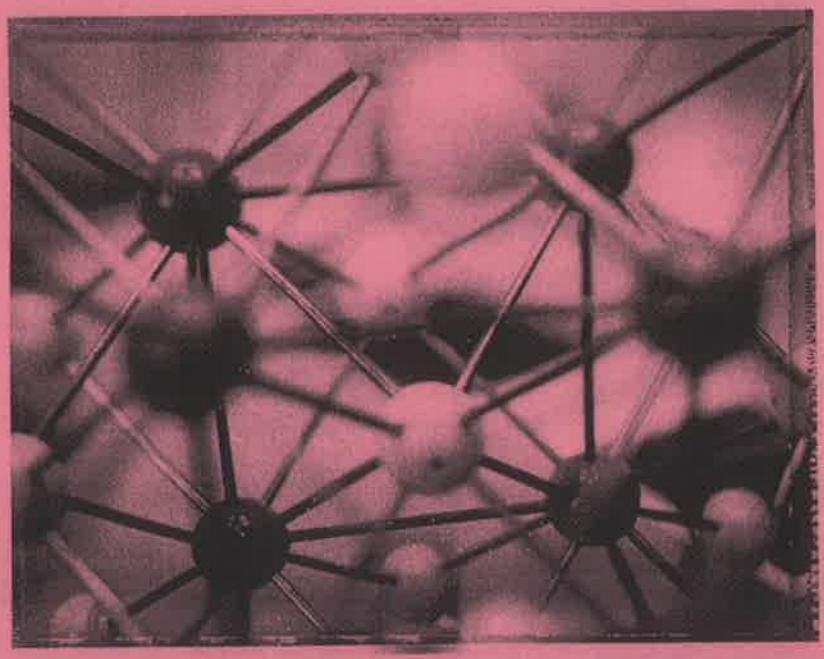
UNIT FIVE:



Bonding and Intermolecular Forces

Unit IIIe:

Bonding and Intermolecular Forces

NAME: DATE:

PAPER CLIP FORMULAS

Each of the following symbols represents a specific type of paper clip. These paper clips are in separate bags on your table.

Sm= Small **R= Regular** **Jb= Jumbo**

Using the correct number and type of paper clips, create each substance based on its formula. When you have made all seven substances, have them approved by your teacher.

SUBSTANCE	FORMULA
1	$JbSm_2$
2	$Jb_2Sm + R_2$
3	$2Sm + R_3$
4	Sm_2
5	Jb_2R
6	$4R$
7	$2\,Jb(R_3Sm)_2$

QUESTIONS:

1. Which of the substances are elements?

2. Which of the substances are mixtures?

3. Which of the substances are compounds?

4. How many total atoms are in each of the substances above?

5. What is a diatomic element? Which substances above are diatomic? Justify your answer.

6. What is a polyatomic ion? Which substance above contains a polyatomic ion? Justify your answer.

7. If R in #5 has an oxidation number of (-2), what is the oxidation number of Jb?

8. If Jb in #7 has an oxidation number of (+4), what is the oxidation number of R3Sm?

9. If Jb in #1 has an oxidation number of (+2), what is the oxidation number of Sm?

10. What is a binary compound? What ending is used for binary compounds? Which substances above represent binary compounds?

NAME: DATE:

THE NATURE OF BONDING

WHY BOND?:

PURPOSE: To study the nature of bonding in various different substances.

SAFETY:

PROCEDURE:

1. Observe a record the phase of each substance at room temperature.
2. Put all small amount of each substance on a watch class and test with for electrical conductivity. Make sure to clean the probe after each test to avoid contamination and errors in results.
3. Add water to each substance on the watch glass. Observe and record it's solubility in water.
4. Test the electrical conductivity of the water-substance mixture (aqueous solution). Record.
5. Fill in the data table and use the data to determine trends.

QUESTIONS:

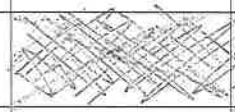
1. Which substances are elements?

2. Which Substances are Compounds?

3. Contrast the properties of metals vs. nonmetals- make a Venn Diagram .

4. Contrast properties of ionic vs. covalent substances.

5. Are there any inconsistences with your data? Explain.

	Physical Appearance	Formula	Phase at Room Temperature	Melt Point (C)	Electrical Conductivity without Water	Solubility with Water	Electrical Conductivity with Water	Type of Bonding Patterns
Water								
Sodium Chloride			801					
Sucrose		$C_{12}H_{22}O_{11}$	185					
Acetone		C_2H_5OH	-117.3					
Ethanol			686					
Potassium Iodide			1539					
Iron Filings, Wire			119					
Sulfur			772					
Calcium Chloride			1083					
Copper			850					Metallic
Glycerin		$C_3H_5(OH)_3$	18.6					
Hydrochloric Acid			-144.8					Covalent
Graphite			More than 4000					
Potassium Nitrate			1412					

DATE:

USING MOLECULAR MODELS TO PREDICT POLARITY

PURPOSE:

To build molecular models of covalent compounds to solidify understanding of Lewis Dot, to use molecular modeling to predict the shape of a molecule and to learn how to associate shape with polarity.

INTRODUCTION:

A molecule is a group of atoms help together by covalent bonds. One molecule represents the smallest unit of a substance that has all the properties of that substance. The atoms in a molecular substance are held together by covalent bonds.

Covalent bonds form when two atoms share electron. A single covalent bond share one pair, a double covalent share two pairs and a triple covalent bond shares three pairs. Covalent bonds may also be describes as polar and non-polar. When the two atoms exert the same attraction for electrons in the bond (electronegativity), then the bond is non-polar. When one of the atoms exerts a stronger attractive force (electronegativity) on the bonded electrons, it is called a polar covalent bond.

Molecules have different three-dimensional shapes that depend upon the number of atoms in the molecule and how they are bonded. A molecule may also be considered polar or non-polar. If the molecule has a symmetrical distribution of charge, it is non-polar. If the molecule has an asymmetrical distribution of charge, it is polar. By constructing a variety of three-dimensional models of molecular compounds, the polarity and shape of the molecule can be determined.

MATERIALS :

Molecular Modeling Kit

SAFETY :

PROCEDURE:

1. Obtain a molecular modeling kit and determine the color code for the various atoms you will work with.
2. Follow the bonding rules for connecting atoms
    a. Single bonds- one stick connecting (represents a bond with two electrons)
    b. Double bonds- two sticks connecting (each stick represents a bond with two electrons for a grand total of four electrons shared.
    c. Triple bonds- three sticks connecting (each stick represents a bond with two electrons for a grand total of six electrons shared.
3. Construct models for the substances listed in the data table. Make a few at a time and fill in the information. Have the models checked by your teacher before taking them apart.
4. Use these models to predict the molecular geometry of each molecule based on symmetry and polarity.
5. When finished, take apart the molecules and place all pieces back into the modeling kit.

UESTIONS:

1. Define the following words
   a. Polar Covalent Bond

   b. Nonpolar Covalent Bond

   c. Polar Molecule

   d. Non-polar Molecule

   e. Electronegativity

   f. Symmetry

2. How do you determine if a covalent bond is polar or non-polar?

3. How do you determine if a molecule is polar or non-polar?

4. Which molecules were non-polar because all the bonds were non-polar? Write out names and formulas.

5. Which molecules had polar covalent bonds but were nonpolar because of symmetry? Write out names and formulas.

6. Which two molecular geometry shapes appear to only produce polar molecules?

7. Which molecular geometry shapes appear to produce both polar and non-polar molecules?

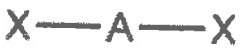
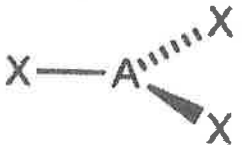
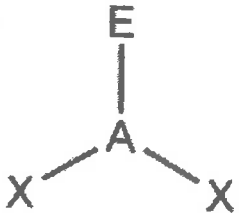
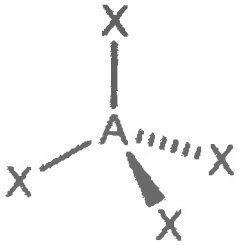
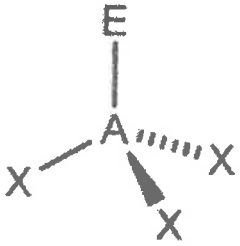
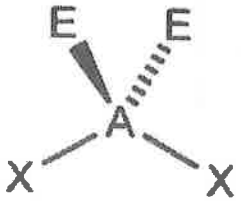
8. How does bonding affect molecular geometry?

	Write the Formula	Draw the Structure	Name the Shape	Determine Polarity Polar/Nonpolar
drogen	H_2			
Water				
Methane (Carbon Tetrahydride)				
Oxygen				
Ammonia (Nitrogen Trihydride)				
Dichloromethane	CH_2Cl_2			
Nitrogen				
Methanol	CH_3OH			
Carbon Tetrachloride				
Carbon Dioxide				
Hydrogen Fluoride				
Hydrogen Sulfide				
Ethyne	C_2H_2			

MOLECULAR SHAPES

X= OCCUPIED

E= EMPTY

Total Bonds	0 lone pair	1 lone pair	2 lone pairs
2	 Linear		
3	 Trigonal planar	 Bent	
4	 Tetrahedral	 Trigonal pyramid	 Bent

NAME: DATE:

A PENNY'S WORTH: A STUDY OF INTERMOLECULAR FORCES

TRODUCTION:

Covalently bonded substances exist as discrete molecules with various shapes and polarities. The distribution of charges in a molecule determines how polar or nonpolar a molecule is. If the molecule has asymmetrical distribution of charge, it is considered a polar molecule. If it has a symmetrical distribution of charge, it is considered nonpolar.

Depending on the polarity of a molecule, certain intermolecular forces of attraction can be present. These intermolecular forces can be present as hydrogen bonds, dipole-dipole interaction, molecule-ion attractions and weak dispersion (van der waal) forces. Hydrogen bonding is a strong intermolecular force between polar molecules. It causes substances to have a higher boiling point that expected.

The following three liquids are all covalently bonded and exhibit intermolecular forces between their molecules. Draw in their chemical structure. Be sure to indicate the lone pairs!

Water	Ethanol	Lamp Oil

IRPOSE:

PROCEDURE:

1. In your lab groups, place as many drops of water on the penny (specify heads or tails) until it overflows onto the paper towel. Repeat this procedure five times and collect all data.
2. Complete step one using ethanol. Record all data below.
3. Complete step one using lamp oil. Record all data below.
4. If time permits, test with various pipettes or on a different side of the penny.
5. Clean the penny by drying thoroughly, wipe the lab table down with water and a sponge. Wash your hands.

DATA:

	Trial One	Trial Two	Trial Three	Trial Four	Trial Five	Shape of Molecule	Polarity of Molecule	Type of IMF	Weak or Strong IMF
Water									
Ethanol									
Lamp Oil									

QUESTIONS:

1. Classify each of these substances as either ionic or covalent.

2. What is electronegativity?

3. Describe the chemical structure and polarity of each of these substances.

4. Draw a Lewis Dot structure for each of these substances.

5. Indicate on the Lewis Dot structure the polarity of each of these molecules.

6. Identify the type of intermolecular force present in each substance.

7. Which substance had the most drops?

8. What relationship can you describe between intermolecular forces and the number of drops held on the penny?

9. Predict how this will change the boiling point if intermolecular forces get stronger? What about weaker? Explain.