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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: $H_2 + O_2 \leftarrow H_2O$
- 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

Energy in Reactions

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

Reaction Coordinate Diagrams



to form the products

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
- $\Delta H = H products H reactants$
 - ΔH = + (_____) More heat goes from _______, into system
- ΔH = (______) 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:

$_{\circ}$ ΔH = ΣΔH_f (products) - ΣΔH_f (reactants)

- What does this mean?
- \circ Δ H = (the sum of the enthalpy of formation of the products) (the sum of the enthalpy of formation of the reactants)
- o Be careful adding and subtracting negative numbers
- Hess's Law Example #1: When methane is burned in oxygen, carbon dioxide and water are produced. $CH_4 + 2 O_2 \rightarrow CO_2 + 2 H_2O$ Substance

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•	Calculate the ΔH when methane is burned using the following:	CH ₄	-74.80 kJ
г		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: NaOH + HCl \rightarrow NaCl + H₂O Substance Δ H₄

	Substance	ΔH _f
٦	NaOH	-426.70 kJ
	HCI	-92.30 kJ
	NaCl	-411.00 kJ
	H ₂ O	-285.83 kJ

<u>Equilibrium</u>

- _____ 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 • H_2O + CO $\leftarrow \rightarrow$ H_2 + 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 $\leftarrow \rightarrow$ 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) NH_4NO_3 (aq) + $\leftarrow \rightarrow N_2O$ (g) + $2H_2O$ (g)
 - 2) $2KCIO_3(s) \leftrightarrow 2KCI(s) + 3O_2(g)$
 - 3) $CO_2(g) + MgO(s) \leftrightarrow MgCO_3(s)$
 - 4) Suppose that for the reaction below it is determined that the equilibrium concentrations are [N₂] = 0.000104 M, [Cl₂] = 0.000201 M, and [NCl₃]= 0.141M. Write the equilibrium expression and solve for the equilibrium constant. N₂ (g) + 3Cl₂ (g) ← > 2NCl₃ (g)

Conditions that Affect Reaction Rates

1)	Nature	e of Reactants- Substances vary greatly in their tendency to react depen strengths and structure. Only effect	ding on their				
2)	Cataly	sts and Inhibitors- Only effect but not					
-,	effect	the rate of both the forward and reverse reaction					
3)	Pressu	Ire- Increase in pressure means increases	. This				
- 1		the rate of reaction.					
4)	Conce	ntration- More molecules means more collisions. This	the rate of reaction.				
5)	Tempe	Temperature- Higher temp means higher speeds which means more collisions. This the					
	rate of	f reaction.					
<u>Le Cha</u>	<u>telier's f</u>	<u>Principle</u>					
•	LeChat	telier's Principle (also called)- when stress is applied to a				
	system	n the system will shift in an effort to offset that stress and establish a new	w				
•	A stres	ss is a change in,,	, or				
	0	Pure and, alor	ng with catalysts and inhibitors do				
		NOT effect equilibrium					
•	These	stressors will cause the forward or the reverse reaction	to change, shifting				
	equilib	prium					
٠	The sh	nift will be					
	0	towards are favored/ to th	ie				
		OR					
	0	towards are favored/ to th	IC				
•	Chang	e in Concentration					
	0	If concentration is increased, the equilibrium will shift	from the increase				
		 If more of a substance is, the system 	stem will shift in a way that will				
		use up the substance added					
	0	If concentration is decreased, the equilibrium will shift	the decrease				
		 If substance is, the system will sl 	hift in a way that will produce				
		more of that substance					
	0	Practice: $N_{2 (g)} + 3 H_{2 (g)} \leftrightarrow 2 NH_{3 (g)}$					
		1) What happens if I increase concentration of N ₂ ?					
		2) What happens if I decrease concentration of H ₂ ?					
•	Chang	e in Temperature					
	0	 First you have to determine if reaction is endothermic or exothermic. 					
	0	• Exothermic reaction- heat is : heat is treated as a					
	0	Endothermic reaction- heat is ; heat is treated	as a				
	0	Think of heat as a reactant or product (but it's not).					
	0	Example: N _{2 (g)} + 3 H _{2 (g)} \leftrightarrow 2 NH _{3 (g)} + 92 KJ					
		1) Is this reaction endothermic or exothermic?					
		2) What happens if reaction is heated?					

- Change in Pressure
 - A change in pressure will <u>only</u> 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
- $\circ \quad \text{Example: N}_{2 (g)} + 3 H_{2 (g)} \longleftrightarrow 2 NH_{3 (g)}$
 - 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:
 - $2H_{2(g)} + O_{2(g)} \leftrightarrow 2H_2O_{(g)} + 95kJ$
 - a. Add O₂_____
 - b. Remove H₂_____
 - 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): $87.6cal + 2KClO_{3(s)} \leftarrow \rightarrow 2KCl_{(aq)} + 3O_{2(g)}$
 - a. Add KCIO₃_____
 - b. Remove O₂_____
 - 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. $87.6cal + 2KClO_{3(s)} \leftarrow \rightarrow 2KCl_{(aq)} + 3O_{2(g)}$
 - a. _____
 - b. ______ c. _____