LAB **χη12** **PROPERTIES OF IONIC AND MOLECULAR COMPOUNDS**

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Two names:

Purpose:

Ionic and covalent compounds together encompass a wide range of physical and chemical properties. PROPERTIES can be DETERMINED by how a substance interacts with its environment. We will explore some of those properties in this lab. In this lab you will observe four physical properties of each of nine compounds in order to get an idea of the differences as well as similarities of properties of ionic versus covalent compounds. Finally, you will determine which property appears to best distinguish between an ionic compound and a covalent compound.

Background information/Notes:

Atoms combine with other atoms so they can achieve a more stable electron arrangement, often an outer octet. So how does this happen? Briefly, they do this by gaining, losing, or sharing electrons with other atoms to form a bond. A bond is the electrostatic attractive force that holds atoms together. This electron change during bonding lowers the total potential energy due to each atom having a more stable electron arrangement.

There are two common ways to categorize compounds as ionic or covalent. 1) By Composition: We can broadly classify chemical bonds into three types depending on the kind of atoms (metals or nonmetals) involved in the bonding. 2) By ΔEN (Electronegativity difference): Electronegativity is the ability of an atom to attract a shared pair of electrons (called a bonding pair). The difference in electronegativity between two bonded atoms can be used as an approximate guide to predict the properties of the bond: Covalent (non-polar), polar, or ionic. This was addressed in the **Electronegativity video**.

For review: Ionic bonds, ionic compounds, Covalent bonds, covalent compounds

Pre-Lab: Answer in the space provided below.

1. How can we determine properties of a substance?

2. Why do atoms combine with other atoms?

3. How does this happen?

4. Define the following terms:

a) Bond

b) valence electrons

c) bonding pair

d) electronegativity

5. Why are valence electrons important?

6. The bonding categories of Group 1 and Group 2 below are determined by their composition, that is, the type of elements they have. Locate their elements on your **periodic table** and see if you can find a pattern.

Group 1 **IONIC BONDS**	Group 2 **COVALENT BONDS**
NaCl (sodium chloride)	H_2O (dihydrogen monoxide)(!)
K_2S (potassium sulfide)	$C_6H_{12}O_6$ (glucose)
TiO_2 (titanium IV oxide)	$C_6H_4Cl_2$ (paradichlorobenzene, PDCB)
CaF_2 (calcium fluoride)	SF_6 (sulfur hexafluoride)

From the two categories of compounds above and your inspection of where their elements are on the periodic table, you should be able to fill in the blanks below with the type of element (metal/nonmetal/metalloid)

a) When a _____ element and a _____ element come together, they generally make an **Ionic Bond**.

b) In the ionic formula (your answer to (a)), which element type always comes first, which always comes second?

c) When two or more _____elements come together, they generally make a **Covalent Bond**.

Gathering Data:

While you watch the video (link below), there are four properties listed below that should be observed (read through them carefully before watching the video), record your observations in the space provided below. You will be asked to make an organized data table, so keep things detailed, clear, and organized.

4 properties:

A) physical appearance- color, texture, physical state of solid, liquid, or gas.

B) solubility in room temperature water. Water is a very polar molecule—it has both partial (+) and partial (-) charge. If the substance disappears when mixed with the water, that means it has dissolved.

C) ability to conduct electricity when mixed with water, using a light bulb. Record not just whether the bulb lights up but how bright, such as using +, ++, or +++ for amount of brightness

D) melting time: given the same amount of heat, which compounds have a LOW melting point (melting time is relatively quick), or a HIGH melting point (melting time is relatively high or does not melt at all).

NOTE that for melting time, YOU will time the melting, starting at zero when the flame is put under the substance, to when the substance begins to melt. Record this melting time in your data table.

1. Watch the Lab video, **Distinguishing Between Ionic and Covalent Compounds**. Much if not all of the observations you record, for the properties listed above **(A-D)**, will end up in the data table. You should therefore closely read the DATA TABLE portion of the lab write-up below before watching the video. You are provided this space to write any observations you may wish, however the observations on which you will be graded will be in the data table.
2. Write down any particular techniques that are used in the lab in the box below.

Observations:

3. **LAB WRITE UP:**

Names, Title, Purpose, Pre-lab, Data Table, and Analysis.

- ❏ **Names** 1 pt

- ❏ **Title** (use title or make one up) 1 pt

- ❏ **purpose** (why are we doing this lab--be thoughtful) 2 pts

- ❏ **Pre-Lab** (done above) 3 pts

- ❏ **Data table**: 10 points. Set up a data table as follows: Insert a **8 × 10** table (go to insert table (create 8 columns, 10 rows). In the first row put a title for each column as follows: Column **1)** lists the names of the 9 compounds, then have the following columns for each compound: **2)** chemical formula for each compound; **3)** ionic or covalent according to composition; **4)** ionic or covalent according to ΔEN, electronegativity difference (see information directly below); **5-8)** results for each of the four property tests.

Information for determining the **Electronegativity difference**, ΔEN: The bonds for which you should **find electronegativity differences** are given to the right of each compound. For small compounds such as these, i**t is the bond with the largest electronegativity difference** that gives the character of the compound (non-polar covalent, polar covalent, ionic).

1. potassium iodide KI	K-I
2. potassium chloride KCl	K-Cl
3. glucose $C_6H_{12}O_6$	C-H, C-O, O-H, C-C
4. paradichlorobenzene (PDCB) $C_6H_4Cl_2$	C-Cl, C-H, C-C
5. potassium nitrate KNO_3	N-O, K-N, K-O
6. benzoic acid C_6H_5COOH	C-H, C-O, O-H
7. paraffin wax $\sim C_{24}H_{50}$	C-C, C-H
8. acetic acid CH_3COOH	C-H, C-O, O-H, C-C
9. hydrogen chloride HCl (the acid is aqueous, see below)	H-Cl

Note that the compound **HCl**, or hydrogen chloride, is normally a gas (=low melting point!). It becomes an acid when dissolved in water, and so we call it hydrochloric acid. This will be discussed in more detail later.

CREATE YOUR DATA TABLE HERE:

❑ **Analysis:** 10 points

1) We have already learned two ways to categorize compounds as ionic or covalent: by differences in electronegativity and by composition: is the compound made of metal–non-metal or all non-metal. Using that criteria, categorize the nine compounds in the lab (this is in your data table), then determine various properties that the compounds have, and then use that data to determine common properties among ionic compounds and common properties among covalent compounds.
2) A) Look at and **discuss in writing** ALL of the evidence—your results of tests A-D—and conclude which properties seem to be more ionic and which seem to be more covalent and which might be more in between.

B) Is there any one property that best indicates whether a compound is covalent or ionic? Explain your reasoning.

3) Does a longer melting time indicate a higher or lower melting point than a shorter melting time?

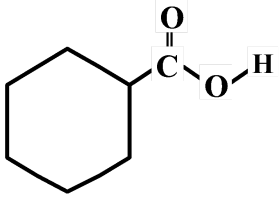
4) Potassium nitrate has several covalent bonds, yet the substance has primarily ionic character. How can this be possible? (Hint: think about the specific ions that make up the compound.)

5) HCl is covalent yet it conducts electricity. Given the amount of its electronegativity difference as well as considering shielding in hydrogen, can you explain what might happen when it is dissolved in water (even though it is covalent)? ALSO, comment on any difference in conductivity between HCl and acetic acid. Do you have an idea of why the two have any difference?

6) Why can dissolved ionic compounds conduct electricity but most covalent compounds cannot?

7) Of the 9 compounds, which two are represented below? (HINT: each vertex represents a carbon with hydrogen bonded to it.) From your answer, what do you think the prefix ***benz*** refers to?

A



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