Chemistry Unit 8

Primary reference: *CHEMISTRY*, Addison-Wesley

Topic	Essential Knowledge	Study Support
Scientific Investigation 1.8 SOL		
Atomic Structure and Periodic Relationships **2.8** **SOL 2a, 2b, 2g**	Radioactive radiation consists of alpha particles, ${}^{4}_{2}He$, beta particles, ${}^{0}_{-1}e$, and gamma particle ${}^{0}_{0}\gamma$. **Alpha** particles have a charge of +2, whereas **beta** particles have a charge of -1. **Gamma** particles have no charge. Alpha particles have low penetrating power, and gamma particles have the largest penetrating power. **Half-life** is the length of time required for half of a given sample of a radioactive isotope to decay.	**Ch 28:** pp 841-849
Nomenclature, Formulas, and Reactions **3.8** **SOL 3e, 3f**	Reactions occurring in both the forward and reverse directions are reversible. Reversible reactions can reach a state of equilibrium where the rates of the forward and reverse reactions are constant. **Le Chatelier's principle** states that when a chemical system is subjected to stress, the system will shift to relieve the stress. Chemical reactions can be shifted by changing reactant and product concentrations, adding or removing heat, or changing the pressure in the system. Catalysts do not impact the equilibrium position. Catalysts change the rate of the forward and reverse reactions equally. ⇆ is used to indicate a reversible reaction. **Entropy** is a measure of a system's disorder/randomness. Entropy increases as solids → liquids→ gases, or as the number of particles increases. There is a natural tendency for systems to move in the direction of maximum randomness(entropy). Spontaneous reactions must be exothermic and/or increase in entropy. Redox Rxns Oxidation-Reduction reations involve the transfer of electrons between atoms.	**Ch 19:** Complete reading guide **Ch 22:** Read pp 645-650 and 654-659
Molar Relationships 4.8 **SOL 4b**	The **limiting reagent**/reactant is the reactant that limits how much product can be made. To solve these, use stoichiometry to determine how much product is made using each reagent. The reagent that produces the least product is the limiting reagent.	**Ch 9:** Read pp 252-255
Phases of Matter and Kinetic Molecular Theory 5.8		

Unit 8 Objectives

I. Equilibrium and Reversible Reactions
   A. Le Chatelier's PrincipleSpontaneous Reactions
   B. Entropy
   C. Identifying Spontaneous Reactions Using Enthalpy and Entropy
II. Nuclear Chemistry
   A. Alpha, Beta and Gamma Radiation
   B. Writing nuclear reactions
   C. Calculations with Half-life
III. Limiting Reagents
IV. Redox Reactions
   A. Oxidation and reduction reactions
   B. Determining oxidation states

(SOL) Learning Objectives—You should be able to:

1. Draw a reaction coordinate diagram with axes labeled, and ΔH, activation energy, product energy, reactant energy, transition state, and catalyst shift clearly identified for exothermic and endothermic reactions.
2. Identify three factors that shift a reaction's equilibrium position.
3. Use double arrows appropriately to indicate a chemical reaction's equilibrium position.
4. Explain the relative rate of forward and reverse reactions at chemical equilibrium.
5. Use Le Chatelier's Principle to predict the impact of changing reaction conditions on the reaction's equilibrium position.
6. Explain the difference between a spontaneous reaction and a non-spontaneous reaction.
7. Understand that ALL SPONTANEOUS REACTIONS RELEASE FREE ENERGY.
8. State the Law of Disorder.
9. Identify factors that increase a chemical system's entropy.
10. Explain under which conditions of entropy and enthalpy changes a reaction will always be spontaneous or non-spontaneous.
11. Know the symbols, masses and charges of alpha, beta, and gamma particles
12. Balance nuclear reactions
13. Differentiate between alpha, beta and gamma radiation with respect to penetrating power.
14. Perform calculations involving the half-life of a radioactive substance.
15. Identify the limiting reagent using stoichiometry
16. Calculate the amount of product produced in a limiting reagent problem.
17. Define oxidation and reduction in terms of loss or gain of electrons.
18. Write unbalanced half reactions for simple redox reactions.
19. Assign oxidation numbers to pure elements (always zero)
20. Assign oxidation numbers to elements in ionic compounds.
21. Memorize basic rules for assigning oxidation numbers to elements in covalent compounds.
22. Assign oxidation numbers to elements in simple molecular compounds and polyatomic ions
23. Track oxidation number changes in chemical reactions.
24. Identify whether a reaction is a redox reaction.

Writing Nuclear Equations

Chem Worksheet 4-4

Name ________________

In the early 1900s scientists discovered that various isotopes will undergo nuclear decay. During this process the unstable nucleus of an atom gives off radiation. When scientists studied this radiation they discovered three types of particles: alpha, beta, and gamma. The **alpha particle** is composed of two protons and two neutrons, so it has a mass of 4 amu and a charge of 2+. A **beta particle** is a high energy electron emitted from the nucleus. A **gamma ray** often accompanies the other decay processes. Gamma radiation has no charge and no mass.

Radiation Type	Symbol	Mass (amu)	Charge
Alpha	${}^{4}_{2}He$ or ${}^{4}_{2}\alpha$	4	2+
Beta	${}^{0}_{-1}e$ or ${}^{0}_{-1}\beta$	$\frac{1}{1840}$	1–
Gamma	${}^{0}_{0}\gamma$	0	0

Equations can be written to show how a nucleus changes during a nuclear decay process. With these nuclear equations we track the atomic number and the mass number. For this reason it is important to correctly write the symbols for each particle involved. A nuclear equation is written for an alpha decay and a beta decay below. Notice that the sum of the atomic numbers is equal on both sides of the arrow. The sum of the mass numbers is also the same on both sides.

$${}^{206}_{84}Po \rightarrow {}^{202}_{82}Pb + {}^{4}_{2}\alpha$$ **alpha decay**

$${}^{124}_{51}Sb \rightarrow {}^{124}_{52}Te + {}^{0}_{-1}\beta$$ **beta decay**

Rewrite the following equations. Fill in all the missing information.

1. ${}^{129}_{53}I \rightarrow {}^{0}_{-1}e + \underline{\ ?\ }$
2. ${}^{216}_{86}Rn \rightarrow {}^{4}_{2}\alpha + \underline{\ ?\ }$
3. $\underline{\ ?\ } \rightarrow {}^{4}_{2}\alpha + {}^{239}_{97}Bk$
4. $\underline{\ ?\ } \rightarrow {}^{0}_{-1}e + {}^{52}_{23}V$
5. ${}^{255}_{?}Rf \rightarrow {}^{4}_{2}\alpha + \underline{\ ?\ }$
6. ${}^{85}_{?}Br \rightarrow \underline{\ ?\ } + {}^{85}_{?}Kr + {}^{0}_{0}\gamma$
7. $\underline{\ ?\ } \rightarrow {}^{0}_{-1}e + {}^{32}_{?}S + {}^{0}_{0}\gamma$
8. ${}^{257}_{101}Md \rightarrow {}^{4}_{2}\alpha + {}^{4}_{2}\alpha + \underline{\ ?\ }$

Write nuclear equations that describe the following processes.

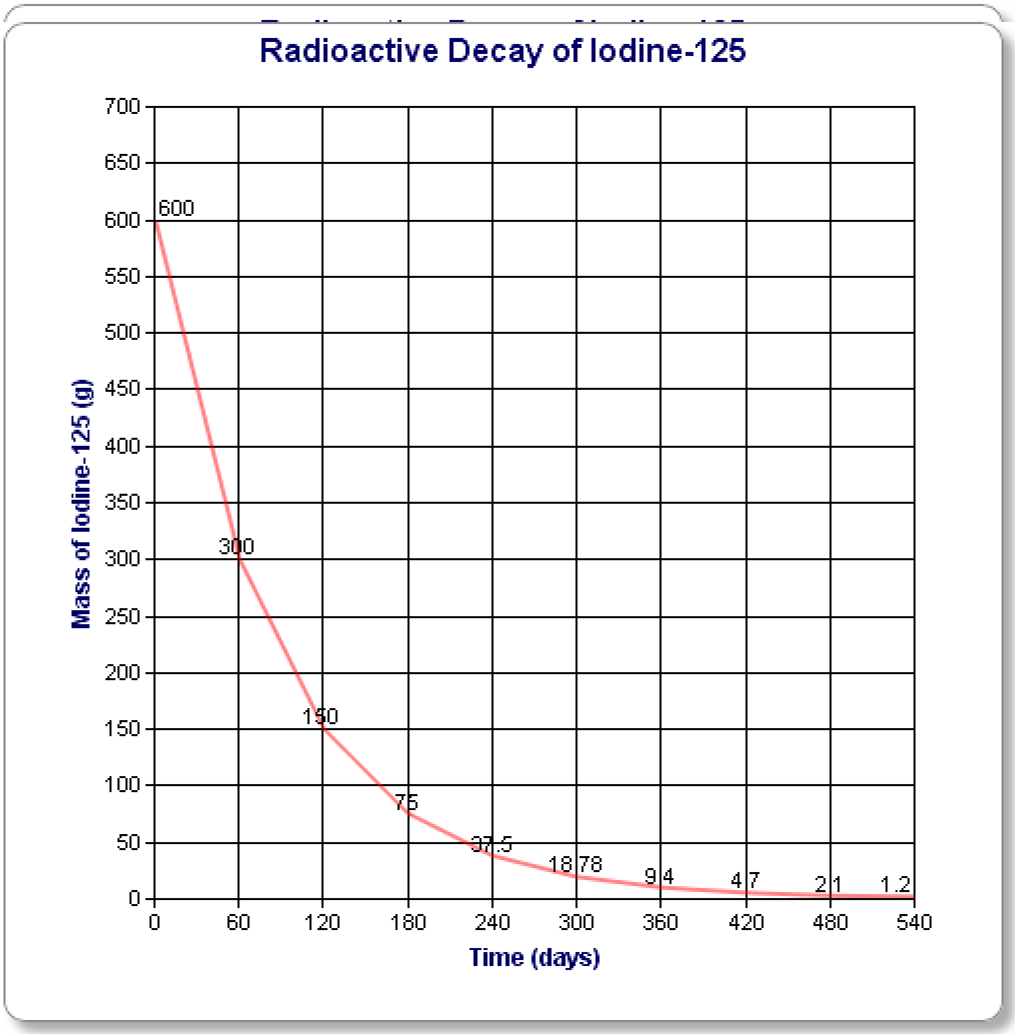
9. Uranium-235 undergoes an alpha decay to produce thorium-231.
10. Lanthanum -144 becomes cerium-144 when it undergoes a beta decay.
11. Neptunium-233 is formed when americium-237 undergoes a nuclear decay process.
12. When protactinium-229 goes through two alpha decays, francium-221 is formed.
13. Uranium-238 undergoes an alpha decay and produces two gamma rays.
14. The neon-22 nucleus is formed when an element undergoes a beta decay.
15. Samarium-146 is produced when an element undergoes an alpha decay.
16. The beta decay of dysprosium-165 creates a new element.

Answer the following questions. Include the mass number when naming isotopes.

17. What atom produces scandium-47 when it goes through a beta decay?
18. What new element is formed when curium-244 emits two alpha particles and three gamma rays?

Half-Life Graph Worksheet

Name: ______________________________________ Date: _____________ Class: _______



1. What percent of iodine has decayed if 5 half-lives have passed?

2. If three half-lives have passed, how many grams of iodine-125 remain undecayed?

3. What fraction of iodine-125 has decayed if there are 37.5 grams left from the original sample?

4. If 130 days have passed approximately how many grams of iodine-125 will remain?

5. What is the half-life of iodine-125?

6. If 315 days have passed, how many grams of iodine-125 will remain undecayed?

7. What mass of iodine-125 has decayed after 6 half-lives?

8. How many grams of Iodine-125 have decayed away if 12.5 % is remaining?

9. What fraction of Iodine-125 remains after 300 days have passed?

10. How many half-lives have passed if 1.2 grams remains?__________ How many grams decayed? ___________

Name ________________________________ Period _______

NUCLEAR EQUATIONS WORKSHEET

1. Write a nuclear equation for the alpha decay of $^{231}_{91}Pa$.

2. Write a nuclear equation for the beta decay of $^{223}_{87}Fr$.

3. Write a nuclear equation for the alpha decay of $^{149}_{62}Sm$.

4. Write a nuclear equation for the beta decay of $^{165}_{61}Pm$.

5. Write a nuclear equation for the alpha decay of $^{249}_{101}Md$.

6. Write a nuclear equation for the alpha decay of $^{146}_{62}Sm$.

7. Write a nuclear equation for the beta decay of $^{198}_{85}At$.

8. Write a nuclear equation for the alpha decay of $^{150}_{64}Gd$.

9. Write a nuclear equation for the beta decay of $^{152}_{54}Xe$.

10. Write a nuclear equation for the beta decay of $^{120}_{55}Cs$.

11. Bombardment of aluminum-27 by alpha particles produces phosphorus-30 and one other particle. Write the nuclear equation for this reaction and identify the other particle.

12. Plutonium-239 can be produced by bombarding uranium-238 with alpha particles. How many neutrons will be produced as a by-product of each reaction? Write the nuclear equation for this reaction.

13. When bombarded with neutrons, lithium-6 produces an alpha particle and an isotope of hydrogen. Write the nuclear equation for this reaction. What isotope of hydrogen is produced?

14. Neutron bombardment of plutonium-239 yields americium-240 and another particle. Write the nuclear equation and identify the other particle produced.

15. One method of producing plutonium-238 is by bombarding uranium-238 with deuterium (hydrogen-2), which produces neptunium-238 and 2 neutrons. The unstable neptunium then decays to produce plutonium-238. Write the nuclear equations for this two-step reaction. What other particle is produced in the second reaction?

Advanced Radioactive & Nuclear Decay Challenge Problems

P1) What is the equation for the number of half-lives that a radioactive sample has undergone?

What does **n** mean? ______________________

What does **t** mean? _______________________

What does **$t_{½}$** mean? ______________________

P2) What is the equation for the *fraction of radioactive parent isotope that remains* after a certain number of half-lives? →

(Note: The original radioactive isotope is called the **parent isotope**. The parent isotope *transmutes* (decays) into the **daughter isotope**.)

P3) Use knowledge of algebraic substitutions to create a more complex equation for radioactive nuclear decay. (Substitute P1 into P2).

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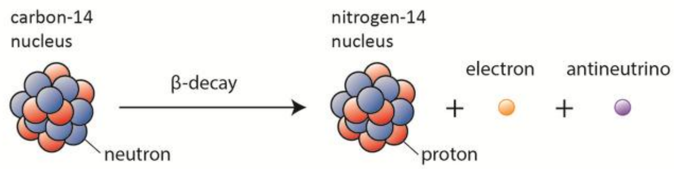
1) A geochemist (a chemist who studies chemical phenomena in geology) finds a rock with a particular microbiological, single-celled organism inside, and he wants to determine the age of the ancient microbe by dating the rock. How old is the rock if it contains 36% of the original mass of the radioactive parent isotope potassium-40? K-40 transmutates into the stable daughter isotope argon-40. The half-life of K-40 is 1.3 billion years.

2) Uranium-238 is radioactive ($t_{½}$ is 4.5 billion years). Lead-206 is the stable transmuted daughter isotope of U-238. If you started with 2.97 kg of U-238, how many grams of Pb-206 will be present in 6.1 billion years?

Note: The age of the Earth is approximately equal to the half-life of U-238, which can be found naturally in rocks. This is why scientists are so certain that Earth is billions (not thousands) of years old.

3) An Egyptian mummy was discovered by a paleoanthropologist (*paleo-* = **old**, *-anthro-* = **human life**, *-ology* = **study of**). A small sample of the mummy was sent to a chemistry lab, and the researchers discovered that there were 0.02667 mg of radioactive carbon-14, and 0.08094 mg of stable nitrogen-14. The half-life of the C-14 is 5,730 years.



a. Which isotope is the radioactive parent isotope? ______________________
b. Which isotope is the stable daughter isotope? ________________________
c. How many milligrams of C-14 were originally present? _______________ mg
d. Determine the *fraction (decimal) of C-14 that remains* after the unknown amount of time that has elapsed. ____________________
e. Determine the age of the mummy.

4) Selenium-83 has a half-life of 25 minutes. How many grams of Se-83 are left after 3 hours if you started with 228 g of Se-83?

Element and symbol	Half life
Sulphur (S)	88 days
Tantalum (Ta)	115 days
Selenium (Se)	120 days
Thelium (Tm)	130 days
Polonium (Po)	138 days
Calcium(Ca)	165 days
Zinc (Zn)	245 days
Cobalt-57 (Co)	270 days
Silver (Ag)	253 days

5) Use the chart to determine the identity of the unknown isotope: A 398.0 gram sample of an unknown parent isotope began the process of nuclear decay, and after about 1.5 years, only 21.5 grams of the parent isotope remained. (The other 376.5 grams of the sample is the unspecified daughter isotope).

What is chemical name of the parent isotope?

6) If you start with 2.822×10^{-3} g of pure, radioactive cobalt-57, how many grams of the cobalt-57 isotope will remain after exactly 4 years?

CHEMISTRY ONLY: How many *atoms* of cobalt-57 will remain after exactly 4 years?

Chapter 19 Part 2: Equilibrium and Spontaneity

Catalyst Effect on Reaction Path

Why do catalysts increase reaction rate?

$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g) + 92kJ$

I. Reversible Reactions

A. Reversible Reactions:____

____

Example:

Chemical Equilibrium: ____

____

Note: ***The concentrations of [products] and [reactants] are usually NOT the same at equilibrium.***

Equilibrium Position:____

____

Example: $H_2O + H_2O \leftrightarrows H_3O^+ + OH^-$

A Catalyst speeds up the forward and reverse reactions ______________________

B. Le Chatelier's Principle: ____

____

C. Factors Shifting Equilibrium Position—how far a reaction proceeds.

1. Concentration of products or reactants
2. Adding or removing heat
3. Increasing or decreasing pressure of reactant gases

1. Impact of changing product or reactant concentrations
   - Adding reactants makes reaction go forward/backwards?
   - Adding more product makes reaction go forward/backwards?
   - Removing product makes reaction go forwards/backwards?

Examples with H_2CO_3 (aq) ⇆ CO_2(aq) + H_2O(l)

Add H_2CO_3 :

Add CO_2 :

Remove CO_2 :

2. Changing the temperature shifts equilibrium

For exothermic reactions, adding heat shifts the equilibrium toward ____________

$2SO_2$(g) + O_2(g) ⇆ $2SO_3$ + heat (exothermic reaction)

Why?

For endothermic reactions, adding heat shifts the equilibrium towards ______________

$CaCO_3$(s) + heat ⇆ CaO(s) + CO_2(g) (endothermic reaction)

Why?

3. Increasing the pressure of reaction gases shifts the equilibrium to minimize the number of moles of gas. The equilibrium shifts if there's an unequal number of reactant and product moles of gas.

$$N_2(g) + 3H_2(g) \leftrightarrows 2NH_3(g)$$

Increasing pressure increases ___________________

Decreasing pressure increases ____________________

II. Determining Whether a Reaction Occurs

A.ALL SPONTANEOUS REACTIONS RELEASE HEAT OR MAKE THE UNIVERSE MORE DISORGANIZED.

Spontaneous Reactions:____

____

Non-Spontaneous Reactions:____

____

Note: spontaneous reaction DOES NOT refer to the speed/rate of the reaction.

Example: An iron nail exposed to oxygen usually reacts very slowly

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) + 1600\ kJ$$

Example: $CH_4(g) + 2O_2(g) \rightarrow$ ______ + _______ + 890 kJ

Example: Above 0ºC, ice melts to water.

Gibb's Free Energy Change Determines Spontaneity

Verbally____

____

Equation $\Delta G = \Delta H - T\Delta S$

Physical and chemical systems proceed spontaneously to the lowest possible energy (Gibb's)

B. Law of Disorder____

____

Entropy:____

____

What increases entropy (randomness)

1. moving to less ordered phases
2. less independent particles → more independent particle
3. increasing temperature

Explain why each reaction/process shows an increase or decrease in entropy?

$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

$4Al(s) + 3O_2(s) \rightarrow 2Al_2O_3(s)$

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

Dissolving $CaCl_2$ in water:

Freezing water:

Air escaping from a tire

Dry ice subliming into gaseous carbon dioxide

D. Will A Reaction Move Forward to Products?

Gibb's Free Energy Reaction Diagram

$$\Delta G = \Delta H - T\Delta S$$

A spontaneous reaction must have negative ΔG. *This means that the free (available) energy that can be used to do work must decrease, making the system more "stable"*

Always, Always, Always IF ____

Never, Never, Never IF ____

Maybe IF ____

____

Determine which reactions are spontaneous in the forward direction:

$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$ + heat

$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$ + heat

Heat + $NaNO_3(s) \xrightarrow[H_2O]{} Na\ (aq) + NO_3^-(aq)$

Name_______________________________ Organic Compound Reading Guide (14 pts)

Read pp 743-744		
1. What are organic compounds?		
2. What are hydrocarbons?		
3. What are alkanes?		
4. Describe carbon's unique ability.		
Read pp 752-753		
5. What are alkenes?		
6. What is the difference between saturated and unsaturated compounds?		
Read pp 759-760		
7. What is the formula for benzene? Draw the structural formula.	Benzenes chemical formula	Benzene's Structural Formula
Read pp 762-763		
8. What are the three typical natural gas components?	1) 2) 3)	
9. Read pp 773: What are functional groups?		

Read pp 778-781(stop before Addition Reactions)	
10. What is an alcohol?	
11. What intermolecular forces are present in alcohols?	
12. Read pp 788: What are carboxylic acids?	
Read pp 795-800	
13. What are polymers?	

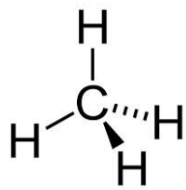
14. Fill in the following table for man-made polymers

Polymer	**Application**
Example: Polyethylene	Milk bottles
Nylon	
Kevlar	

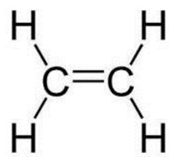
Chapter 25: Organic Chemistry

I. Organic Compounds: ____

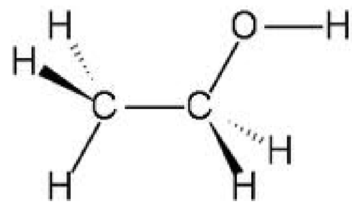
____



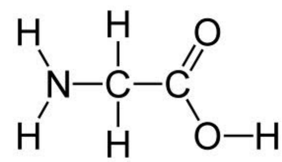
methane



ethene



ethanol



glycine

A) Hydrocarbons: ____

II. Alkanes: ____

A) Straight-chain alkanes: ____

____

1) Naming Straight Chain Alkanes—they all end with ________

Methane: CH_4	Pentane C_5H_{12}
Ethane: C_2H_6	Hexane: C_6H_{14}
Propane: C_3H_8	Heptane: C_7H_{16}
Butane: C_4H_{10}	Octane: C_8H_{18}

Methane, propane, butane and octane are important petrochemical fuels

Formula Types:

Example: Butane

Molecular Formula:	
Structural Formula	
Condensed Structural Formulas	1.
	2.
	3.
Carbon skeleton	
Line-angle	

Line-angle formulas—more examples

Hexane: Octane:

2) Properties:

Alkanes are non-polar because they have no polar bonds.

B) Branched Alkanes

1) Substituents are any atoms or groups of atoms that replace a hydrogen on a straight chain alkane.

2) Alkyl group: ____

Examples 2-methylpentane and 2,4-dimethylhexane using carbon skeletons

III. Unsaturated Hydrocarbons: ____

____

Examples: 2-pentene and 2-pentyne

Structural formula:

Line-angle:

Saturated Hydrocarbons:____

____

A) Alkenes: ____

Examples: ethane 2-butene

B) Alkynes: ____

Examples:

Ethyne(acetylene) 2-butyne

IV. Hydrocarbon Rings:____

____

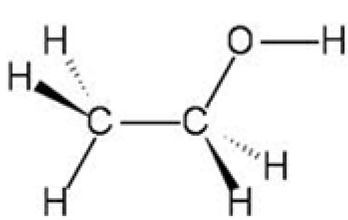
Examples

cyclopentane		
cyclohexane		
benzene		

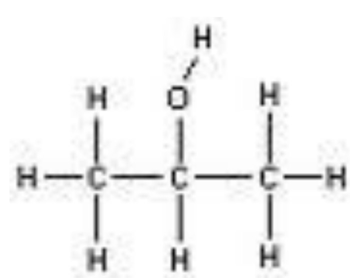
V Functional Groups

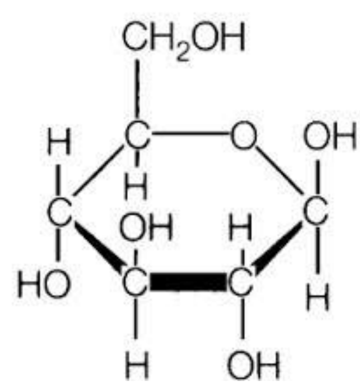
Alcohols have C-O-H groups. They dissolve easily in water and are polar molecules.

Ethanol



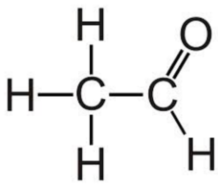
Propanol



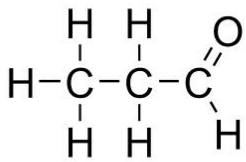


Glucose (a sugar)

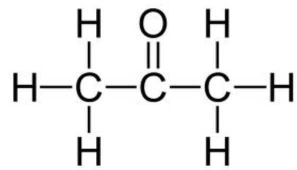
Aldehydes and Ketones have C=O groups. They are polar compounds.



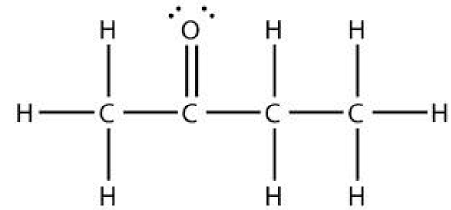
aldehyde



aldehyde



Ketone



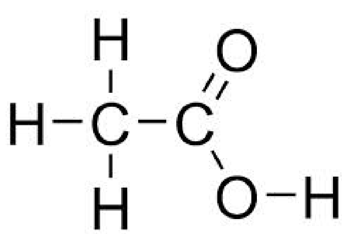
ketone

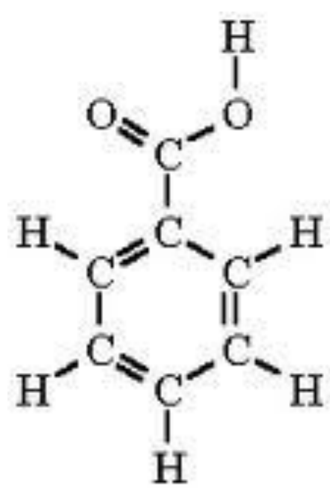
1. What do aldehydes and ketones have in common?

2. What is different between aldehydes and ketones.

3. Are aldehydes and ketones saturated or unsaturated compounds?

Carboxylic Acids have COOH groups. The carboxylic acid group makes molecules polar and helps them dissolve in water.



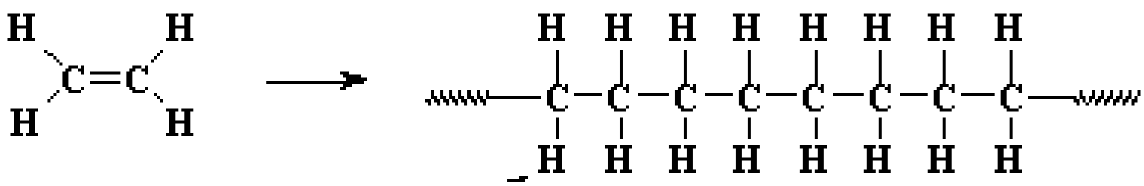


VI Polymers

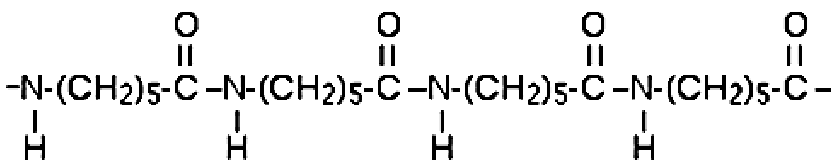
Polymers form when small molecules (monomers) link together to make long chains. Natural polymers include proteins and nucleic acids. Human-made (synthetic polymers) include polyethylene, nylon, and Kevlar.

<u>Human-made Polymers</u>

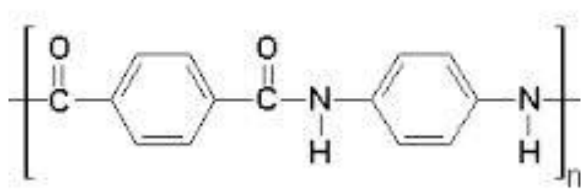
Polyethylene



Nylon



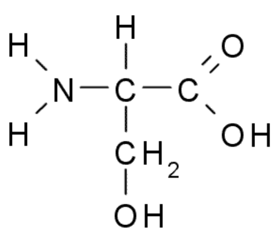
Kevlar



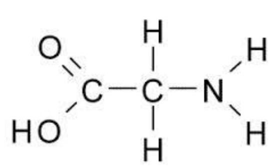
<u>Biological Polymers</u>

Proteins are made of amino acids. Even though a protein can be very complex, it is basically a long chain of amino acid monomers all twisted around like a knot.

Serine



Glycine



Nucleic Acids (DNA and RNA) are made up of monomers called "**nucleotides**." The five monomers are **uracil**, **cytosine**, **thymine**, **adenine**, and **guanine**.

Chapter 22 Note Guide

I) Review of Reaction Types, Entropy, Enthalpy and Spontaneity

Reaction types: Single Replacement, Double Replacement, Combustion, Synthesis, Decomposition, Neutralization

Reaction	Type	Exothermic or Endothermic	Positive Entropy ?	Spontaneous ? (-ΔG)
$CH_4(g) + O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ + heat				
$Na(s) + H_2O(l) \rightarrow NaOH(s) + H_2(g)$ + heat				
$AgNO_3(aq)+KCl(aq) \rightarrow AgCl(s)+KNO_3(aq)$+heat				
$2KClO_3(s)$ + Heat $\rightarrow 2KCl(s) + 3O_2(g)$				
$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ + heat				
$NaOH(aq)+HCl(aq) \rightarrow H_2O(l) + NaCl(aq)$ + heat				

II) What is Oxidation and Reduction?

A) Historical definitions of Oxidation and Reduction

Oxidation____

Example: $C(s) + O_2(g) \rightarrow CO_2(g)$ + heat Rxn type:

Reduction:____

Example: $2Fe_2O_3(s) + 3C(s)$ + heat $\rightarrow 4Fe(s) + 3CO_2(g)$ Rxn type:

B) Modern definition of Oxidation and Reduction

Oxidation____

Reduction____

Redox Reaction:____

C) Half Reactions:____

____

Example: $Mg(s) + S(s) \rightarrow MgS(s)$ Rxn type:

LEO says GER

OIL RIG

Reducing Agent:____

Oxidizing Agent:____

Example: $2Al(s) + 3Br_2(l) \rightarrow 2AlBr_3(s)$ + heat Rxn type:

Example $2Zn(s) + O_2(g) \rightarrow 2ZnO(s)$

D) Assigning oxidation numbers in compounds

Oxidation Number:____

____

Rules

1. *All pure element's oxidation number is 0.*
   Example: Fe(s) = Fe^0 and Cl_2(g) = Cl^0

2. *For any compound, the oxidation numbers must add to zero. For a polyatomic ion, the oxidation numbers must add to the final charge.*

3. *In Binary Ionic compounds, the oxidation number is the ionic charge*
   Examples: NaCl Li_3N TiO_2

4. *Hydrogen = +1 with non-metals and -1 with metals*
   Examples: NaH NH_3

5. *Fluorine = -1*
   Examples: NF_3 CF_4 PF_5

6. *Oxygen usually = -2 but Fluorine is more electronegative*.
   Examples: CO_2 SO_3 OF_2

7. *Halogens = -1 except with oxygen—then figure it out*.
   Example: PBr_3 NI_3 ClO_3^-

Try These:

SO_2 S=_____ O=_____

SiO_3^{2-} Si=_____ O=_____

KNO_3 K=_____ N=_____ O=______

Oxidation number does not equal the actual charge in a covalent compound or polyatomic ion. Example NaN_3

E) Tracking oxidation number changes in reactions

Examples:

$2AgNO_3(aq) + Cu(s) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

$2Fe_2O_3(s) + 3C(s) + heat \rightarrow 4Fe(s) + 3CO_2(g)$

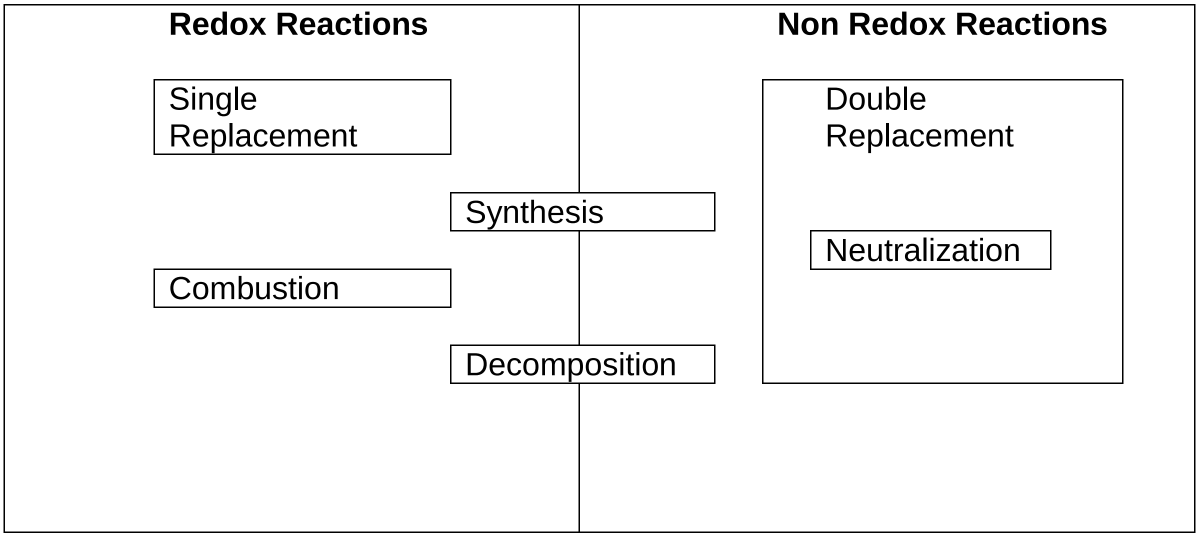
$2H_2(g) + O_2(g) \rightarrow 2H_2O(l) + heat$

III) **Identifying Redox Reactions**.

Look for a change in oxidation states during the reaction.

Reaction	Type	Redox?
$CH_4(g) + O_2(g) \rightarrow CO_2(g) + 2H_2O(g) + heat$		
$Na(s) + H_2O(l) \rightarrow NaOH(s) + H_2(g) + heat$		
$AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq) + heat$		
$2KClO_3(s) + Heat \rightarrow 2KCl(s) + 3O_2(g)$		
$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) + heat$		
$NaOH(aq) + HCl(aq) \rightarrow H_2O(l) + NaCl(aq) + heat$		
$N_2(g) + O_2(g) + heat \rightarrow 2NO(g)$		
$N_2O_4(g) + heat \rightarrow 2NO_2(g)$		

IV) Venn Diagram for Reaction Types



Summary of Oxidation and Reduction

Oxidation	**Reduction**
Loss of electrons	*Gain* of electrons
Called the “reducing agent”	Called the “oxidizing agent”
Oxidation number *increases*	Oxidation number *decreases*
LEO	GER
OIL	RIG

Limiting and Excess Reagents***(p 252 –p256)***

Limiting Reagent____

____

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

A tank contains 2 molecules of N_2 and 4 molecules of H_2. Which is the limiting reagent? Which is the excess reagent?

How many molecules of ammonia, NH_3 were produced?

<u>Limiting Reagent Calculations</u>: Perform stoichiometry for each reagent. The limiting reagent is the reagent that yields the least amount of product. This is the amount of product produced.

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

A tank contains 12 moles of N_2 and 31 moles of H_2. Which is the limiting reagent?

Given 12 mole N_2, find mole NH_3 produced

Given 31 mole H_2, find mole NH_3 produced

How many moles of ammonia, NH_3 were produced?

$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

A tank contains 20.0 liters of SO_2 and 18 grams of O_2. Which is the limiting reagent? How many moles of sulfur trioxide, SO_3 was produced?

1st… do the SO_2 calculation (Ignore O_2 since you're pretending it's unlimited *for now only*)

2nd O_2 calculation (Ignore SO_2 since you're pretending it's unlimited *for now only*)

Compare the two product amounts and choose the "worst case"

$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

Given 6.70 mol of sodium and 3.50 mol of chlorine gas, which one is the limiting reagent? How many moles of sodium chloride were produced?

Not all limiting reagent problems will ask for the limiting reagent. Anytime the problem provides two reactant quantities, it's a limiting reagent problem.

$$FeF_3(aq) + 3KOH(aq) \rightarrow Fe(OH)_3(s) + 3KF(aq)$$

If 3.0 grams of FeF_3 reacts with 6.0 grams of KOH, how many grams of KF will be produced?(Ans = 4.6. grams)

$$Ca(OH)_2(aq) + 2HBr(aq) \rightarrow CaBr_2(aq) + 2H_2O(l)$$

60. grams of calcium hydroxide is placed in a flask with 100. grams of hydrobromic acid. Which is the limiting reagent? How many grams of water will be produced?(Ans = 22.3 g)