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ABSTRACT

As a set of seven Learning Activity Packages (LAPs) for individualized instruction in chemistry, the units cover problems in stoichiometry, energy levels, chemical bonding, matter and its forms, electrochemical processes, chemical kinetics and equilibrium, metals, and non-metals. Each unit contains a rationale for the material; a list of behavioral objectives for the unit; a list of resources including texts, periodical articles, laboratory experiments, audiovisual aids, and science activities; a problem set for student self-evaluation; and suggestions for advanced study. A related chemistry LAP is SE 016 425. (CC)

The $\Delta H_f$ (CO) = −26.41 kcal and the $H_c$(CO) = −67.64 kcal. The $\Delta H_f$ ($CO_2$) is .(14). kcal.

The heat of formation of compound X equals the sum of heats of formation of products of compound X minus the heat of .(13). of compound X.

# LAP

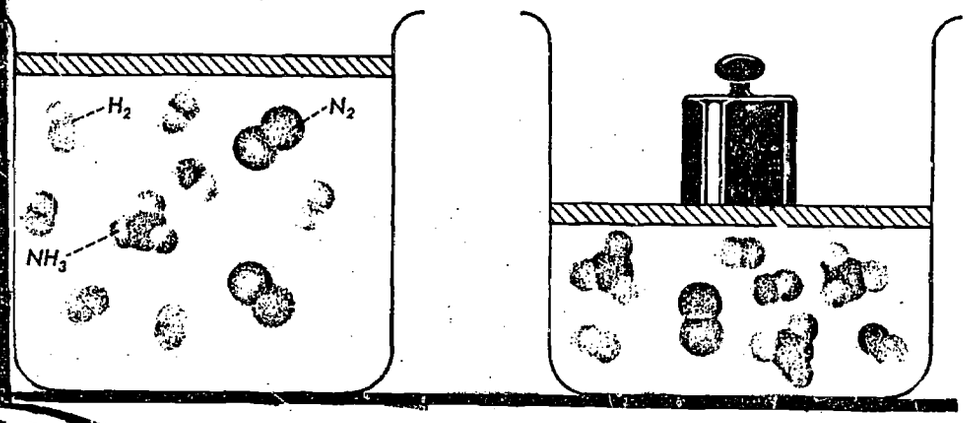
LEARNING ACTIVITY PACKAGE



# Rate of Chemical Reaction

## CHEMICAL KINETICS AND EQUILIBRIUM

Pressure increases the yield of ammonia since the equilibrium shifts in the direction which produces fewer molecules.




Ninety Six High School · Ninety Six, S.C.

CHEMISTRY II

REVIEWED BY

LAP NUMBER 41A

WRITTEN BY N. Jones

## Rationale

Everyone has had the feeling of being pulled in two directions at once and having to settle for some kind of compromise between alternatives. Chemical reactions frequently have the same problem. In chemistry two general forces, the tendency toward maximum disorder and the existence in the lowest energy state, gives rise to equilibrium. Thus far in your study of chemistry you have written and discussed all chemical reactions as though states of equilibrium didn't exist. Upon the completion of this LAP you will be able to understand what happens when substances react as to speed, properties of a system and the potentials of elements. This will give you a better understanding of principles of Electrochemistry.

BEHAVIORAL OBJECTIVES

After completing your program of study, you will be able to:

I. Define

1. Kinetic Theory
2. Catalyst and types
3. Thermodynamics
4. Endothermic
5. Exothermic
6. Ionization constant and equilibrium constant
7. Solubility product

II. Contrast positive enthalpy changes with negative enthalpy changes.

III. Explain how free energy relates to enthalpy and entrophy

IV. Write equations showing reactions going to completion and equilibrium reactions.

V. Name and verify 6 factors affecting the rates of reactions.

VI. Illustrate the 3 kinds of reactions that go to completion.

VII. State the Law of Mass Action and be able to apply this law to the Equilibrium constant.

VIII. Apply the principle of Le Chatelier to various kinds of equilibrium.

## Resources

A. Books

1. "Chemistry" Sienko and Plane pp. 241-256
   pp. 257-298
2. "College Chemistry" Frey pp. 315-329
3. "Chemical Systems" Webster pp. 351-354
4. " Concepts In Chemistry" Harcourt pp. 263-282
5. "General Chemistry" Selwood pp. 187-200
6. "Chemistry and Investigative Approach" Cotton and Lynch pp. 290-299

B. Paper Back Book

* Kinetics and Equilibrium pp. 1-193

C. Filmstrip

Energy of Reaction EBF

Energy Visual Sciences

Activity (Must be done by all students)

A.

1. Investigate Hess's Law what analogy could you give for this law?

2. Write a paragraph on the life of Henri Hess

3. Write a paper explaining the Hess Law

4. Diagram Hess's Law

B. Demonstrate Kinetics by showing the rate on nature of reactants by mixing .10m $FeSO_4$ with acidified .002m $KMNO_4$.

# EXPERIMENTS

| Experiments | Experimental Chemistry |
|---|---|
| #19 | Chemical Kinetics pp. 121 |
| #20 | Chemical Equilibrium pp. 127 |
| #22 | Oxidation Potentials pp. 135 |
| #34 | Measuring the Potentials of Electrochemical Cells pp. 239-240 |

Self-Evaluation Equilibrium LAP 41 A

Goal I Supply the word that best completes the definition.

1. The branch of science concerned with the velocity of chemical reactions _____

2. Any substance used to change the rate of a chemical reaction _____

3. The branch of science concerned with heat and mechanical energy _____

4. A chemical reaction involving the absorption of heat _____

Goal II

1. What kind of change is a heat content change?

_____

2. What symbol is used to represent any enthalpy change?

_____

3. A reaction that releases a large amount of heat is said to be exothermic. What is this type of enthalpy? _____

4. A reaction which absorbs large amounts of heat and generally must be heated has what type of enthalpy?

_____

5. How does a negative free energy change proceed?

_____

6. $\Delta H$ is used to represent enthalpy what does the $\Delta$ signify? _____

Goal III

1. Give a formula that proves that free energy is related to enthalpy and entrophy.

2. Explain each phase of the formula.

3. Why does the free energy decrease in a spontaneous reaction?

4. What is meant by free energy?

Goal IV. Tell if the following reactions go to completion. (answer yes or No)

1. $2KClO_3 \longrightarrow 2KCl + 3O_2$

2. $C_6H_{12}O_6 \longrightarrow 6C + 6H_2O$

3. NaCl(dilute) + KBr(dilute) $\longrightarrow$ NaCl + KCl + NaBr + KBr

4. $H_3O^+ + HCO_3^- \longrightarrow 2H_2O + CO_2$

5. FeS + NaCl $\longrightarrow$

6. $BaCO_3 + HNO_3 \longrightarrow$

7. $CuO + H_2SO_4 \longrightarrow$

8. $Na_3PO_4 + CuSO_4 \longrightarrow$

9. $2NO + H_2 \longrightarrow$

Goal V Name 6 things that determine the reaction rates.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

Goal VI. A. Complete each of the following reactions. Indicate with appropriate arrows whether each reaction is reversible or irreversible.

1. $Mg + H_2SO_4 \longrightarrow$ _____

2. $NaOH + HCl \longrightarrow$ _____

3. $HC_2H_3O_2 + KOH \longrightarrow$ _____

4. $Ba(NO_3)_2 + H_2SO_4 \longrightarrow$ _____

B. Explain why each of the above reactions are reversible or irreversible.

1. _____

2. _____

3. _____

4. _____

Goal VII A. Give the 2 results.

In the Law of Mass action in reversible reactions equilibrium when the reaction shifts toward the formation of more products. 1. _____

2. _____

B. Give the representation for equilibrium constant.

_____

C. Write an equation to represent any equilibrium constant. _____

D. Write the equilibrium expression for the production of hydrogen iodide _____

Goal VIII.

A. **Platinum** catalyst changes the rates of the reactions between $SO_2$ and $O_2$, but it cannot shift its point of equilibrium. Explain in terms of Le Chatelier's Principle.

1. _____

2. _____

Advanced Study

1. If Keq for $2A + B \longrightarrow 2C$ is 8, set up the expression used to calculate the concentration of C at equilibruim, if the starting conditions were one-half mole each of A and B in a ten liter container.

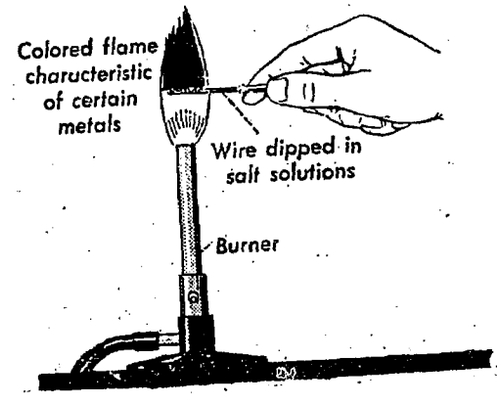
2. Investigate the relationship between the energy of activation and the thermodynamic quantities of $\Delta H$, $\Delta S$ and $\Delta G$.

3. Prepare a report on the step-by-step mechanism of multi-step reactions. Include all steps.

4. Explain the expression for the equilibrium constant for the equilibrium system. $CaCo_2 \rightleftharpoons CaO \_ CO_2$

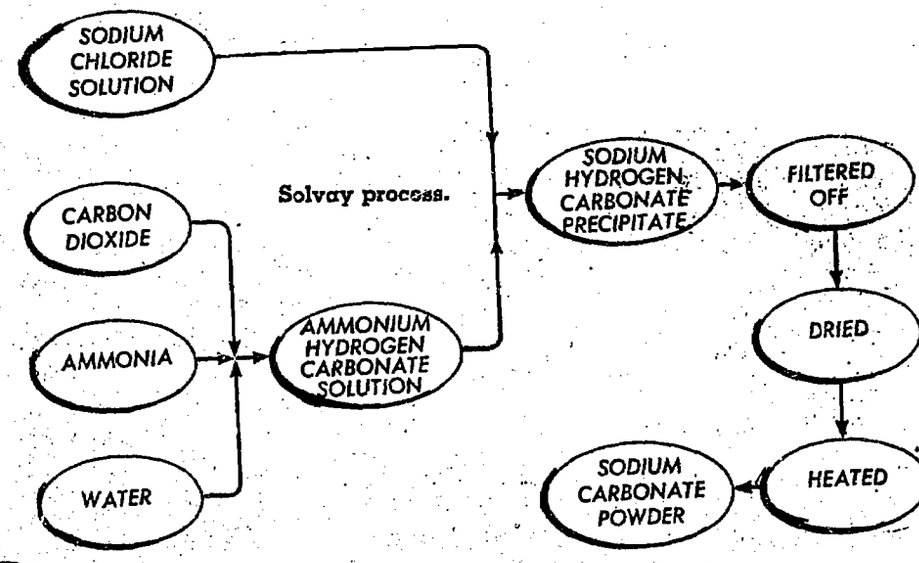
5. Calculate the K for an equilibrium mixture consisting of $3.560 \times 10^{-3}$ mole/liter of $H_2$, $1.250 \times 10^{-3}$ mole/liter of $I_2$, and $15.59 \times 10^{-3}$ mole/liter of HI

# LEARNING ACTIVITY PACKAGE






# METALS




Ninety Six High School - Ninety Six, S.C.

## Chemistry II

LAP NUMBER 42

WRITTEN BY N. Jones

REVIEWED BY

RATIONALE (Reason why)

In previous laps you learned fundamental principles of chemistry and characteristic behavior of hydrogen, oxygen and water. You will now consider a detailed descriptive chemistry of metals. If a metal was known that was strong and light, metallic objects could function more efficiently. Is there a metal less dense than water? Your study of metals will enable you to understand how elements are grouped in your next lap.

BEHAVIORAL OBJECTIVES:

After completing your program of study, you will be able to:

I. Define:

| | |
|---|---|
| metals | alloys |
| nonmetals | corrosion |
| metalloids | caustic |
| alkali metals | reducing agents |
| hydrides | efflorescent |
| deliquescent | |

II. Compare the physical and chemical properties of:

A. metals and non-metals

B. groups of metals

III. Contrast the properties of alkali metals with alkaline earth metals as to:

1. position and classification in the Periodic Chart
2. chemical activity
3. chemical preparation
4. uses
5. occurrences
6. ionization and oxidation potentials

IV. Demonstrate your knowledge of metallurgical process by naming them and explaining the operation of each .

V. Describe in writing the Solvay Process including:

1. three useful equations
2. the products and by products
3. the raw materials

VI. Describe the flame tests for lithium, sodium and potassium, and other metals.

## RESOURCES

I. Books:

1. "Modern Chemistry" - Holt, Rinehart, Winston - pp. 407-421, 422-435.
2. "College Chemistry" - Frey - pp. pp. 461-471.
3. "General Chemistry" - Selwood - pp. 242-261.
4. "Chemistry" - Merrill - pp. 172-176, 199, 312.
5. "Chemistry" - Sienko, Plane - pp. 350-381.

II. Magazines:

1. "Chemistry" - March 1971 - Negative Hydrogen, pp. 8-11.
2. "Chemistry" - April 1971 - Cesium Properties of Puns, pg. 25.
3. "Chemistry" - May 1971 - Magnesium, pp. 6-10.
4. "Chemistry" - July-August 1971 - Lithium, pp. 10-12.

III. Experiments:

"Experimental Chemistry" - Sienko and Plane

# 34 - pp. 183-184

# 35 - pp. 185-188

# 36 - pp. 189-191

IV. Filmstrips:

The Chemistry of Iron 45F

The Chemistry of Steel 60F

Changing Ores into Metals 50°

Chemistry of Baron and Aluminum

Self-Evaluation Test

Lap 42 - Chemistry II

I. Select the letter of the correct answer.

GOAL I

1. The unusual physical property of the alkali metals is their (a) luster (b) electrical conductivity (c) softness (d) heat conductivity _____

2. The strongest reducing agent of the followins is (a) NA (b) Li (c) Cs (d) Fr _____

3. Non-sparking alloys are composed of copper and (a) beryllium (b) magnesium (c) calcium (d) strontium _____

4. Compounds of the alkaline earth metals which contain the $H^-$ ion are (a) acids (b) hydrates (c) hydroxides (d) hydrides _____

5. When pure, none of the alkali metals has (a) metallic luster (b) low density (c) high meeting point (d) high electrical conductivity _____

6. Among the following, the best reducing agent is (a) cesium (b) potassium (c) sodium (d) lithium _____

7. Alkali metals are obtained from their molten chlorides by (a) reduction with copper (b) reduction with electricity (c) the Downes process (d) the soda lime process _____

8. Members of Group IA on the periodic chart are known as alkali metals because they form (a) strong bases (b) Bronsted-Lowry bases (c) soluble salts (d) efflorescent salts _____

II. 1. Metallic properties are determined by (a) the number of neutrons (b) the number of protons (c) the number of electrons (d) the number of free electrons _____

2. The most common crystalline structure of metals is (a) tetragonal (b) rhombohedral (c) orthorhombic (d) closest-packed. _____

Self-Evaluation Test (con't)

3. Which of the following elements would be the best protecting iron against corrsion? (a) tin (b) copper (c) silver (d) chromium _____

4. Column VI A on the Periodic Chart contains (a) Mostly metals (b) only gases (c) mostly non-metals (d) eight electrons in the outer level _____

5. Non-metals are found in the periodic table at the (a) top right (b) bottom right (c) bottom left (d) center top _____

6. Select the non-metal from the following (a) sodium (b) sulfur (c) silver (d) magnesium _____

7. The ionization potentials of metals are (a) relatively low (b) relatively high (c) vary from element to element (d) never vary _____

8. The number of valence electrons usually found in the outer shells of non-metals are (a) 1 to 2 (b) 1 to 3 (c) 3 to 4 (d) 5 to 7 _____

9. Silicon is an example of a (a) metal (b) non-metal (c) metalloid (d) alloy _____

10. The most metallic elements are found on the Periodic Chart in (a) lower right hand corner (b) lower left hand (c) upper right hand corner (d) upper left hand corner _____

III. 1. Cesium, which loses electrons easily is used in (a) anti-knock gasoline (b) photoelectric cells (c) photographic dark room lamps (d) tempering metals. _____

Self-Evaluation Test (con't)

2. The deliquescence of sodium hydroxide makes it useful as a _____ . reducing agent (b) oxidizing agent (c) hydrogenating agent (d) drying agent

3. Group II A compounds are usually reduced to their respective metals by _____ . (a) heating (b) electrolysis (c) reactions with carbon (d) reactions with water

4. The most abundant metal in the earth's crust is _____ . (a) iron (b) aluminum (c) boron (d) silicon

5. The two most common alkali metals are _____ . (a) Lithium and Rubidium (c) Sodium and Potassium (d) Calcium and Potassium

6. In the alloying of alkaline-earth metals, aluminum, zinc and manganese are used to increase the structural strength of _____ . (a) magnesium (b) sodium (c) barium (d) berylbium

IV. A. What is the most common method of preparing the alkali metal elements? _____

GOAL IV

B. What is the most economical production method for barium and strontium? _____

C. Name the two compounds that are essential in the Hall-Héroult Process. A. _____

B. _____

V. Complete the following on the Solvay Process.

GOAL V

1. The only by-product of the entire process is _____ .

2. The first by-product of the Solvay Process is _____ .

Self-Evaluation Test

3. What two raw materials are used in the Solvay Process?

   A. _____

   B. _____

4. What is the most important manufactured compound of sodium?

   A. _____

   B. _____

5. What are the two basic raw materials used in the Solvay Process?

   A. _____

   B. _____

6. Give the final balanced equation in the Solvay Process.

   _____

VI. Various elements impart characteristic colors to a colorless gas flame when small amounts of their compounds are heated in the flame. In the space at the right, describe the flame-test color of the elements listed.

GOAL VI

1. Lithium _____
2. Sodium _____
3. Potassium _____
4. Rubidium _____
5. Cesium _____
6. Calcium _____
7. Strontium _____
8. Barium _____

## Advanced Study

1. Explain the deviations from the diagonal rule for the electron configurations of Molybdenum, Palladium, and Gadolinium.

2. Explain the deviations from the diagonal rule of the electron configurations of Thorium, Curium and Gold.

3. Predict all possible valences for the following elements and give your evidence argon, aluminum, antimony, bromine and europium.

4. Predict all possible valences for the following elements and give your evidence: Sodium, silicon, uranium, cerium, and cobalt.

5. a. What property of metalloids has led to their use in transistors?

   b. Lithium is frequently listed as more reactive than sodium, contrary to predictions. Find out why.

6. Mendeleev made predictions about five elements in addition to Germanium. Find out what these elements were and how accurate his predictions were.

# LEARNING ACTIVITY PACKAGE

**Where there are three men walking together, one or the other of them will certainly be able to teach me something.**

# STOICHIOMETRY

Ninety Six High School
Ninety Six, S.C.

## Chemistry II

REVIEWED BY D. Kitchens

LAP NUMBER 39-A

WRITTEN BY Naomi Jones

## Rationale (Reason Why)

You have observed changes taking place around you everyday such as, iron rusting, wood burning, and ice melting. Are these merely phase changes or chemical changes in which new substances are formed? Chemical reactions can be expressed qualitatively (words) or quantitatively (numbers). The fundamental knowledge of chemistry has been built upon careful quantitative analysis of substances. In this Lap you will study the quantitative relationships implied in chemical reactions as well as the forces holding atoms together. Stoichiometry is important from commercial and industrial standpoints because it is possible to calculate actual amounts of reacting materials needed to produce specified amounts of products. In a later Lap on Kinetics, Equilibrium and Electrochemistry you will apply quantative relationships.

STOICHIOMETRY

Lap 39 - Chemistry II

BEHAVIORAL OBJECTIVES:

After consulting your resources you will:

OBJ. I - Write on paper the three classes of stoichiometric relationships.

OBJ. 1 II - Write the two general steps in solving any stoichiometric problem.

OBJ. III - Make application of the efficiency of the mole method in solving problems in stoichiometry.

OBJ. IV - List the important steps in the mole method.

OBJ. V - Determine the weight of one mole of a substance when given the formula.

OBJ. VI - Solve weight-weight, weight-volume and volume-volume problem.

OBJ. VII - Determine in the laboratory the mass or volume of a product produced in a given chemical reaction by the mole method.

## RESOURCES

I. Books:

1. Chemistry - Sienko and Plane - pp. 103-132.
2. Chemistry - Merrill - pp. 293-305, pp. 288-290.
3. Modern Chemistry - Holt, Rinehart, Winston - pp. 118-120.
4. Chemistry - Silver Burdette - pp. 65-67, 70, 75-80, 88-89.
5. Fundamental Concepts (Paper back) - pp. 194-196, 197-207.

II. Experiment #9 - pp. 69-72.

III. Problems - Lab Manual - pp. 97-98 - Problems D, E, F, H, and J.

Self-Evaluation

OBJ. I 1. Name the 3 classes of stoichiometric relationships.

a. _____

b. _____

c. _____

OBJ. VI 2. How many liters does one mole of any gas at STP occupy?

_____

OBJ V. 3. Find the weight of one mole of sulfuric acid ($H_2 SO_4$).

(atomic weight of Hydrogen=1, sulfur=32, oxygen=16)

_____

OBJ. II 4. List the 2 general steps in solving any stoichiometric problem

a. _____

b. _____

OBJ. VII. 5. Iron (Fe) burns in air to from a black, solid oxide ($Fe_3 O_4$).

a. Write the equation for the reaction _____

b. How many moles of oxygen gas are needed to burn one mole of iron? _____

OBJ. VII 6. How many liters of hydrogen at STP can be produced from the action of 6.5 grams of zinc with hydrochloric acid?

a. Write the balanced equation _____

b. Express the weight (6.5g) of zinc in moles _____

c. How many moles of hydrogen gas does one mole of zinc yield?

_____

d. How many liters of hydrogen is produced by 6.5 grams of zinc reacting completely? _____

OBJ. VII 7. How many liters of oxygen are required to burn 10 liters of methane (CH4)?

a. Write the balanced equation _____

b. How many moles of methane are in the 10 liters? _____

c. How many moles of oxygen? _____

d. How many liters of oxygen? _____

OBJ. VII. 8. How many grams of $Na_2SO_4$ are formed from the reaction of 2 grams of NaOH with $H_2SO_4$?

a. Write the balanced equation _____

b. 2 moles of Na OH produce how many moles of $Na_2SO_4$? _____

c. How many grams of $Na_2SO_4$ are formed? _____

OBJ. III. 9. Why is the mole method an efficient way to solve problems in stoichiometry? _____

OBJ. IV 10. List the 5 key steps in the mole method

a. _____

b. _____

c. _____

d. _____

e. _____

## ADVANCED STUDY

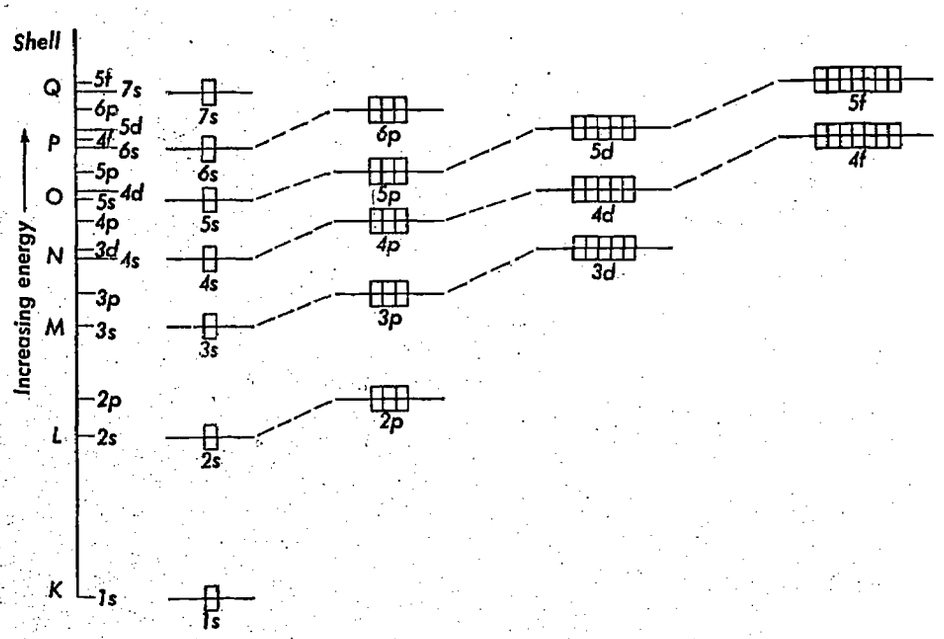
1. Investigate and make a written report on the part played by Cannizaro in gaining acceptance for Avogadro's Principle.

2. a. Determine the mass of one liter of acetylene ($C_2H_2$) under standard conditions.

   b. Determine the volume of air necessary for the complete combustion of 100 liters of ethylene ($C_2H_4$), which results in the formation of carbon dioxide and water.

# LAP

LEARNING
ACTIVITY
PACKAGE




# ENERGY LEVELS

Ninety Six High School
Ninety Six, S.C.

## CHEMISTRY II

REVIEWED BY J. Ritchie

LAP NUMBER 39B

WRITTEN BY N. Jones

BEHAVIORAL OBJECTIVES:

After completing the program of study you will:

Goal I: List and define the four quantum numbers.

Goal II: Label sub-shells for each energy level.

Goal III: State the maximum number of electrons each shell and each sub-shell can hold.

Goal IV: Make a chart showing the sub-shells of each energy level from the lowest to the highest.

Goal V: For each of the first thirty-six elements on the Periodic Chart write the valence determination.

Goal VI: Write the electron configuration for the first thirty-six elements on the Periodic Chart.

Goal VII: Construct the three P type orbitals on one set of axes by using 1/8 inch dowels and clay.

Goal VIII: Draw orbital and dot notations for any given element.

Resources :

I. Readings

A, Books

1. "Chemistry" Sinko and Plane pp. 50-78

2. "College Chemistry" Frey pp. 38-43

3. "Modern Chemistry" Feffner pp. 386-400

4. "Concepts in Chemistry" Greenstone pp. 42-47

5. "Chemistry" Merrill pp. 144-153

6. "General Chemistry" Selwood pp. 25-29

7. "Chemistry" Choppin, Jaffe, Summerlin, Jackson pp. 208-229

8. "Chemistry" Cotton and Lynch pp. 158-185

B. Charts

1. Atomic Energy Level Chart

2. Periodic Chart

C. Transparency

Eye-Gate Energy Levels 003-11

D. Filmstrip

Electron Arrangement and Chemical Bond

No. 9087 EB

Goal I 1. Name the 4 quantum numbers a._____

b._____

c._____

d._____

Goal II 2. Complete the following chart by filling the maximum
III. IV number of electrons for each subshell and the total
for each energy level.

| Energy Level | Sublevels S | P | D | F | Total |
|---|---|---|---|---|---|
| 1st or K | ___ | | | | |
| 2nd or L | ___ | ___ | | | |
| 3rd or M | ___ | ___ | ___ | | |
| 4th or N | ___ | ___ | ___ | ___ | |

Goal III 3. Give the maximum number of electrons for the following

a. 2s _____

b. 3 p _____

c. 4d _____

d. 3d _____

e. 5s _____

f. 6p _____

g. 4f _____

h. 7s _____

Goal VI 4. Write the electron configuration for the following:

a. Potassium(19) _____

b. copper (29) _____

c. Krypton (36) _____

d. Strontium (38 _____

e. Iodine(53) _____

f. Barium (56) _____

VIII 5. Write the orbital notations for the following:

a. carbon(6) _____

b. Fluorine (9) _____

c. sodium(11) _____

d. silicon(14) _____

VIII 6. Make dot notations for the following:

a. argon(18) _____

b. magnesium(12) _____

c. phosphorus(15) _____

d. chlorine(17) _____

e. manganese(25) _____

Goal II III,VI Diagram the electron configuration for the highest level of the following elements. Any electrons for each of the following must be in their lowest energy state (label orbitals)

a. Sodium Atom _____

b. Bromine Atom _____

c. Krypton atom _____

d. Oxygen atom _____

e. Nitrogen atom _____

Goal VII. 8. Draw the probability shape fo the three 2 p orbitals.

# PERIODIC TABLE OF IONIZATION ENERGIES



## LEARNING ACTIVITY PACKAGE

## BONDING

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | 24.6 He 2 |
| | | | | | | | | | | | | 8.3 B 5 | 11.3 C 6 | 14.5 N 7 | 13.6 O 8 | 17.4 F 9 | | 21.6 Ne 10 |
| | | | | | | | | | | | | 6.0 Al 13 | 8.1 Si 14 | 11.0 P 15 | 10.4 S 16 | 13.0 Cl 17 | | 15.8 Ar 18 |
| 7.6 Ni 28 | 7.7 Cu 29 | 9.4 Zn 30 | | | | | | | | | | 6.0 Ga 31 | 8.1 Ge 32 | 10.5 As 33 | 9.7 Se 34 | 11.8 Br 35 | | 14.0 Kr 36 |
| 8.3 Pd 46 | 7.6 Ag 47 | 9.0 Cd 48 | | | | | | | | | | 5.8 In 49 | 7.3 Sn 50 | 8.6 Sb 51 | 9.0 Te 52 | 10.4 I 53 | | 12.1 Xe 54 |
| 9.0 Pt 78 | 9.2 Au 79 | 10.4 Hg 80 | | | | | | | | | | 6.1 Tl 81 | 7.4 Pb 82 | 8.0 Bi 83 | Po 84 | At 85 | | 10.7 Rn 86 |

| | |
|---|---|
| 13.6 H 1 | |

| I | II | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5.4 Li 3 | 9.3 Be 4 | | | | | | | |
| 5.1 Na 11 | 7.6 Mg 12 | | | | | | | |
| 4.4 K 19 | 6.1 Ca 20 | 6.6 Sc 21 | 6.8 Ti 22 | 6.7 V 23 | 6.8 Cr 24 | 7.4 Mn 25 | 7.9 Fe 26 | 7.9 Co 27 |
| 4.2 Rb 37 | 5.7 Sr 38 | 6.6 Y 39 | 7.0 Zr 40 | 6.8 Nb 41 | 7.2 Mo 42 | Tc 43 | 7.5 Ru 44 | 7.7 Rh 45 |
| 3.9 Cs 55 | 5.2 Ba 56 | 5.0 Lu 71 | 5.5 Hf 72 | 6 Ta 73 | 8.0 W 74 | 7.9 Re 75 | 8.7 Os 76 | 9.2 Ir 77 |
| Fr 87 | 5.3 Ra 88 | Lw 103 | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6.2 Cd 64 | 6.7 Tb 65 | 6.8 Dy 66 | Ho 67 | Er 68 | Tm 69 | 6.2 Yb 70 |
| Cm 96 | Bk 97 | Cf 98 | Es 99 | Fm 100 | Md 101 | 102 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5.6 La 57 | 6.9 Ce 58 | 5.8 Pr 59 | 6.3 Nd 60 | Pm 61 | 5.6 Sm 62 | 5.7 Eu 63 |
| Ac 89 | Th 90 | Pa 91 | 4 U 92 | Np 93 | Pu 94 | Am 95 |

Ninety Six High School · Ninety Six, S.C.

CHEMISTRY II

REVIEWED BY Ritchie

LAP NUMBER 39C

WRITTEN BY N. Jones

Lap 39 - Section

Chemistry II - Bonding

BEHAVIORAL OBJECTIVES:

After completing your program of study, you will be able to:

Goal I. Define:

a. Electronegativity

b. Electron affinity

c. Ionization Energy

d. Polarity

e. Dipole

Goal II. Name the types of chemical bonds and compare the types.

Goal III. Classify bonds as to:

a. Polar and non polar

b. Ionic and covalent

Goal IV. Predict whether a bond will form between two elements or radicals based on their electronegativities, ionization energy and electron affinity.

Goal V. Define and demonstrate multiple bonds.

Goal VI. Write three elements that generally form multiple bonds and give reasons why.

## RESOURCES

I. Readings:

A. Books:

1. "Concepts In Chemistry" - Gunstone, Sutman, Hollingsworth, pp. 260-262, 102-105, 109-111, 535-575.

2. "Modern Chemistry" - Metcalfe, Williams, Castkr, pp. 90-92.

3. "College Chemistry" - Frey, pp. 124-126, 129, 133, 136-137, 377, 409, 473, 565, 581, 595.

4. "General Chemistry" - Selwood, pp. 36, 44.

5. "Chemistry" - Sienko and Plane, pp. 76-99.

B. Booklets:

1. "The Chemical Bond" - Gerard A. Kass.

2. "General Chemistry Workbook" - Pierce and Smith.

3. "Fundamental Concepts of Modern Chemistry" - Amsco, pp. 49, 406-407, 50-51, 430, 416-417, 430.

C. Transparencies:

Eye-gate No. 003-15 - Covalent Bonding

Self-Evaluation - Section C

Goal I. Arrange the following elements in order of the increasing force with which the valence electrons are held: Bismuth, Chlorine, Neon, Tellerium, Thallium.

I

a. _____

b. _____

c. _____

d. _____

e. _____

Goal II. The following pairs of atoms are all covalently bonded. Arrange the pairs in order of decreasing polarity of the bonds.

V

a. Boron and Nitrogen _____

b. Carbon and Sulfur _____

c. Hydrogen and Selenium _____

d. Iodine and Technetium _____

e. Nitrogen and Oxygen _____

Goal III. Classify the bonds between the following pairs of atoms as principally ionic or covalent.

III

a. Boron and Carbon _____

b. Fluorine and Silicon _____

c. Hydrogen and Chlorine _____

d. Magnesium and Nitrogen _____

Goal IV. Predict the number of covalent bonds between each of the following atoms in molecules:

V

a. $F_2$ _____

b. $SiO_2$ _____

c. PN _____

Goal V. Use the table of electronegativity and predict whether each of the following is an ionic or a covalent compound.

III

a. Magnesium Oxide (MgO) _____

b. Hydrogen fluoride (HF) _____

Self-Evaluation (con't from p. 3)

c. Potassium iodide (KI) _____

d. Nitrogen dioxide _____

III VI. Predict whether each of the following covalent substances are polar or non polar.

a. Fluorine _____

b. Sulfur dioxide _____

c. Nitric oxide _____

I VII. Select the letter of the correct answer)

1. The attraction of an atom for an electron is called:

(a) electronegativity (b) electron affinity

(c) ionization potential (d) ionization energy

(e) sublimation energy _____

2. The tendency of an atom to attract electrons in a bond with another atom is called:

(a) Ionization energy (b) Electronegativity

(b) Polarity (c) Electron affinity _____

3. A compound whose molecules are dipoles is:

(a) carbon dioxide and water (b) water and ammonia

(c) ammonia and methane (d) methane and carbon dioxide

_____

VIII. Select the letter of the correct answer:

II 1. Electrons transfer from one atom to another in compounds that form by: (a) covalent bonds (b) ionic bonds _____

2. The covalent bond between like atoms is a (a) Polar bond (b) non polar bond _____

3. If two pairs of electrons are shared by two atoms, the molecules contain (a) a double bond (b) a coordinate covalent bond _____

IX. Name three elements that generally form multiple bonds.

VI

a. _____

b. _____

c. _____

Advanced Study - Section C

1. Read the booklet "The Chemistry of Noble Gases" by the United States Atomic Energy Commission.

   From the booklet:

   a. Make graphic representatives of s and p orbitals.

   b. Due to evidence, name the 3 noble gases that are still inert?

   c. Why are noble gases inert?

   d. Write the formulas for the Xenon flurides.

   e. Give the important uses of inert gases.

   f. Write a paragraph on the occurence and the production of the noble gases.

2. Try to predict the bond angles of the following:

   a. HTe H in $H_2Te$

   b. HPH in $Ph_3$

   c. CPC in P $(CH_3)$

   d. Cl as Cl in Ac $Cl_3$

   e. FCF in $ClF_3$

3. Try to predict the bond lengths of the following:

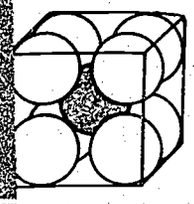
   a. Cl-Cl in $CO_2$

   b. N-H in $NH_3$

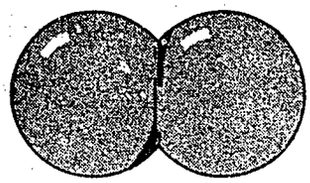
   c. C-N in $(CH_3)_3$ N

   d. H-Br in HBr

   e. C-C in $CH_3$ $CH_3$



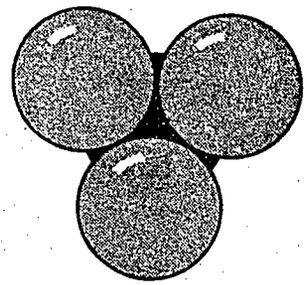
Sodium



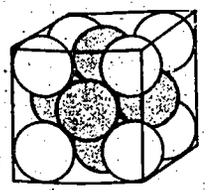
Chlorine



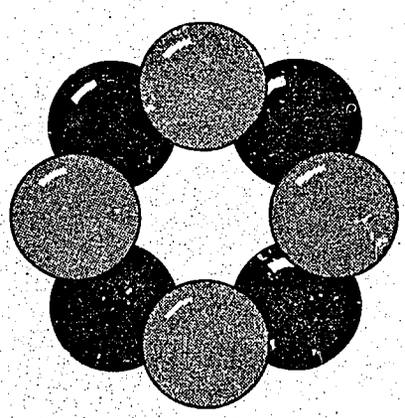
# LEARNING ACTIVITY PACKAGE



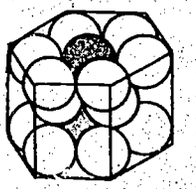
Phosphorus



Aluminum



Sulfur



Magnesium

## MATTER AND ITS FORMS

Ninety Six High School
Ninety Six, S.C.

## CHEMISTRY II

REVIEWED BY S. Ritchie

LAP NUMBER 40

WRITTEN BY N. Jones

## * Special Instructions

Section I - Gases

This section should be completed in three weeks.

Section II - Liquids

This section should be completed within one week.

Section III - Solids

This section should be completed within two weeks.

Total time for entire Lab is 6 weeks.

I. Rationale (Reason Why)

We usually think of rock as a solid. Yet there are areas of the earth's crust where rock is being formed from a liquid. An example is the liquid lava that flows from a volcano during an eruption being cooled and solidifying. Again, we usually think of the constituents of the atmosphere as gaseous. But dry ice is carbon dioxide in the solid state. Have you ever seen liquid carbon dioxide? If not, why not?

We have studied bonding and how it occurs. In this LAP we are going to study bonded materials in all three phases along with specific properties of each phase. Some of the properties we will study are diffusion, surface tension, viscosity and solubility. The knowledge of these properties of the phases will be valuable in studying equilibrium, energy kinetics and the chemistry of metals.

## Section I Gases

Behavioral Objectives

After completing the program of instruction you will be able to:

I. Define: Evaporation, condensation, diffusion, critical temperature and critical pressure

II. Determine the rate of diffusion of two gases according to Graham's Law of Diffusion

III. Write 3 assumptions of the kinetic theory in relation to gases

IV. List 2 conditions necessary for liquefying a gas.

V. Identify the law and be able to solve problems using:

A. Boyle's Law: Given the pressure and the volume, find the new volume at a new pressure

B. Charles' Law: Given the volume and temperature, find the new volume at a new temperature

C. A combination of Laws: Given the pressure, volume, and temperature determine

1. The new volume when given the new temperature and pressure.

2. The new pressure when given the new volume and temperature.

3. The new temperature when given the new volume and pressure.

4. Gay Lussacs' Law: Given the pressure and temperature, determine the new pressure at a new temperature.

Resources

I. Readings

1. "College Chemistry"- Frey pp. 79-104
2. "Concepts In Chemistry"- Greenstone, Sutman, Hollingsworth pp. 146-152
3. "Chemistry"- Sienko and Plane pp. 160-161, 133-166
4. "Chemistry"- Smoot, Price, Barrett pp. 269-305

II. Graphic Chemistry Chart p. 5

III. Magazine- "Chemistry" Feb. 1971 pp. 25-29

An Experimental Method to Study Charles' Law

IV. Filmstrips- Boyles' Law EB

Charles' Law EB

V. Experiments "Experimental Chemistry"

pp. 53-55 # 10 Gases and Absolute Zero

"Laboratory Chemistry"

pp. 135-136 #19 The Gas Law

141-143 #20 Effect of Temperature

153-154 # 21 Diffusion of Gases

Self-Evaluation Section I Gases

Obj.

V I. Match column B with a letter from column A

Column A

A. varies inversely as the pressure at constant temperature

B. volume-temperature relationship of a gas

C. relative rates of diffusion of gases

D. Pressure exerted by a gas varying directly with its absolute temperature

E. volume varies directly with absolute temperature

F. volume varies inversely with the pressure

Column B

1. Charles' Law_____

2. Graham Law_____

3. volume_____

4. Boyle's Law_____

5. Gay Lussac's Law_____

IV II. List 2 ways of liquefying a gas.

a._____

b._____

I 2. Define critical temperature

III. Select the letter of the correct answer:

(III) 1. Two assumptions of the kinetic theory that explains Brownian movement are that molecules change direction after colliding with other molecules and that (a) increased temperature decreases molecular motion (b) molecules are rarely in constant motion (c) the total kinetic energy of a gas is constant

(d) kinetic energy is inversely proportional to absolute temperature _____

Obj. 2. According to the kinetic theory, gas molecules have all the following characteristics except that of: (a) moving rapidly in random fashion (b) filling what ever space is available to them (c) being widely separated (d) diffusing at the same rate _____

3. One of the basic assumptions of the kinetic theory is that (a) heat has no effect on molecular motion (b) molecules move only when struck by Alpha particles (c) molecular collisions are perfectly elastic (d) the law of the Conservation of energy does not apply to gases. _____

IV. Select the correct letter

I 1. A liquid changes directly to a gas by
(a) condensation (b) evaperation (c) sublimation
(d) Ionization _____

2. The process of converting a liquid to a gas by increasing the size of very small particles up to colloidal size
(a) condensation (b) evaporation (c) sublimation
(d) Ionization _____

3. The process of spreading out spontaneously to fill a space uniformly is (a) equilibrium (b) diffusion (c) dispersion
(d) deviation _____

4. The highest temperature at which it is possible to liquefy a gas with any amount of pressure (a) celsius temperature
(b) absolute temperature (c) Standard Temperature
(d) critical temperature _____

(II) V. Using Graham's Law of diffusion calculate the relative rates of diffusion of helium and argon.
(a) Write the mathematical representation of Graham's Law_____

(b) The relative rate of diffusion of helium and argon are_____

(V) VI. 1. A 225 ml. volume of gas is collected at 57°C. What volume would the sample occupy at Standard Temperature?

_____

2. A 500 ml. sample of hydrogen is collected when the pressure is 300mm. What volume will the gas occupy when the pressure is 760 mm?

_____

3. A gas measures 200 ml. at 20°C and 750 mm pressure. What will be its volume at 15°C and 735 mm. pressure?

_____

4. A cubic foot of gas at 300°K exerts a pressure of 20 pounds per square in Ch on a container, what pressure will the gas exert when the temperature increases to 400°K?

_____

Advanced Study Section I Gases

I. A. Determine the molecular weight of a gas when 1 liter, under standard conditions weighs 1.35 grams.

B. A sample of carbon tetra chloride vapor weighs 3.89 grams and occupies 790 CC at 100°C and 743 mm of pressure. What is the approximate molecular weight of the $CCl_4$ ?

II. A. What properties should a gas have to make it suitable as a refrigerant? Explain

B. Account for the observation that when a carbon dioxide fire extinguisher is operating, a fine cloud of $CO_2$ "snow" forms.

Section II Liquids LAP 40

Behavioral Objectives

After completing the program of instruction you will be able to.

Obj. I. Define for a liquid:

1. volume
2. fluidity
3. non compressibility
4. diffusion
5. evaporation

II. Relate equilibrium to phase changes and vapor pressure to temperature and phase changes.

III. State 3 reasons for evaporation of liquids.

IV. Define and give examples of:

1. solution
2. solution equilibrium
3. liquefaction
4. colloids
5. suspensions

V. Identify all the types of solutions

VI. Write the 2 principal factors that determine solution rate.

Resources

I. Readings

1. "Chemistry" - Smoot, Price Barrett pp. 307-318, 221-237
2. "Modern Chemistry" Holt, Rinehart, Winston pp. 161-165
3. "Chemistry" Sienko and Pland pp. 167-175, 207- 211
4. "Chemistry" Choppin, Jaffee, Summerlin, Jackson pp. 120-143

II. Experiments

1. "Experimental Chemistry # 12 pp. 89-92
   Molecular Mass of a Condensable Vapor
   Experiment #
2. "Laboratory Chemistry" # 26
   Molecular Weight Determination by Boiling Point and Freezing Point pp. 185-190
   # 28 Quantitative Determination of the solubility Constant of a slightly soluble salt pp. 197-202

III. Tape Wollensak C-77556 Changing States of Matter

Self-Evaluation Section II Liquids Lap 40

Obj.

I. I. Match the letter of column A with the correct word in in Column B

Column A

a. a property of flow

b. the space occupied

c. spreading out spontaneously

d. unable to occupy less space

e. shanging of state from solid to liquid

f. changing of state from liquid to gas

g. a property of solidity

1. Evaporation_____

2. Diffusion_____

3. Fluidity_____

4. Noncompressibility___

5. volume_____

(II) II. a. How are temperature and vapor pressure related?

_____

b. What is the boiling point of a liquid, in terms of vapor pressure?_____

(III) III. Molecules possess kinetic energy is one reason for evaporation of liquids. Give 2 other reasons.

a._____

b._____

(IV) IV. Select the letter of the correct answer.

1. The dissolving madium in a solution is the (a) solute (b) suspended phase (c) solvent (d) precipitate____

2. The physical state in which the opposing processes of dissolving and crystallizing of a solute occur at an equal rate (a) gaseous (b) solution equilibrium (c) colloidal (d) suspension _____

3. Gases may be liquefied by (a) cooling and decreasing the pressure (b) cooling and then heating (c) heating and then cooling. _____

4. Colloid particles remain (a) temporarily in suspension (b) temporarily in diffusion (c) permanently in suspension (d) permanently solid. _____

5. In a suspension the particles (a) never settle out (b) always settle out (c) seldom settle out (d) don't all settle out _____

(V) V. Give the state of matter for the solute and the solvent of the following

| | Solute | Solvent |
|---|---|---|
| 1. air | _____ | _____ |
| 2. mercury in copper | _____ | _____ |
| 3. soda water | _____ | _____ |
| 4. sugar in water | _____ | _____ |

(VI) VI. Name the 2 factors that determine solution rate

a._____

b._____

Advanced Study Section II Liquids

I. Sodium chloride is hygroscopic. Find out why, in damp weather, table salt may clog the holes in the shaker.

II. Try to separate a solution of two liquids by distillation, with and without a fractionating column.

III. Obtain an unknown substance from your teacher and attempt to identify it experimentally by determining its solubility curve.

Section III Solids

Behavioral Objectives

After completing the program of instruction you will be able to:

Obj. I List and define 5 properties of solids

Obj. II Classify solids according to their 4 types of structures and give properties and examples of each of the 4 types.

Obj. III Define:

Hygroscopic

Deliquescent

Efflorescence

Precipitate

Crystal

Water of crystallization

Sublimation

Obj. IV. Discuss equilibrium, heat of fusion ,kinetic energy, and calories in relationship to temperature and phase changes.

Obj. V. List the 6 types of crystals and demonstrate that you understand the 6 types of crystals by drawing each type and discussing the axes of each type.

Obj. VI. Write a description of the 5 general forms of crystal "Packing" and illustrate each with a drawing and examples.

Resources

I. "Chemistry" Sienko and Plane (4th Edition) pp. 155-174

2. "College Chemistry" Frey pp. 115-119

3. "Concepts In Chemistry" Greenstone, Suman, Hollingsworth pp. 138-142

4. "Chemistry" Smoot, Price, Barrett, pp. 242-267

5. "Chemistry"- Choppin, Jaffe, Summerlin, Jackson pp. 149-143

6. "Crystal and Crystal Growing" Holden, Singer (paper Back) (Resource Center)

7. "Understanding Chemistry" Lessing pp. 110-133

II. Magazine "Chemistry" Arpil 1971

Stress collisions and constants pp. 10-12

III. Experiments

1. "Experimental Chemistry" # 15 Crystal Structure pp. 101-106

# 16 Molecular Mass from freezing point lowering pp. 107-112

2. "Laboratory Chemistry" # 18 Hydrated Crystals pp. 129-134

# 17 Atom arrangement in Crystals pp. 123-128

Self-Evaluation Section III Solids LAP 40

Obj.

(I) I. Solids have definite shapes and volumes. List 3 other properties of solids

a. _____

b. _____

c. _____

(II) II. Complete the following on classes of solids.

| Name | Properties | Example |
|---|---|---|
| 1. | 1. | 1. |
| 2. | 2. | 2. |
| 3. | 3. | 3. |
| 4. | 4. | 4. |

(III) III. Supply the word that best fits the definition given

a. The process by which hydrates lose moisture when exposed to air. _____

b. The process of compounds removing moisture from the air to form hydrates _____

c. The process of compounds removing enough moisture from air to dissolve in that moisture to form a solution. _____

d. A solid with a regular pattern of internal order throughout its structure. _____

e. A substance, usually a solid, which separates from a solution due to some physical or chemical change _____

f. Water that has united with some compounds as they crystallize from solution. _____

(IV) IV. Complete the following

a. When the average kinetic energy of molecules in a piece of matter increases the matter becomes(hotter, cooler) _____

b. Temperature is a measure of (potential, kinetic) energy of particles _____

c. Amounts of heat energy are expressed in (degrees, calories) _____

d. The 2 measurable properties of matter used to define a calorie are (mass and density, mass and temperature). _____

(V) V. Complete on Crystals

| Name | axes description |
|---|---|
| 1. | 1. |
| 2. | 2. |
| 3. | 3. |
| 4. | 4. |
| 5. | 5. |
| 6. | 6. |

(VI) VI. 1. Which of the following is a type of crystal packing?

a. orthorhomic c. monoclinic
b. hexagonal d. tetragonal _____

2. The particles in a simple cubic crystal appear at the
a. center of the unit cell
b. middle of each face
c. middle of each face and the corners
d. corners _____

3. The face-centered cubic close packing and the hexagonal close packing are usually found in
a. metals c. gases
b. nonmetals d. hard nonmetals _____

4. The body-centered cubic packing is found in
a. magnesium c. beryllium
b. sodium d. iodine _____

Advanced Study Section III Solids Lap 40

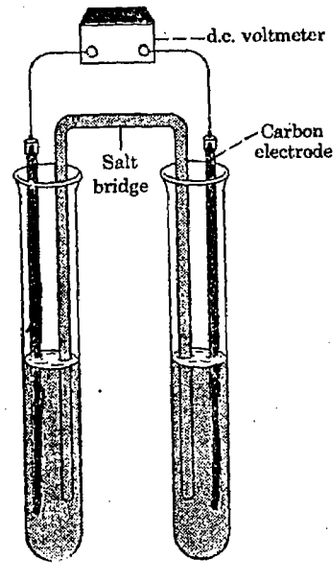
I. Look up the lives of W. L. and W. E. Bragg. Write a report on the processes they used to determine crystal structure.

II. A. Make models of each crystal system

B. Collect crystals which illustrate each of the three systems.

# LEARNING ACTIVITY PACKAGE

# Electrochemical




## Half-cell Reactions

Ninety Six High School · Ninety Six, S.C.

CHEMISTRY II

LAP NUMBER 41

WRITTEN BY N. Jones

REVIEWED BY



32472

6

Electrochemistry

Chemistry II - LAP 41

Behavioral Objectives:

I. Demonstrate your ability to understand Coulomb's Law by solving problems relating to the law.

II. Explain how Faraday's Laws gave further evidence of Dalton's Atomic Theory and solve problems involving the Laws.

III. Explain the difference between oxidation and reduction in terms of

a. experimental chemical behavior
b. change in oxidation number
c. half-reaction equations

IV. When given reactants of an electrolytic process, go through the following procedures

a. Write half-cell reactions for those substances oxidized and explain why oxidation has occurred.
b. Write half-cell reactions for those substances that are reduced and explain why reduction occurs.
c. Write the products and balance the equation.

V. Given redox equations

a. demonstrate how conservation of energy and matter is maintained using half reactions

b. balance equations

c. use table of oxidation potentials to determine the spontaneity of reaction

d. compute $E^{o}$ total for redox reactions

Self Evaluation

Electrochemistry, LAP 41

Goal I. A. Express Coulomb's Law of relationships:

1.

2.

3.

B. Write an equation to show Coulomb's Law:

C. Solve this problem according to Coulomb's Law:

Two electrons at a distance of 1 unit (d=1) repel each other with a force of two units (f=2). If the distance between the electrons is doubled, what will the force of repulsion be between the two electrons?

_____

Goal II. A. What 2 types of cells do Faraday's Laws apply?

1.

2.

B. State the 2 Laws of Faraday which are the basis for all electrochemical calculations:

1.

2.

C. What current must be used to plate two moles of copper on an electrode in three minutes?

_____

D. A current of 10 amp. is passed through molten $MgCl_2$ for 15 minutes, between inert carbon electrodes. Give the reactions at the electrodes, and compute the amount of product of each.

Reactions: Cathode 1.

Anode 2.

Self Evaluation - Electrochemistry - LAP 41 con't.

Weight of magnesium

Weight of Chlorine

Goal III. A. Complete the following on oxidation numbers:

1. The oxidation number of an atom of a free element is _____

2. The oxidation numbers of a monatomic ion is equal to its _____

3. The algebraic sum of oxidation numbers of atoms in the formula of a compound is _____

4. The oxidation number of hydrogen is usually _____

5. In peroxides the oxidation number of oxygen is _____

6. The algebraic sum of the oxidation numbers of the atoms in the formula of a radical is equal to its _____

B. What is the result of an oxidation reaction?

_____

C. In the following equations which substances are oxidized? (left or right)

1. $Na^{0} - e^{-} \rightarrow Na^{+1}$

2. $Fe^{0} - 2e^{-} \rightarrow Fe^{+2}$

3. $2Cl^{-1} - 2e^{-} \rightarrow Cl_{2}^{0}$

D. In the following equations which substances are reduced? (left or right)

1. $Na^{+1} + e^{-} \rightarrow Na^{0}$

2. $Fe^{+3} + e^{-} \rightarrow Fe^{+2}$

3. $Br_{2}^{0} + 2e^{-} \rightarrow 2Br^{-1}$

E. In balancing redox reactions the second step includes what two things?

1. _____

2. _____

G. Assign oxidation numbers to each element in the reaction between hydrogen sulfide and oxygen.

_____

Self Evaluation - Electrochemistry - LAP 41 con't.

H. Write the electronic reaction for the oxidation part of the reaction. _____

I. Write the electronic reaction for the reduction part of the reaction. _____

J. Free oxygen is diatomic, how many electrons must be gained? _____

K. 1. Write oxidation half-reaction of $2Mg + O_2 \rightarrow 2MgO$

_____

2. Write the reduction half-reaction of $2Mg + O_2 \rightarrow 2MgO$

_____

IV. A. Balance the oxidation-reduction equation $Cl_2 + I^- \rightarrow Cl^- + I_2$

1. Write the balanced reduction half-reaction. _____

2. Write the balanced oxidation half-reaction. _____

3. Write the total balanced redox reaction. _____

B. Write a balanced oxidation-reduction reaction for the following: $Al + Hg^{+2} \rightarrow Hg_2^{+2} + Al^{+3}$

1. Write the reduction part. _____

2. Write the oxidation part. _____

3. Write the oxidation half-balanced. _____

4. Write the reduction half-balanced. _____

5. Write the total balanced redox reaction. _____

V. A. Complete the following on oxidation, potential and reaction prediction:

1. Reduction is the (gain, loss) of electrons. _____

2. A substance that releases electrons to other substances easily is called _____.

3. The best reducing agent is _____.

4. The poorest reducing agent is _____.

5. A forward reaction is an oxidation reaction due to

_____

6. The electrochemical formula for the best reducing agent is _____

7. The electrochemical formula for the poorest reducing agent is _____

B. Show that the following reaction occurs and the reverse does not occur. $Cu + Cu^{+2} + Ag$

1. Write the half-reactions and obtain their voltage from the electrochemical series. _____

_____

2. Write the half-reaction as the reaction takes place and balance the electrons.

_____

_____

3. Why does this reaction occur spontaneously?

_____

## Activities

I. Books:

*1. "Solving Chemistry Problems," Merrill, pp. 220-236

2. "Chemistry," Merrill, pp. 404-414

3. "Redox and Electrochemistry," Kass, pp. 1-158

4. "Chemistry," Sienko and Plane, pp. 299-324

5. "Modern Chemistry," Amsco, pp. 313-346

II. Experiments:

*1. "Experimental Chemistry," Sienko and Plane

a. Determination of the Faraday, pp. 131-134

b. Oxidation Potentials, pp. 135-140

2. "Laboratory Chemistry," Merrill, Oxidation-Reduction Reactions, pp. 225-232

III. Filmstrip:

Electrochemistry - 500

Putting Electrolysis to Work - 600

Questions to be handed in: pp. 321

"Chemistry," Sienko and Plane

Problems:

13 - 5

13 - 10

13 - 24

13 - 25

## Advanced Study

1. Balance the following equations:

   a. $Kmno_4 + H_2SO_3 \rightarrow Mn\ SO_4 + KHSO_4 + H_2SO_4 + H_2O$

   b. $K_2Cr_2O_7 + H_2SO_4 + KI \rightarrow Cr_2(SO_4)_3 + I_2 + H_2O$

   c. $NH_3 + O_2 \rightarrow NO + H_2O$

   d. $As_2O_3 + HNO_3 + H_2O \rightarrow H_3AsO_4 + NO$

   e. $I_2 + H_2SO_3 + H_2O \rightarrow HI + H_2SO_4$

   f. $H_3AsO_4 + H^+ + Zn \rightarrow AsH_3 + H_2O + Zn^{+2}$

   g. $MnO_4^{-2} + H^+ \rightarrow MnO_4 + MnO_2 + H_2O$

   h. $MnO_4 + SO_3 + H_2O \rightarrow Mn^{+2} + SO_4^{-2} + H^+$

2. Select any industrial chemical process and make a list of all oxidation - reduction reactions which take part in the process.

3. Assuming maximum appropriate values for oxidation numbers, assign formulas to hypothetical binary compounds for the following pairs of elements.

| | |
|---|---|
| a. Pr and O | e. Sr and H |
| b. Ba and N | f. Fr and C |
| c. Cr and O | g. Li and O |
| d. Ca and P | h. Fe and S |

4. Make a list of three oxidation-reduction reactions that occur in nature and three oxidation-reduction reactions that occur in the preparation of a meal in a modern kitchen.

5. In reference work, study the Nernst Equation and then compute the voltage of a cell in which one half-cell is made with zinc and 1.0 M $Zn^{++}$ and the other half-cell is Zn and 0.1M $Zn^{++}$.

6. Compute the voltage of a cell in which one half-cell is the hydrogen at a pressure of 2 atm, and the other half-cell is zinc and $Zn^{++}$ at 1.0 M.

7. The storage cell is the most commonly known source of electrical energy for automobiles. Draw the storage cell. Tell the composition of the cathode and the anode. What is the electrolyte? What are the half-reactions when the lead storage cell is discharging? What is the acid content and the approximate density of the acid in a charged cell?