SeaGlide_TEAM	Polar Bonding	Lesson # 1 (60 minutes)

Description:

Students will take the role of a matchmaker. Their job is to find their client, Al, a date. It is the job of the students to find all the possible suitors that are compatible with Al using their knowledge of bonding, valence electrons, and electronegativity. The ability to bond with other elements is determined by the number of valence electrons an element has. This lesson explores the ideas of bonding and how they apply to the other areas of chemistry, specifically electrical energy.

Students will be able to:

- Make predictions of compound/molecule characteristics based on periodic trends
- Understand why the trends exist
- Describe the importance & roles played by valence electrons
- Make connections between polarity and electrical properties
- Discover galvanic cell properties
- Connect content understandings between polar compounds & electrical circuits

Students Will Understand:

Students will use the periodic table as a guide in order to learn and identify the connections that exist between Aluminum and the given elements that show characteristics of being compatible. These trends are based on the atomic number of an element as well as the number of electrons in its valence shell. In galvanic cells and electrical circuits, these electrons move from one compound to another, generating electricity. This lesson will illustrate how these interactions occur between elements.

Key Definitions & Concepts: [1]

- **Polarity**: is a separation of electric charge, each pole has a negatively charged end and a positively charged end.
- **Galvanic cell**: also known as voltaic cells, are electrochemical cells in which spontaneous oxidation-reduction reactions produce electrical energy. (Batteries are made of electrochemical devices such as one or more galvanic cells).
- **Molecule**: the smallest particle in a chemical element or compound and they are also made up of atoms held together by chemical bonds.
- **Intermolecular bonds**: the sum of all the forces between neighboring molecules.
- **Periodic Trends**: specific patterns that are present in the periodic table that illustrate different aspects of a certain element (e.g. electronegativity, ionization energy, electron affinity, atomic radius, melting point, and metallic character).
- **Valence Shell**: the outermost shell of an atom containing the valence electrons.

Standards: **[Copied from: 2]**

HS-PS1-1: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms

- Students will learn the basic ideas of polar bonding of compounds. By understanding the organization and trends within the periodic table, they can theorize about a polar compound.

CHEM 3.2.10.A1: Explain the unique properties of water (polarity, high boiling point, forms hydrogen bonds, high specific heat) that support life on Earth

- Students will understand how water is a polar molecule and will observe the properties that make it polar.

CHEM 3.2.10.A2: Compare and contrast different bond types that result in the formation of molecules and compounds.

- Students will find it easier to understand the concept of polar bonding once they identify the different types of intermolecular (chemical) bonds formed between molecules and compounds. They should become familiar with the different types of bonds such as Van der Waals forces, hydrogen bonds, ionic bonds, metallic bonds and polar covalent bonds.

Background Information

Prior Knowledge:

- Elements consist of a nucleus, made up of protons and neutrons, surrounded by an electron cloud.
- Familiarization with the periodic table as it consists of trends that provides information on element characteristics, such as the number of valence electrons.

Science Practices: [Copied from: 3]	**Core Ideas: [Copied from: 4]**	**Cross Cutting Concepts: [Copied from: 5]**
● Analyzing and interpreting data ● Constructing explanations and designing solutions ● Obtaining, evaluating, and communicating information	● Types of Interactions ● Structure and Properties of Matter ● Nuclear Processes ● Chemical Reactions	● Energy and matter ● Structure and function ● Stability and change

Possible Preconceptions/Misconceptions:

Students should have some experience in Chemistry and should therefore be familiar with ionic and covalent bonding. Because polar bonding involves particles exhibiting a positive or negative charge, students may believe polar bonding applies exclusively to ionic compounds. However, covalent molecules apply also.

Lesson Plan - 5E(+) Model

Engage:

The instructor will begin the lesson by asking students about what it means to be complementary. This will get students to think about how things are categorized and work together to create something. The students will need to use this complementary thinking later on in the lesson. For elements to share electrons, several checks must be made. These include electronegativity, the octet rule, etc. Students

will connect the idea of complementary to how elements form ionic and covalent polar bonds. The bonds formed by these complementary elements are created and broken, generating electrical energy discussed in the Elaboration. The instructor will use this 5 minute intro discussion as a segway to the next section of the lesson that has the students complete the worksheet *Bonding in Chemistry*.

Explore:

Part I: Introduction

The instructor will distribute the worksheet *Bonding in Chemistry* that includes questions that are designed to access prior knowledge relating to the periodic table and types of bonds. The instructor will break the students into groups of three.

Part II: *Benchmark Lesson*: Identifying Bonds & Electronegativity

Students will complete the worksheet *Bonding in Chemistry* and answer the questions based solely on identifying ionic and covalent bonding. The questions are designed to establish the difference between an ionic and covalent bonds, then extend it to valence electrons and their effect on bonding. The purpose of this worksheet is for students to be able to look at elements, identify whether the bond between them is ionic or covalent, and explain the role of electronegativity in the molecule. This is a fundamental idea in Chemistry, required for further advancement in the discipline. This should take about 15 minutes.

Part III: *Investigation Lesson*: Find Al a Date

Students will be asked to design a matchmaking website compatibility profile for their client, Al. Using the information provided from the worksheet, *Find Al a Date*, and from the Exploration, students will predict the compatibility of Aluminum to other given elements by forming a polar bond with the corresponding elements and making evidence-based conclusions. Students will be required to take the knowledge gained in this lesson and apply it in a fun activity by providing their responses in a format of their choosing. For this assignment, it is recommended that the students be graded holistically. The rubric for this assignment can be found within the attachments section and is titled, *Find Al a Date: Rubric.* This portion of the lesson is an individual assignment that should take 20 minutes to complete.

Explain:

Throughout the exploration of this lesson, students will engage in discussions and activities that seek to discover their understanding of the topic at-hand as it relates to polar bonding in chemistry. Instructors should informally ask questions to promote thoughtful discussion that is designed to aid in addressing any questions or concerns that some students may have. Students are expected to formalize their answers throughout the entirety of the lesson via the worksheets, the experiment and the exit ticket.

Elaborate:

Students will extend their understanding of polarity to explore the effect that polarity has on electricity by completing the *Cola Battery* experiment. Electricity is generated by the movement of electrons through a circuit, in this case a galvanic cell. The simplicity of this system allows for easy debugging. After learning that electrons are shared evenly and unevenly, the students discover that electrons can move in a continuous loop (circuit). Students gain further understanding of galvanic cells through the

cola battery activity by visually seeing the galvanic cell setup. The instructor will demonstrate this to the students, then allow them with 10-15 minutes to complete the experiment in groups of three.

Evaluate:

The importance of this lesson is to demonstrate how valence electrons and electronegativity affects the formation of polar bonds. The instructor should assess student understanding both formally and informally throughout the lesson. This is done through listening to students' conversation and observing how students work through the worksheet problems. During this time, the instructor has the ability to address misconceptions that either individual students or the entire class may have. Through the match-making activity, the instructor is able to formally assess student understanding while also allowing for student choice. This also serves as a literacy component by allowing students to verbalize their understanding through the compatibility profile. The lesson ends with a 5 minute exit ticket that serves as an additional formal assessment by assessing student understanding of polar bonding and its relation to periodic trends and electrochemistry.

Enrich:

This lesson can be differentiated by having students create a diagram to show the flow of current within a galvanic circuit including cathode, anode, charge, and direction of current flow. Students can then use their diagram to explain the chemistry of a car battery. This lesson primarily focuses on the impact that polarity has on simple compounds, molecules, and galvanic cells. Car batteries consist of several hundred galvanic cells, producing the energy necessary to power the car. The multiple galvanic cells result in a exponential increase in electrical energy output from the system. This is important because it can be applied to other vehicles, such as planes and ships.

All associated documents are attached below

Reference *Annotated Bibliography* on the very last page of this packet

Name:_____ Date:_____

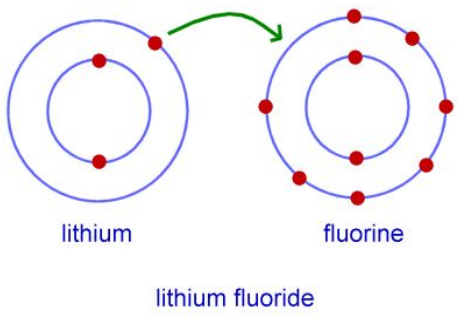
Bonding in Chemistry [1]

1. Why are certain combinations of elements considered compounds whereas others are not?

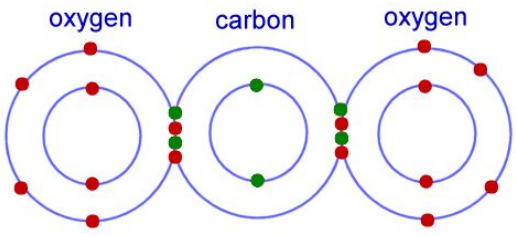
2. What role do valence electrons play in bonding?

3. How can periodic table trends help us determine if a combination of elements contains polar bonding?

4. Observe the model of atoms below and label if the bond is ionic or covalent. Could the combination be polar?



lithium fluoride



carbon dioxide

Name:_____ Date:_____

Find Al a Date

Good Afternoon Matchmakers!

Your newest client has just arrived. Their name is Al (short for Aluminum) and they are seeking a partner to share their life with. Al is a post-transition metal with a +3 charge. They like long walks on the beach, cooking in the kitchen, and learning about space. Al currently works in the aerospace industry, designing aircrafts to explore the vastness of the universe. Below are the possible partners we have for Al:

Oxygen, Chlorine, and Bromine

Write why you think Al should date these possible partners. Include things like valence shell electrons, real-world applications, and if these partners will share or take Al's electrons! (Al stated that they are more than happy to share and give up their electrons).

Send me the compatibility profiles so I may review them before Al gets them. Your work reflects directly on our matchmaking agency.

Good Luck Matching!

Find Al a Date: Rubric

Points	0 - 1	2 - 3	4 - 5
Compound Definition & Chemical Formula	The student either does not define the compound and its associated formula or does so incorrectly.	The student defines the compound formed and includes the associated chemical formula, but one or two mistakes were made.	The student clearly defines the compound formed and includes the associated chemical formula correctly.
Valence Electrons	The number of valence electrons for each element is identified incorrectly.	The number of valence electrons of only one element is identified correctly.	The number of valence electrons per element is identified correctly.
Bonds	The number and types of bonds formed are either not stated and described or are incorrect.	The number and types of bonds formed are either stated or described with few errors.	The number and types of bonds formed are stated and described fully and correctly.

Find Al a Date: Grade Sheet

	Aluminum & Oxygen	Aluminum & Chlorine	Aluminum & Bromine
Compound Definition & Chemical Formula			
Valence Electrons			
Bonds			
Total			

Grade Sheet Total: _____

Name:_____ Date:_____

Cola Battery

Introduction:

The workings of a galvanic cell are quite simple. It involves a chemical reaction that makes the electrical energy available as the end result. During a redox reaction, a galvanic cell utilizes the energy transfer between electrons to convert chemical energy into electrical energy. Galvanic cell utilizes the ability to separate the flow of electrons in the process of oxidation and reduction. This causes a half reaction and connecting each with a wire so that a path can be formed for the flow of electrons through such wire. This flow of electrons is essentially called a current. This current can be made to flow through a wire to complete a circuit and obtain its output in any device, such as a television or a watch.

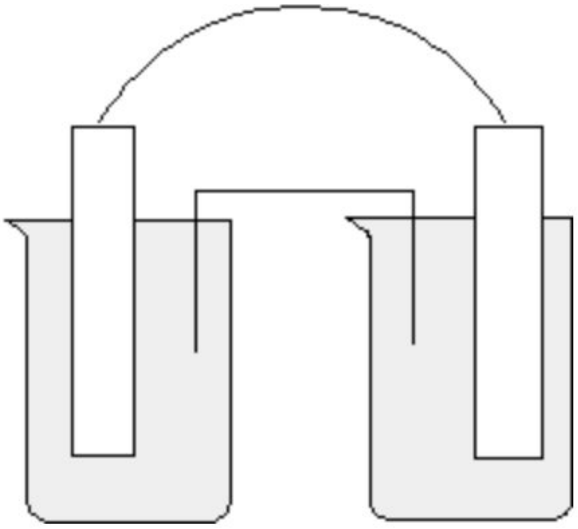
Materials:

- Soda Water Bottle or coca cola bottle
- One paper cup or any non-conductive material cup
- Aluminum strip
- Copper Strip
- LED (Light Emitting Diode)
- Alligator clips
- Electric Wire
- Scissor, Tape, Clip etc.

Procedure:

1. Pour 100-150mL of soda into the cup
2. Sand one end of the Aluminum and Copper strips
3. Place the metal strips inside the cup, with the sanded ends facing up, making sure that the strips are ***NOT*** touching
4. Attach electrical wire to the Aluminum and Copper strips using alligator clips
5. Connect the opposite ends of the alligator clips to the LED
6. Watch the LED light up!
7. Clean up the experiment station
8. Answer the questions regarding the experiment on the next page

1. Label the following Galvanic cell with the materials in this lab and depict the flow of electrons. Assume that the reaction used two cups instead of one.

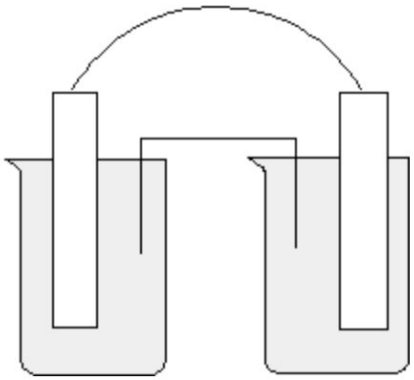


2. The cathode receives the electrons and the anode donates the electrons. Which metal strip was the anode? How about the cathode? Explain.

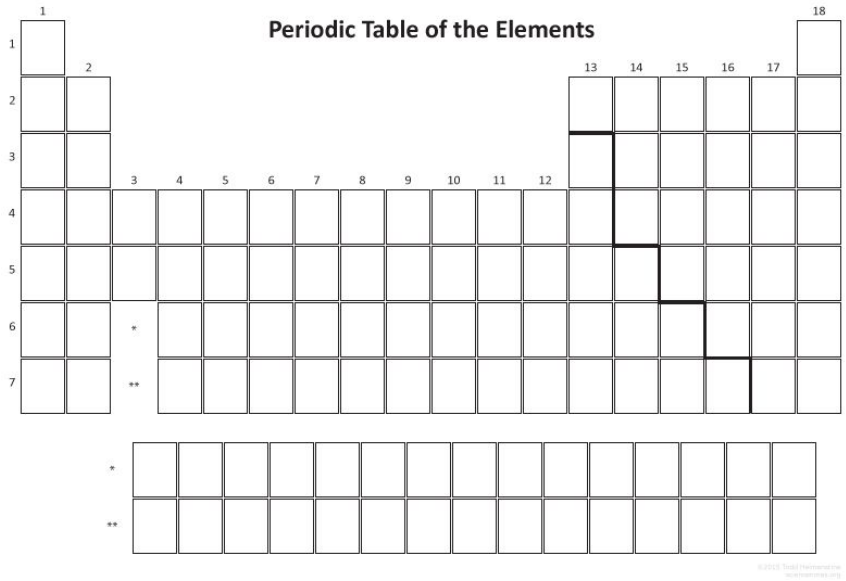
Name:_____ Date:_____

Exit Ticket

1. Label all parts of the galvanic cell below and indicate the flow of electrons.



2. Indicate the trend of increasing electronegativity on the periodic table below.



Name:_____ANSWER KEY_____Date:_____

Bonding in Chemistry [1]

1. Why are certain combinations of elements considered compounds whereas others are not?

   Compounds are made of ionic bonds. Not all combinations consist of ionic bonds. (i.e. covalent bonds).

2. What role do valence electrons play in bonding?

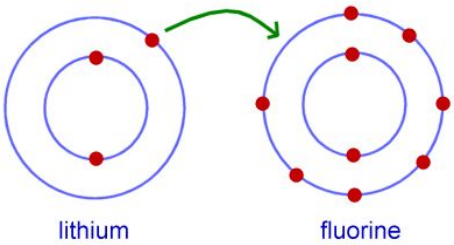
   Valence electrons have the highest energy level and are held more loosely so in bonding when elements react to form compounds valence electrons could be transferred from one atom or another to be shared between atoms.

3. How can periodic table trends help us determine if a combination of elements contains polar bonding?

   Based on how elements are arranged on the periodic table due to their electronegativity.

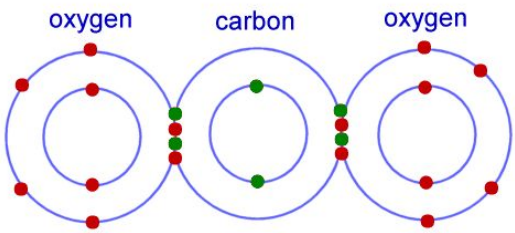
4. Observe the model of atoms below and label if the bond is ionic or covalent. Could the combination be polar?

Ionic bond
(polar)



lithium fluoride

Covalent bond
(nonpolar)



carbon dioxide

Name:_____Answer Key_____ Date:_____

Find Al a Date: Rubric

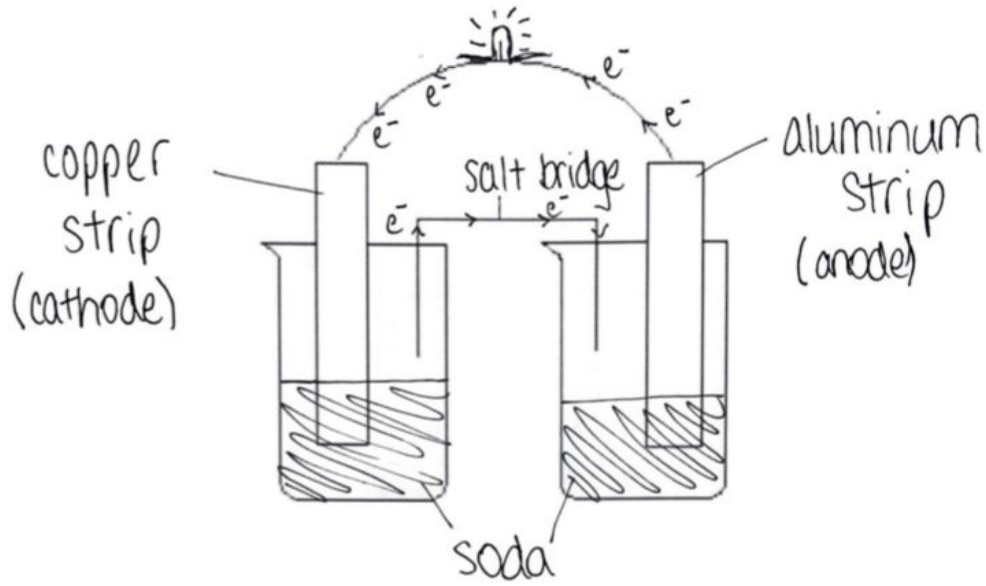
Below is a table that includes the complete description of each polar bond with Aluminum. Each bullet under the "Expected" line provides the information necessary for students to receive full credit per compound. The information following the "Bonus" line provides the instructor with compatibility information in the event that he/she chooses to re-address the conclusion of this activity with the students on a subsequent day.

Aluminum & Oxygen	Expected: ● Aluminum and Oxide bond to form Aluminum Oxide (Al_2O_3). ● Aluminum has three valence electrons, while Oxygen has six. ● Oxygen takes the valence electrons from Aluminum to form two double bonds and one single bond between the elements. Bonus: ● Aluminum Oxide is most commonly used for dental and bone implants.
Aluminum & Chlorine	Expected: ● Aluminum and Chlorine bond to form Aluminum Chloride ($AlCl_3$). ● Aluminum has three valence electrons, while Chlorine has seven. ● Each Chlorine takes one valence electron from Aluminum to form three single bonds between the elements. Bonus: ● Aluminum Chloride is commonly used in chemistry labs for complex reactions and for developing plastic polymers.
Aluminum & Bromine	Expected: ● Aluminum and Bromine bond to form Aluminum Bromide ($AlBr_3$). ● Aluminum has three valence electrons, while Bromine has seven. ● Each Bromine takes one valence electron from Aluminum to form three single bonds between the elements. Bonus: ● Aluminum Bromide is extremely reactive and corrosive, meaning they are not a healthy relationship :(.

Name:_____ANSWER KEY_____Date:_____

Cola Battery

1. Label the following Galvanic cell with the materials in this lab and depict the flow of electrons. Assume that the reaction used two cups instead of one.



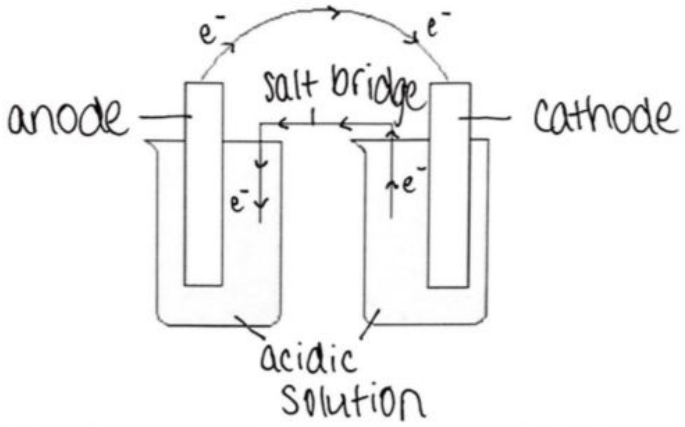
2. The cathode receives the electrons and the anode donates the electrons. Which metal strip was the anode? How about the cathode? Explain.

   The copper strip is the cathode, and the aluminum strip is the anode. This is due to the difference in electrical reduction potential, with copper being greater than aluminum.

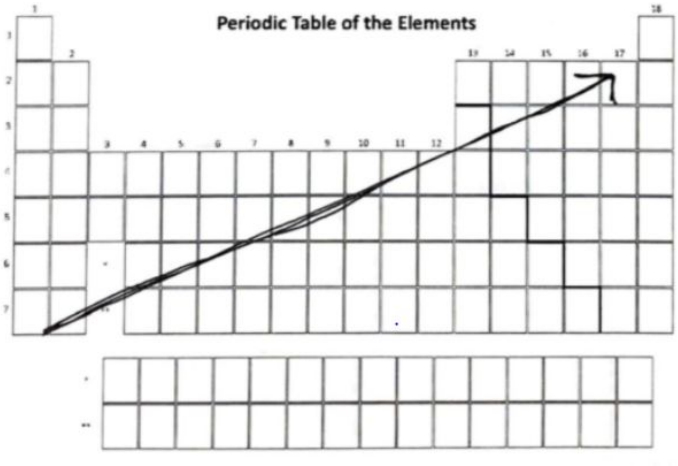
Name:_____ANSWER KEY_____Date:_____

Exit Ticket

1. Label all parts of the galvanic cell below and indicate the flow of electrons.



2. Indicate the trend of increasing electronegativity on the periodic table below.



Electronegativity increase from the bottom-left of the periodic table towards the top-right.

Annotated Bibliography

[1] Libretexts. (2019, February 23). 20.3: Voltaic Cells. Retrieved January, 2019, from https://chem.libretexts.org/Bookshelves/General_Chemistry/Map:_Chemistry_-_The_Central_Science_(Brown_et_al.)/20:_Electrochemistry/20.3:_Voltaic_Cells

This reference was used for excerption purposes within the Polar Bonding lesson plan. The reference was directly excerpted to develop vocabulary and the necessary information discussed in this lesson plan.

[2] Nsta. (n.d.). Access the Next Generation Science Standards by Topic. Retrieved January 18, 2019, from https://ngss.nsta.org/AccessStandardsByTopic.aspx

This website was used in each lesson in the Water Chemistry & Biology module to select proper national set standards for science subjects that each lesson is centered around.

[3] Nsta. (n.d.). Science and Engineering Practices. Retrieved January 18, 2019, from https://ngss.nsta.org/PracticesFull.aspx

This website used in every lesson in the Water Chemistry & Biology module to find Standards for Science and Engineering Practices that are applicable in each lesson.

[4] Nsta. (n.d.). Disciplinary Core Ideas. Retrieved from https://ngss.nsta.org/DisciplinaryCoreIdeasTop.aspx

This website was used in each lesson in the Water Chemistry & Biology module to select appropriate disciplinary core ideas set forth by the NSTA that are at the center of each lesson.

[5] Nsta. (n.d.). Crosscutting Concepts. Retrieved from https://ngss.nsta.org/CrosscuttingConceptsFull.aspx

This website was used in each lesson in the Water Chemistry & Biology module to selecting appropriate crosscutting concepts set forth by the NSTA that apply to each science lesson.