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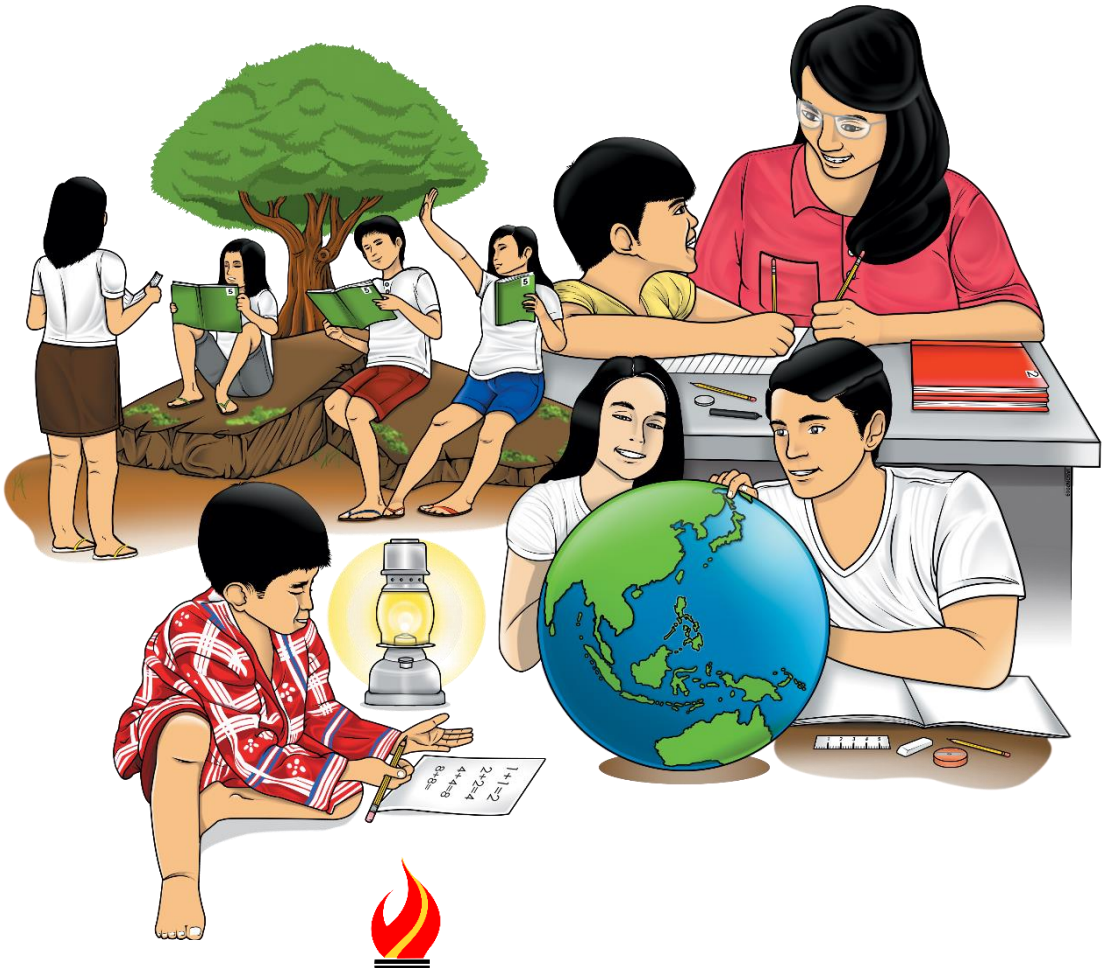
Science

Quarter 2 – Module 3: Properties of Ionic and Covalent Compounds



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Science

Quarter 2 – Module 3:
Properties of Ionic and Covalent Compounds

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

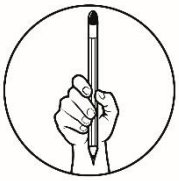
What I Need to Know

At the end of this module, you should be able to:

1. Recognize different types of compounds (ionic or covalent) based on their properties such as melting point, hardness, polarity, and electrical and thermal conductivity.

2. Specifically, after going through this module, you will be able to:
    a. Differentiate between ionic and covalent molecular compounds
    b. Distinguish and explain the properties of ionic and covalent molecular compounds

Lesson 1 Properties of Ionic and Covalent Molecular Compounds



What I Know

I. Multiple Choice: Read the statements carefully. Choose the letter of your answer and write it on your answer sheet.

1. Which type of compound results from the combination of metal and non-metal elements?
   a. Ionic compounds
   b. Covalent molecular compounds
   c. Organic compounds
   d. Acids and Bases

2. Which type of compounds result from the combination of two nonmetallic elements?
   a. Ionic compounds
   b. Covalent molecular compounds
   c. Organic compounds
   d. Acids and Bases

3. These are electrostatic forces of attraction that results from the complete transfer of electrons from one atom to another.
   a. Covalent bonds
   b. Ionic bonds
   c. Metallic Bonds
   d. Polar and Nonpolar Bonds

4. All of the following describes ionic compounds ***EXCEPT:***
   a. They form crystals
   b. They are hard and brittle
   c. They have high melting and boiling points
   d. They possess polar and nonpolar characteristics

5. Why are ionic compounds good conductors of electricity?
   a. Ionic compounds are electrical in nature.
   b. The strong electrostatic attraction between ions allows electricity to freely flow.
   c. Aqueous solutions of ionic compounds cause to dissociate ions and are free to conduct electricity.
   d. Strong electrostatic attraction between crystal lattice of ionic compounds is strong which needs high temperature to melt or boil these compounds

6. Which of the following example is ionic in nature?
   a. CO_2 c. NaCl
   b. H_2O d. CO

7. Which of the following compounds is covalent?
   a. Sodium Hydroxide c. Barium chloride
   b. Table sugar d. table salt iii

8. Which explains the flammability of covalent molecular compounds?
   a. Molecules easily react flames
   b. They contain carbon and hydrogen atoms that react readily with oxygen gas.
   c. Covalent molecular compounds share their electrons forming polar and nonpolar bonds.
   d. Because they generally have low melting and boiling points and the addition of small amount of energy causes intermolecular attraction to break.

9. What accounts for the polarity of compounds?
   a. It is a result of the uneven partial charge distribution between various atoms in a compound.
   b. The structure of covalent compounds is unique that's why they can be polar and nonpolar.
   c. The strength between covalent bonding causes molecules to have polar and nonpolar characteristics
   d. Due to some exceptions, the sharing of electrons between atoms in covalent compounds results in a stable balance of attractive and repulsive forces between atoms.

10. It is the ability of an atom in a molecule to attract shared electrons toward itself.
   a. Polarity c. Chemical Bonding
   b. Ionic Bonding d. Electronegativity

What's New

https://www.needpix.com/photo/674099/sugar-cup-pile-of-sugar-sweet-trays-trickle-blue-fall-nibble

https://pxhere.com/en/photo/1135962

Figure 1: Two Different Substances with Similar Appearance

Can you guess from the pictures above which is table sugar, and which is salt? How are you going to identify which substance is sugar and which is salt?

Self – Activity I: Taste Test

What you need:

- Teaspoon
- ½ tablespoon of sugar
- ½ tablespoon of salt

What to do:

- Taste about a pinch of sugar. Observe how long it takes to melt all the sugar in your mouth.
- Taste about a pinch of salt. Observe how long it takes to melt all the salt in your mouth.

Questions:

1. Both the refined sugar and iodized salt appear crystalline white. What would be the easiest way to identify which is the sugar and the salt?
2. Describe the tase of each compound.
3. Which substance melts faster in your mouth?
4. Why do you think one substance melts faster than the other?

There are many chemical compounds that looks almost the same, like refined sugar and iodized salt. It may be easy to identify the two substances by tasting, but this method of identifying substances does not apply to other compounds as some can be toxic and corrosive.

There are two common types of compounds based on their chemical bonding characteristics – **Ionic Compounds and Covalent Compounds.**

What is It

Compounds are formed between the chemical combinations of two or more elements. To distinguish between the types of compounds, one should first take note of the type of elements that are chemically combined.

Figure 2 shows the compounds formed based on the type of elements combined.

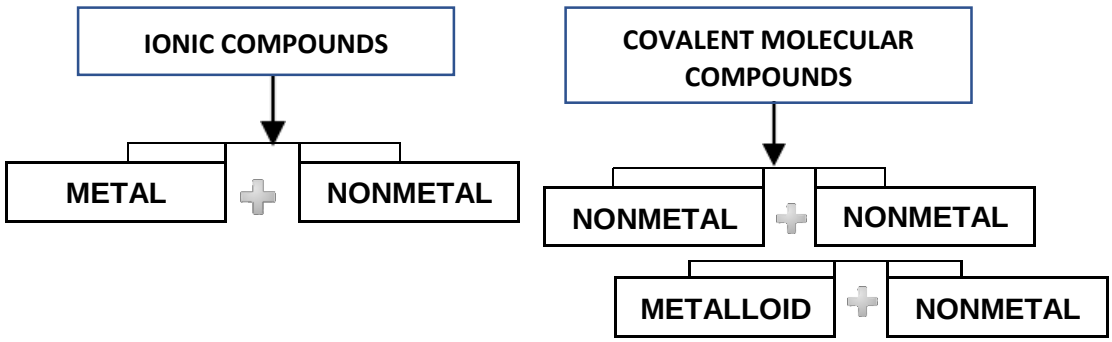


Figure 2: Compounds Formed Based on the Types of Elements Combined

To determine if an element is a metal, non-metal, or metalloid, one should refer to their location in the periodic table. Figure 3 shows the location of these three types of elements. The pink colors are the metals, the blue ones are nonmetals, and the green elements are the metalloids. As you can see, most elements are metals and placed on the left side of the periodic table except for Hydrogen. On the right side are the nonmetals separated by a stair-like barrier of elements which are the metalloids or semi-metals.

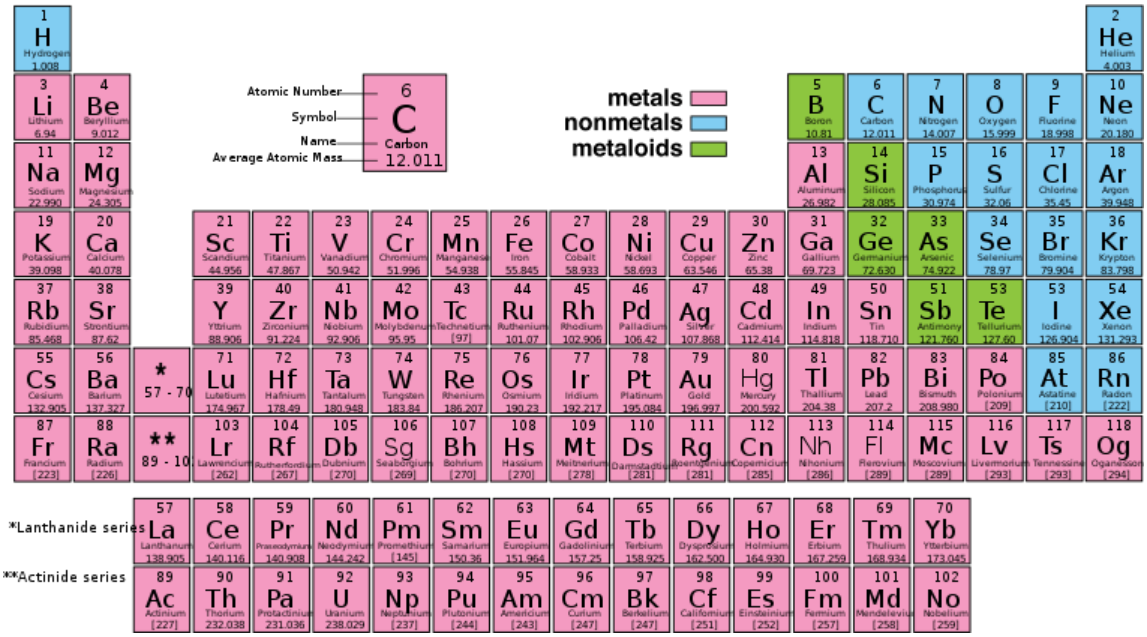
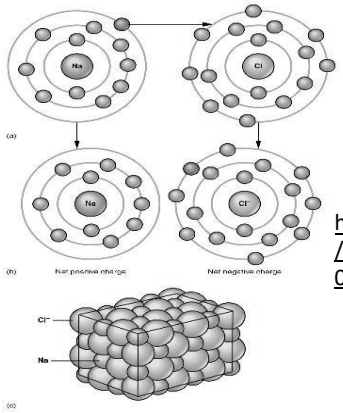


Figure3: Periodic Table of Elements showing the metals, nonmetals, and metalloids

The Ionic Compounds

Based on Figure 2, **Ionic compounds** are formed between a metal and a nonmetal. The chemical combination between the two types of elements results in the formation of ionic bonds between the atoms. **Ionic bonds** are the electrostatic force of attraction that holds **cations** (positively charged atom) and **anions** (negatively charged atoms) together.

Sodium Chloride (NaCl) or table salt is an example of an ionic compound. It is the combination of Sodium (a metal) and Chlorine (a nonmetal). Sodium becomes a cation (Na^+) as it loses an electron which transfers to the chlorine atom. Chlorine atom gaining the electron becomes an anion (CI^-) and eventually, an ionic bond is formed holding these ions together.



https://commons.wikimedia.org/wiki/File:207Ionic_Bonding-01.jpg

Figure 4: Ionic Bonding between Sodium and Chlorine

The table below show examples of ionic compounds and their uses.

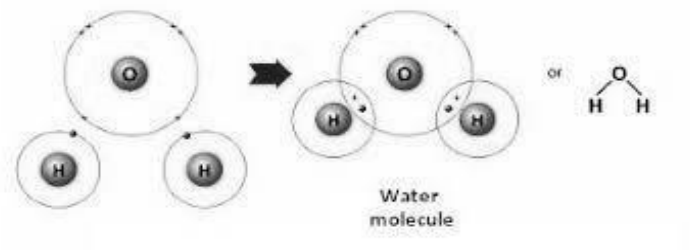
Table 1: Common Ionic Compounds and Their Uses

Ionic Compound	Chemical Formula	Importance and Uses
Potassium iodide	Kl	Iodized salt uses as dietary supplement.
Soduim fluoride	NaF	An ingredient in toothpaste that helps prevent cavities and tooth decay.
Sodium bicarbonate	$NaHCO_3$	Baking soda: used in baking and as an antacid to reduce stomach acid, treats indigestion and upset stomach.
Sodium hydroxide	NaOH	Used as a cleaning agent, it is the component of soap and detergents
Barium hloride	B_aCI_2	Used in making fireworks producing the green-colored explosions

Covalent molecular compounds or simply **covalent compounds** are substances that are formed from the chemical combination of two or more nonmetallic elements. Based on Figure 2, it could be between a nonmetal and another nonmetal, or a metalloid and a nonmetal. Table sugar or sucrose (C12H22O11) is an example of a covalent molecular compound. It is a combination of carbon, hydrogen, and oxygen atoms.

In a covalent compound, atoms of the different elements are held together in molecules by **covalent bonds**. Unlike ionic bonds in which electrons completely transfer from one atom to another, covalent bonds share their **valence electrons**. The force of attraction between the shared electrons and the positive nuclei of both atoms holds the atoms together in the molecule. A molecule is the smallest particle of a covalent compound that still has the properties of the compound.

Figure 4 shows the sharing of electrons between Hydrogen and Oxygen atoms to form the water (H2O) molecule. This sharing of electrons results in a covalent bond between atoms.



https://brainly.in/question/6316008

Figure 5: Covalent bonding between H and O to form water molecule

There are many covalent molecular compounds. Most of these are formed with carbon and are found in living things. The smallest, simplest covalent compounds have molecules with just two atoms and are referred to as binary molecular compounds.

Below is a list of some examples of Covalent Molecular Compounds and their uses.

Table 2: Lists of Some Covalent Molecular Compounds and their Importance.

Covalent Molecular Compound	Chemical Formula	Importance and Uses
Methane	CH4	An odorless, colorless gas used mainly as fuel to produce heat and light.
Ammonia	NH3	Ammonia is used as a refrigerant gas, for purification of water supplies, and in the manufacture of plastics, explosives, textiles, pesticides, dyes, and other chemicals.
Ozone	O3	Ozone is a gas that occurs naturally in trace amounts in the stratosphere. It protects life on Earth from the harmful UV rays of the sun. This gas is toxic to living organisms at ground level.
Carbon dioxide	CO2	It is an essential gas for plant and animal processes– like photosynthesis and respiration. The excessive amount in the atmosphere is unsafe as it is a greenhouse gas. In the industry, carbon dioxide in liquid and solid form is used as a refrigerant and in fire extinguishers.
Water	H2O	Water exists in three states of matter and is essential to life processes, as our body needs water to help regulate body temperature and maintain bodily functions. It is also essential for daily and domestic use. Water also plays an important role in the balance of the ecosystem.

Self-Check I: Let us check your understanding. Identify which of the following compounds is ionic and covalent based on the types of elements combined. Write your answer in your answer sheet.

Example:

Ionic 1.) *Sodium Chloride (NaCl)*

Take note that Sodium (Na) belongs to Group IA and is a metal, while chlorine is a nonmetal that belongs to Group VIIA. Since it is a combination of a metal and a nonmetal thus it is an ionic compound.

Covalent 2.) *Nitrogen monoxide (NO)*

Nitrogen (N) is a nonmetal located at Group IVA and Oxygen is also a nonmetal that belongs to Group VIA in the periodic table. Nitrogen oxide is a combination of nonmetals; therefore, it is a covalent compound.

1. Carbon dioxide (CO_2)
2. Ferrous sulfide (FeS)
3. Aluminium chloride ($AlCl_3$)
4. Water (H_2O)
5. Glucose ($C_6H_{12}O_6$)
6. Potassium iodide (Kl)
7. Barium chloride (B_aCl_2)
8. Nitrogen gas (N_2)
9. Sodium hydroxide (NaOH)
10. Sucrose ($C_{12}H_{22}O_{11}$)

PROPERTIES OF IONIC AND COVALENT MOLECULAR COMPOUNDS

When sugar and table salt placed side by side, it may appear the same because they are both white crystalline solids. From the self-activity performed, you have notice that table salt is salty and sugar is sweet. These properties suggest that they are different substances.

Sugar is a covalent molecular compound made up of sucrose (C12H22O11) molecules, while table salt is made up of sodium chloride (NaCl) ions.

Tasting is the best way to identify the physical property of a substance, but it is not always a safe way because there are compounds that are toxic and poisonous.

Table 3: Properties of Ionic and Covalent Molecular Compounds

PROPERTIES OF IONIC COMPOUNDS	PROPERTIES OF COVALENT MOLECULAR COMPOUNDS
• They Form Crystals • They have high melting point and boiling point • They are hard and brittle • They conduct electricity in aqueous solution • They are nonconductors of electricity in solid form	• They have low melting points and boiling points • Most are soft and flexible • They are flammable • They are not conductors of electricity • They can be classified as polar or nonpolar molecules

Table 3 lists the properties of ionic compounds and covalent molecular compounds. Why do you think these compounds possess these properties?

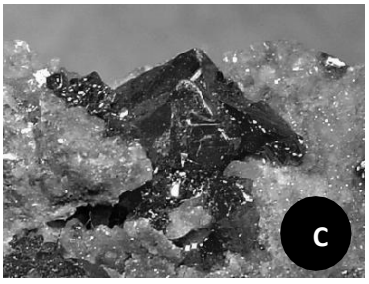
PROPERTIES OF IONIC COMPOUNDS

1. Formation of Crystals

The ionic bond formed between the cation and anion is very strong. The ions are arranged in a regular, geometric structure called **crystal lattice.** Different ionic compounds have different crystal forms. Naturally occurring ionic crystals are found in rocks and minerals; they are mixed with transition metal elements to give rise to brilliant colors

https://commons.wikimedia.org/wiki/ File:Halite3.JPG

https://en.wikipedia.org/wiki/File:Amethyst._Magaliesburg,_South_Africa.jpg



https://upload.wikimedia.org/wikipedia/commons/b/b1/Cinnabar-180777.jpg

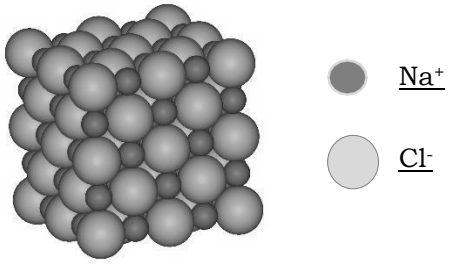
Figure 6: A.) Rock Salt Crystals (Halite) B.) Amethyst crystals, a form of quartz (SiO_2), the iron ions mixed in the crystal is responsible for the purple color C.) Cinnabar – a mercury sulfide (HgS) mineral and an ore of mercury.

Have you seen these rocks and minerals around? Try to collect a sample of rocks with crystals and compare their similarities and differences, you may refer to the pictures above for examples.

2. They have high melting points and high boiling points

Ionic compounds have very high melting and boiling points. The ions in a crystal lattice are closely packed together creating a strong electrostatic force of attraction between them. Figure 6 shows a small representative bit of the crystal lattice of Sodium chloride. The more ions there are in a crystal structure, the stronger the ionic bonds. Therefore, a large amount of energy is required to overcome these bonds.

Table salt melts at 801 ˚C and boils at 1413˚C. Ceramics are made of ionic compounds and are effective heat resistant and are suitable for cookware.



https://commons.wikimedia.org/wiki/File:Sodium-chloride- 3D-vdW.png

Figure 7: Crystal Lattice of Sodium Chloride

3. They are hard and brittle.

Solid ionic compounds are hard and rigid because of the strong electrostatic attraction between ions, but they are also brittle.

Applying pressure or mechanical force, like hammering the crystals, causes the ions with the same charge move closer resulting into an electrostatic repulsion. The repulsion between like charges is enough to split the crystals apart.

They conduct electricity when dissolved in water.

When ionic compounds are dissolved in water to form an aqueous solution, the cations and anions are dissociated or separated and are free to conduct electricity through the solution. These ionic substances that conduct electricity are referred as **electrolytes**

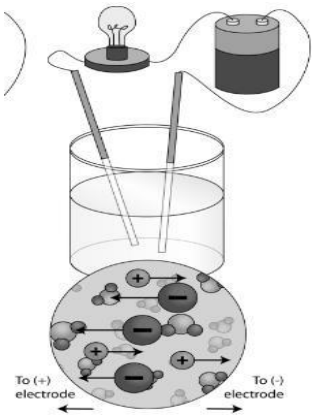


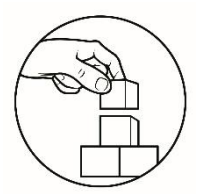
Figure 8: A water solution of ionic compound that conducts electricity

The figure shows a simple electrolysis set-up, where two electrodes (positive and negative) are connected to a light bulb and a source such as a battery. When an ionic compound (ex. Salt) is dissolved in water, the ions break out individually into cations and anions. These ions are then free to move. When the electrodes are dipped into the salt solution, the cations flow into the negative electrode while the anions flow into the positive electrode causing electricity to flow. This in turn lights the bulb.

Floodwaters contain many dissolved ionic compounds. One should be careful in case live wires come into contact with floodwaters. You can get electrocuted.

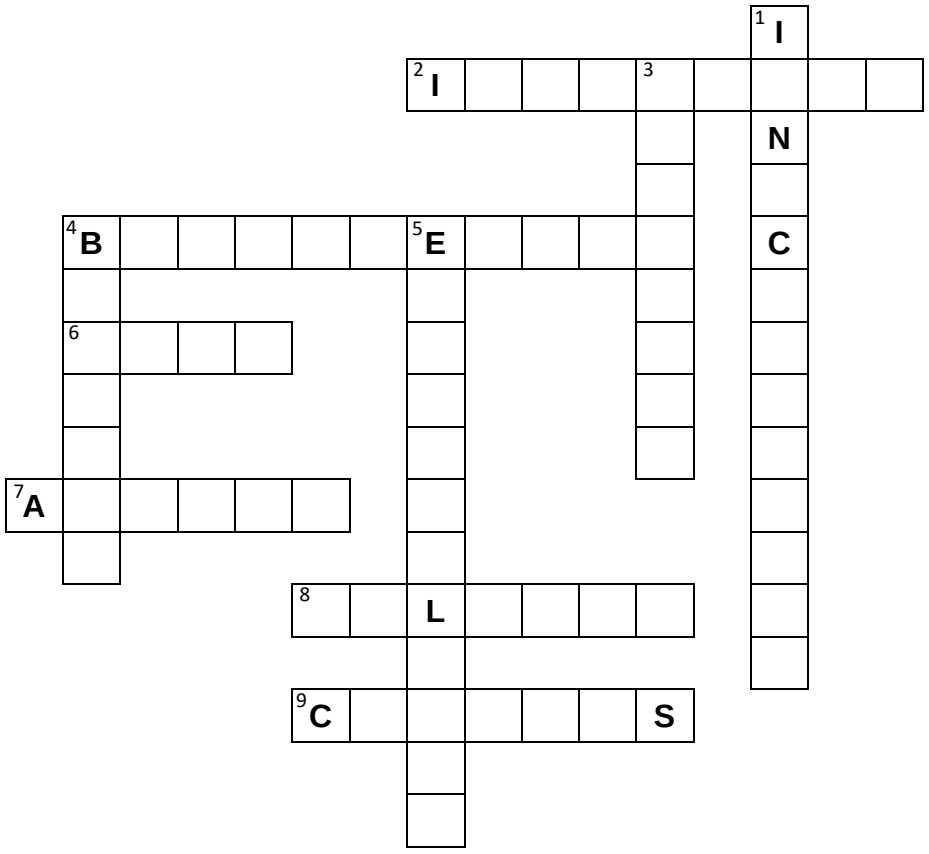
4. They are nonconductors of electricity in solid form

Solid ionic compounds do not conduct electricity, instead, these are good insulators. This is because the ions are locked into its crystal lattice and ions cannot move out, so the solid cannot conduct electricity. Only ionic compounds in liquid (molten) form or aqueous solutions are good electrical conductors.



What's More

I. Crossword Puzzle. Complete the crossword by filling in a word that fits each clue.



ACROSS

2. Electrostatic force of attraction
4. Breakability
6. Charged atoms
7. Negatively-charged atoms
8. Liquefied by heat
9. Positively-charged atoms

DOWN

1. Results from the combination of metals and nonmetals
3. Solid network of ions
4. Bringing a liquid to the temperature in which it turns into vapor
5. Ionic substance that conducts electricity

https://commons.wikimedia.org/wiki/File:1130_Banana_cue_Street_vendors_02.jpg

https://www.wallpaperflare.com/flan-sweet-dessert-sugar-delicious-caramel-food-and-drink-wallpaper-wvrjr

Figure 9: Melted sugar (sucrose) in your delicious banan cue and leche flan

Take a look at the pictures above. Have you tasted and tried eating these foods? Can you describe the flavor and taste of these foods? What do you think is the common ingredient present in these foods?

Self – Activity II: Sugar Syrup

What you need:

- 5 tablespoon of sugar
- ½ cup of water
- Small saucepan / casserole
- Gas burner/stove
- Wooden ladle
- Stop watch or watch

What to do:

- Mix sugar and water in the saucepan.
- Turn on the stove/gas burner and heat the sugar mixture slowly.
- Using a wooden ladle, constantly stir the mixture while heating.
- Observe the time it takes for the sugar mixture to become sticky. Record the time.
- Put off the burner once the first sign of bubbles appears. Record the time.
- Transfer your sugar syrup in a clean bottle or cup.

Questions:

1. How long before the sugar mixture turns sticky?
2. How long did the mixture boil?
3. Did the mixture boil fast or slow?
4. What do you think will happen to the syrup if you extend the time to heat it?
5. What type of compound is sugar?

Table sugar or sucrose (C12H22O11) is one of the common sugars that have many uses especially in the culinary world.

In your activity, it only took a short time to melt and turn the sugar mixture into syrup. Extending the time to heat the mixture will burn your syrup. This is because sugar is a covalent molecular compound and has low melting and boiling point.

Table 3 has shown the properties of both ionic and covalent molecular compounds. This time, you will look into the properties of covalent compounds.

PROPERTIES OF COVALENT MOLECULAR COMPOUNDS

1. **They have generally low melting and boiling points**

The covalent bonds between atoms are quite strong, but the intermolecular forces, the attraction between molecules can be relatively weak. The addition of a small amount of energy separates these molecules easily. Therefore, they have low melting and boiling points.

2. **Most covalent compounds are soft and flexible**

This is because covalent bonds are relatively flexible and easy to break, which causes molecular compounds to form gases, liquids, and soft solids at room temperature. However, there are exceptions primarily when molecular compounds assume crystalline form.

3. **They are flammable**

Covalent compounds tend to be more flammable than ionic compounds. **Combustion** is a reaction that releases energy when the compound reacts with oxygen to produce carbon dioxide (CO2) and water. Many of these molecular compounds that undergo combustion contain hydrogen and carbon atoms.

4. **They are not conductors of electricity**

When dissolved in water, covalent compounds separate into molecules rather than ions so, they do not conduct electricity.

5. **They can be classified as Polar and Nonpolar Molecules**

Covalent Molecular Compounds can be **polar** or **nonpolar.** The polarity of molecules results from the differences in the electronegativity of the bonded atoms.

Electronegativity (EN)is the ability of an atom in a molecule to attract shared electrons toward it. Figure 10 shows the electronegativity values of the elements in the periodic table.

H 2.1																	He
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	Ar
K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.8	Ni 1.8	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	Kr 3.0
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5	Xe 2.6
Cs 0.7	Ba 0.9	La 1.1	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Ti 1.8	Pb 1.8	Bi 1.9	Po 2.0	At 2.2	Rn 2.4
Fr 0.7	Ra 0.7	Ac 1.1	Unq	Unp	Unh	Uns	Uno	Une									

Ce 1.1	Pr 1.1	Nd 1.1	Pm 1.1	Sm 1.1	Eu 1.1	Gd 1.1	Tb 1.1	Dy 1.1	Ho 1.1	Er 1.1	Tm 1.1	Yb 1.1	Lu 1.2
Th 1.3	Pa 1.5	U 1.7	Np 1.3	Pu 1.3	Am 1.3	Cm 1.3	Bk 1.3	Cf 1.3	Es 1.3	Fm 1.3	Md 1.3	No 1.3	Lr

https://www.webassign.net/ncchem/electronegativity.html

Figure 10: Electronegativity (EN) Values of Atoms of Elements

The greater the electronegativity of an atom the stronger is its ability to attract shared electrons towards itself and away from the less electronegative atom. The electrons are not shared equally and part of the molecule carries a partial positive charge(δ+) and the other part carries a slight negative charge(δ-) creating a **dipole**.

For instance, consider the covalent bonding between Hydrogen (H) and Fluorine (F). Fluorine has an EN = 4.0 while Hydrogen has an EN = 2.1, thus fluorine is more electronegative than hydrogen and so the shared electrons spend more time around the fluorine atom creating a partial negative charge. The arrow points to the slightly negative side of the molecule. This kind of bonds is a ***polar covalent bond.***

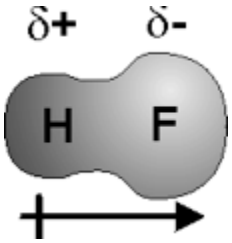


Figure 11: Unequal Sharing of Electrons Between H and F

When two identical atoms covalently bonded with each other like diatomic Hydrogen (H2), there would be equal sharing of electrons between the Hydrogen atoms. This type of bond is a ***nonpolar covalent bond*** form *nonpolar molecules.*

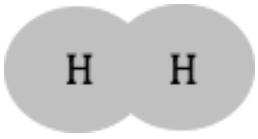


Figure 12: Equal Sharing of Electrons Between 2 Hydrogen and atoms

To determine if the type of bond is polar or nonpolar, one has to consider the electronegativity difference between the bonded atoms. The greater the difference, the more polar is the bond.

Table 4. Electronegativity Difference to Classify Bonds

Electronegativity Difference	**Bond Type**
0 ≤ 0.4	Nonpolar
0.5 – 1.9	Polar
≥2.0	Ionic

Based on Table 4 the electronegativity difference between H-F bond is:

Combining Atoms	**H**	**F**
EN Values	2.1	4.0
Difference	1.9	
Type of Bond	Polar covalent	

Examples:

Combining Atoms	**H**	**H**
EN Values	2.1	2.1
Difference	0	
Type of Bond	Nonpolar covalent	

Combining Atoms	**Na**	**Cl**
EN Values	0.9	3.0
Difference	2.1	
Type of Bond	Ionic	

If the difference in electronegativity is greater than or equal to 2.0, the electrons are completely transferred instead of being shared. An ionic bond would result rather than a covalent bond.

A. Calculate the electronegativity difference and give the kind of bond that exists between the atoms in each pair. Refer to Figure 9 for the Electronegativity values. The first is done for you.

Atoms	**EN Difference**	**Type of Bond (Ionic/Polar Covalent/Nonpolar Covalent)**
1.) Ca and O	Ca = 1.1 O = 3.5 3.5 – 1.1 = **2.4**	Ionic Bond
2.) Si and H		
3.) O and F		
4.) Br and H		
5.) C and H		

What I Have Learned

The following statements are the properties of ionic and covalent molecular compounds. Color the circle RED if the property is an ionic compound, and BLUE if the property is a covalent molecular compound

◯ 1) Formed between nonmetallic elements

◯ 2) formed between a metal and a nonmetal element

◯ 3) held by ionic bonds

◯ 4) held by covalent bonds

◯ 5) Relatively low melting and boiling points

◯ 6) Relatively high melting and boiling points

◯ 7) Good conductors of electricity in aqueous solutions

◯ 8) Insulators in solid form

◯ 9) Hard and brittle

◯ 10)Soft and flexible

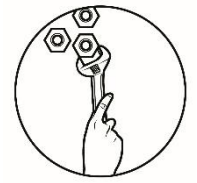
◯ 11)Can be classified as polar and nonpolar

◯ 12)Consists of Cations and anions

◯ 13)There is a complete transfer of electrons from one atom to another

◯ 14)There is sharing of valence electrons between atom

◯ 15)Flammable because of the presence of carbon and hydrogen atoms



What I Can Do

Laboratory Activity No. 1

Properties of Covalent and Ionic Compounds

When atoms combine in a chemical bond, chemical compounds will be formed, and these two types are; ionic compounds and covalent molecular. Ionic compounds are the compounds formed from the transfer of electrons (ionic bonding) while covalent molecular compounds formed from the sharing of electrons (covalent bonding). These resulting compounds have distinct physical properties such as melting point, solubility in water, and electrical conductivity in aqueous solutions.

In this activity, you will be able to:

1. Construct an improvised electrical conductivity apparatus
2. Recognize the properties of covalent molecular compounds
3. Differentiate the properties of covalent and ionic compounds

Materials:

A. For the Construction of Improvised Electrical Conductivity Apparatus

- Masking Tape
- Insulated Copper wire (unused/spare electrical wires)
- 9-Volts battery
- Aluminum Foil
- 3.7 Volts Light Bulb and socket
- 2 pcs Popsicle Sticks

B. Needed for the activity

- Alocohol Lamp/Gas Lamp/Candle
- Match
- Mortar and pestle (if not available a bottle will do as an alternative)
- Paper Tape
- Pen markers
- 4 pcs. Glass/Cups
- 4 pcs Table Spoons
- 4 pcs Teaspoons
- 5oo ml Distilled Water
- Grated candle wax
- 3 tbsp. of salt
- 3 tbsp. of sugar
- 1 small pack MSG (Monosodium Glutamate)

Procedure:

A. Constructing the Improvised Electrical Conductivity Apparatus

1. Wrap two popsicles sticks in aluminum foil. These will be your electrodes.

2. Cut three pieces of 6-inches insulated copper wire and strip a half-inch of insulation off each end.

3. Connect one end of a wire to the positive terminal of the battery - hold it in place with masking tape. Connect the other end of the wire to the light bulb socket. (Just wrap the wire around the bottom of the bulb, if you don't have a socket. You may have to secure it with tape.)

4. Take the second piece of wire and connect the light bulb socket with one of the electrodes. Use masking tape to stick the bare end of the wire on the aluminum foil near the top of the electrode.

5. Use the third piece of wire to connect the negative terminal of the battery with the other electrode.

6. Test out your circuit by touching the two electrodes together. This should complete the circuit and allow electricity to flow from one terminal of the battery to the other, lighting up the light bulb in the process. If the bulb doesn't light up, check the wire connections to make sure they are all secure and then try again.

Take a look at Figure 12 to have a check and compare your electrolytic circuit.

https://www.homesciencetools.com/article/saltwater- circuit-project/

Figure 13: An Improvised Electrical Conductivity Apparatus

B. Test for Solubility

1. Prepare glasses and mark them A, B, C, and D with paper tape. Fill each glass half-full with distilled water.
2. Put a teaspoon of sugar in glass A and stir 2-3 minutes. In glass B, place the grated candle wax and stir within 2-3 minutes also.
3. Repeat procedure number 2 for glasses C and D, this time with salt and MSG respectively.
4. Observe what happens to the sample substances.
5. Save the solutions for use in Procedure B

C. Test for Electrical Conductivity

1. Prepare the improvised electrolytic circuit.
2. Using the glasses with the solutions, dip the electrodes in glass A containing the sugar solution, and observe the light bulb. Make sure that the electrodes are not touching each other. Write your observation in Table 3.

3. Wash the electrodes before dipping it into another solution to avoid contamination.

4. Dip the electrodes in glass B a containing solution of grated candle was. Observe the light bulb. Wash the electrodes.

5. Repeat procedures 2 and 3 for glass C containing salt solution, and glass D containing MSG solution respectively.

D. Reaction to Heat

1. Take a scoop of sugar enough to fill ¼ of a tablespoon.

2. Heat the spoon above a flame by using an alcohol lamp (you may use a common household lamp or a candle but take extra caution when working with flames.)

3. Record the time when the sugar melted completely.

4. Repeat procedures 1-3 this time with grated candle wax, salt and MSG respectively.

E. Test for Hardness

1. Place one teaspoon of sugar in a mortar and grind the granules with the pestle into power. Observe the ease and/or difficulty of grinding the substances.

2. Set aside the powdered sugar and clean the mortar and pestle.

3. Repeat procedures 1-2 with grated candle was, salt and MSG.

4. Record observations in Table 1 below.

(Note: if you don't have mortar and pestle you may use a glass bottle to powdered the substances by rolling a bottle on it.)

Table 1: Data and Observation on the Properties of the Given Sample

SAMPLE	SOLUBILITY	ELECTRICAL CONDUCTIVITY	REACTION TO HEAT	DESCRIBE HOW IT MELTS	TEST FOR HARDNESS	TYPE OF COMPOUND
	Did the substance dissolve? YES/NO	**Did the bulb lit?**	**Time to melt (s)**	**Fast/ Slow**	**Is the substance easy to grind? YES/NO**	**Ionic/ Covalent**
Sugar						
Grated Candle Wax						
Salt						
MSG						

Guide Questions

a. Which sample dissolves easily in water?
b. Which sample conducts electricity in a solution?
c. Which sample melts easily?
d. Which sample is easy to grind or powered?

2. Why do MSG and salt conduct electricity in solution?
3. Why do sugar and grated candle wax melt easily?
4. Does distilled water conduct electricity? Explain why?
5. Based on the given data on Table 1, differentiate the properties of ionic and covalent compounds.

Table 2: Comparison between Ionic and Covalent Molecular Compounds

PROPERTIES OF IONIC COMPOUNDS	PROPERTIES OF COVALENT MOLECULAR COMPOUNDS

Generalization:

Assessment

I. Multiple Choice: Read the statements carefully. Choose the letter of your answer and write it on your answer sheet.

_____1. It is the tendency of an atom to attract electrons

a. Polarity
b. Ionic Bonding
c. Chemical Bonding
d. Electronegativity

_____2. What accounts for the polarity of compounds?

a. It is a result of the uneven partial charge distribution between various atoms in a compound.
b. The structure of covalent compounds is unique that's why they can be polar and nonpolar.
c. The strength between covalent bonding causes molecules to have polar and nonpolar characteristics
d. Due to some exception, the sharing of electrons between atoms in covalent compounds results in a stable balance of attractive and repulsive forces between atoms.

_____3. Which of the following explains the flammability of covalent molecular compounds?

a. Molecules easily react with heat-producing flames.
b. They contain carbon and hydrogen atoms that react readily with oxygen gas.
c. Covalent molecular compounds share their electrons forming polar and nonpolar bonds.
d. Because they generally have low melting and boiling points and the addition of a small amount of energy causes intermolecular attraction to break.

_____4. Which of the following compounds is covalent?

a. Sodium Hydroxide
b. Table sugar
c. Barium chloride
d. table salt

_____5. Which of the following example is ionic in nature?

a. CO_2
b. H_2O
c. NaCl
d. $C_{12}H_{22}O_{11}$

_____6. Which type of compound results from the combination of metal and nonmetal elements?

a. Ionic compounds
b. Covalent molecular compounds
c. Organic compounds
d. Acids and Bases

_____7. Which type of compounds results from the combination of two nonmetallic elements?

a. Ionic compounds
b. Covalent molecular compounds
c. Organic compounds
d. Acids and Bases

_____8. These are electrostatic forces of attraction that results from the complete transfer of electrons from one atom to another.

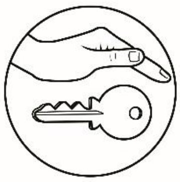
a. Covalent bonds
b. Ionic bonds
c. Metallic Bonds
d. Polar and Nonpolar Bonds

_____9. All of the following describes ionic compounds *except:*

a. They form crystals.
b. They are hard and brittle.
c. They have high melting and boiling points
d. It possesses polar and nonpolar characteristics.

_____10. Why are ionic compounds good conductors of electricity?

a. Ionic compound are electrical
b. The strong electrostatic attraction between ions allows electricity to flow freely
c. Aqueous solutions of ionic compounds cause ions to dissociate and are free to conduct electricity
d. Strong electrostatic attraction between crystal lattice of ionic compounds is strong which needs high temperature to melt or boils these compounds.



Answer Key

Table 1: Data and Observation on the Properties of the Given Sample

SAMPLE	SOLUBILITY	ELECTRICAL CONDUCTIVITY	REACTION TO HEAT	DESCRIBE HOW IT MELTS	TEST FOR HARDNESS	TYPE OF COMPOUND
	Did the substance dissolve? YES/NO	**Did the bulb lit?**	**Time to melt (s)**	**Fast/ Slow**	**Is the substance easy to grind? YES/NO**	**Ionic/ Covalent**
Sugar	Yes	No	Answer may vary	Fast	Yes	Covalent
Grated Candle Wax	No	No	Answer may vary	Fast	Yes	Covalent
Salt	Yes	Yes	Answer may vary	Slow	No	Ionic
MSG	Yes	Yes	Answer may vary	Slow	No	Ionic

Questions:

6.
- a. Sugar, salt and MSG
- b. Salt and MSG
- c. Wax and sugar
- d. Wax and sugar

7. Because they are ionic compounds, when dissolved in water they break down into their component ions which allowing the charged atoms to flow freely in the electrodes.

8. They are covalent compounds. They are composed of molecules with weak intermolecular forces allowing small amount of energy to separate the molecules from the force of attraction.

9. No. Distilled water is a covalent molecular compound.

10. Based on the data on Table 1, differentiate the properties of ionic and covalent compounds.

Generalization:

Ionic and covalent compounds differ in their physical properties such as solubility, electrical conductivity, melting and boiling points, hardness and polarity.

Table 2: Comparison between Ionic and Covalent Molecular Compounds

PROPERTIES OF IONIC COMPOUNDS	PROPERTIES OF COVALENT MOLECULAR COMPOUNDS
Ionic compounds are soluble in water It conducts electricity It melts slowly which means it has high melting and boiling It is hard but brittle	Some are soluble in water others are not It melts easily which means it has low melting and boiling points They are soft and flexible

Assessemnt:

1.	D	6. A
2.	A	7. D
3.	B	8. B
4.	B	9. D
5.	C	10. C

What I know

1. A
2. B
3. B
4. D
5. C
6. C
7. B
8. B
9. A
10. D

Self Check: Identify whether compound is ionic or covalent

1. Covalent
2. Ionic
3. Ionic
4. Covalent
5. Covalent
6. Ionic
7. Ionic
8. Covalent
9. Ionic
10. Covalent

What's More: Crossword Puzzle

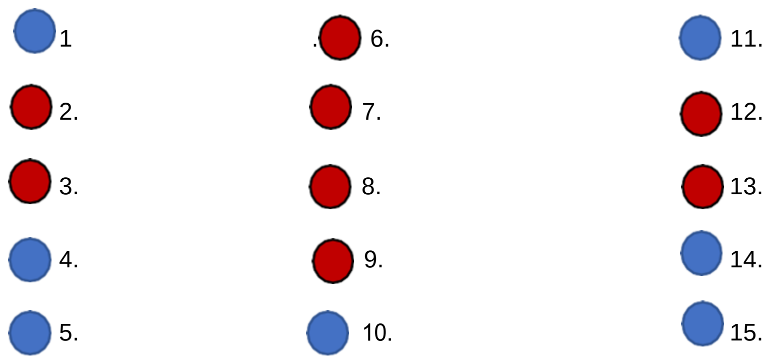
Across
2. ionic bons
4. brittleness
6. ions
7. anions
8. melting
9. cations

Down
1. Ionic compound
3. crystals
4. boiling
5. electrolytes

What's More: Calculating Electronegativity Difference

Atoms	EN Difference	Type of Bond (Ionic/Polar Covalent/Non polar Covalent)
1.) Ca and O	2.5	Ionic
2.) Si and H	0.3	Nonpolar covalent
3.) O and F	0.5	Polar covalent
4.) Br and H	0.7	Polar covalent
5.) C and H	0.4	Nonpolar covalent

What I Have Learned



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