine at least 3 ways you could stress the reaction above to cause an increase in the concentration of oxygen gas. $87.6cal + 2KClO_{3(s)} \leftrightarrow 2KCl_{(aq)} + 3O_{2(g)}$
 - a. _____
 - b. _____
 - c. _____