<table>
<tr><th colspan="2">Lesson 1-5: Polarity</th></tr>
<tr><td>Curriculum Expectations</td><td>C2.3predict the shapes using the valence shell electron pair repulsion (VSEPR) model, and draw diagrams to represent their molecular shapes [AI, C]

C2.4 predict the polarity of various chemical com- pounds, based on their molecular shapes and the difference in the electronegativity values of the atoms [AI]</td></tr>
<tr><td>Learning Goals</td><td>Learning Goals:

By the end of this lesson you will:
Understand how to calculate differences in electronegativity values
Understand how to predict bond dipoles
Understand the connection between polarity and physical properties
Be able to determine molecular polarity</td></tr>
<tr><td>Success Criteria</td><td>Success Criteria:

I know I have achieved the learning goals when I:
Can predict electronegativity values based on the periodic table
Can calculate bond dipoles
Determine the bond type based on EN
Can determine molecular polarity</td></tr>
<tr><td>Teacher Prep</td><td>Twist-ties or string for Molecular tug-of-war minds on activity
Print out sheets for Electronegativity gridlock game if doing in groups or individually.
Check that molecular polarity simulator works.
Materials for the water polarity group activity:
plastic cups or beakers to hold water
coins (pennies, nickels, dimes)
eyedroppers
paper towels
Periodic table with electronegativity values</td></tr>
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Minds On

Goal: This activity will allow students to be able to visualize the tug-of-war for electrons that occurs between atoms within the same molecule.

1. <u>Molecular Tug-of-war</u>

Instructions:

Note: you can use twist ties, string, or other materials that can be grabbed and pulled without breaking.

1. Fold 2 twist-ties in half and loop them together into a Y-shape.
2. Have one student hold both ends of one twist tie in their hands and offer the other two ends of the other twist ties to 2 other students.
3. Ask the other students in the class what would happen to the center of the wire if each student pulled their end of the twist tie with equal force in the direction that they are pointing.
4. Have a class discussion, relating the pulling of the twist ties to the pulling of shared electrons between atoms in a molecule.

   Emphasize that unequal forces can be provided by having more atoms on one side or by having a stronger pulling ability.

Action

****Refer to the Differentiation Resources link for additional practice worksheets, and to enrich your classroom teaching using different tools throughout the lesson. ****

1. Polarity Worksheet

- Have students complete the handout as they work their way through the lesson *or* you can assign the handout as homework to completed after class and taken up in the next session.

2. 1-5A: Electronegativity and Bond Polarity:

- Put the image of the periodic table with electronegativity values up on a screen for the class to view.
- Have students read the introduction and section A.
- Review the content using the powerpoint presentation linked to at the top of the lesson page.
- Emphasize that electronegativity is a tool that can be used to help determine the polarity of a bond between two atoms as well as a tool to determine whether an atom will readily ionize or not.
- Have students read through sections B & C on their own
- Review the content using the powerpoint presentation.

- Have students answer the embedded question
- Take up the answer with the students.

3. 1-5A: Polarity Simulator

- Have students open the polarity simulator on their own computers and instruct them to explore the features of the 2-atoms tab.
- Students will answer the questions related to the simulator.
- Take up the answers as a class, explore together the effect of electronegativity on bond polarity.
- Have students read section E.
- Review content using the powerpoint.

4. 1-4A: Lewis Structures

- Have students read sections A & B on their own.
- Review with the class valence electrons and how to use the periodic table to quickly determine the number of valence electrons in each neutral atom.
- Play the vide from section C for the whole class.
- Review and clear up any questions.
- Have students read sections D and E on their own.
- Students should answer the embedded question on their own.
- Teacher will take up the answer to the embedded questions.
- Use the additional resources at the bottom of the page to differentiate the instruction and offer additional review opportunities for the students.

5. Electronegativity Gridlock Activity

- To be completed in groups, individually or with the whole class. If you are using the activity as a whole class, click on the link for the online version of the gridlocks activity and display the grid for the whole class to observe.
- If in groups or individually, give printouts for the students to complete.
- Explain the rules to the class.

Teacher information:

Gridlock Puzzles are designed to do 3 major things:

1. They give the students a problem solving context for the activity – students like solving problems and there is a sense of satisfaction in completing the gridlock. There can be an aspect of competition as well: who solved the most, who was quickest or who made the least mistakes. In the online versions the students are trying to beat the clock.

2. The students need to engage with the factual information the gridlock is based on. In order to solve the puzzle they need to recall the relationships between the data

established in the first part of the activity. For example they need to recall that 3 electron pairs gives trigonal planar geometry or that sulfuric acid forms sulfate salts. Whilst they are solving the gridlocks they should find themselves referring to the initial data repeatedly so much so that they recall a fair bit of it by the end.

3. It develops some important thinking skills. The students have to survey the data given in the gridlock to find which squares can initially be filled in. They cannot simply choose a square at random and fill it in because there may not be enough information yet in the grid to narrow down the options to one possible answer. This thinking skill is sadly missing in the students who, given a titration calculation want to straight multiply a concentration by a volume to give the moles of the reactant asks for despite not having all the relevant information yet. Gridlocks also encourage logical reasoning e.g. 'it has to be x because it can't be w, y or z'.

How they might be used:

Gridlocks are suitable for an episode in a lesson or homework. They are designed to be follow up activities rather than an introduction to a topic. The students should have met at least some of the data the gridlocks are based on. The online gridlocks could be tackled by students working individually or a class using a projector. The paper based gridlocks are easy to set and readily peer or self-assessed. Some gridlocks go beyond specifications and could be used as extension activities.

6. 1-5B: Molecular Polarity
B. Molecular Polarity Investigation

- Have students open the polarity simulator on their own computers and instruct them to explore the features of the 3-atoms tab.
- Students will answer the questions related to the simulator.
- Take up the answers as a class, explore together the different ways to effect molecular polarity.
- Demonstrate using the simulator on a screen for the whole class to observe.
- Points of emphasis: unbalanced electronegative forces in a molecule can create a polar molecule.
- Balanced electronegative forces can create a non-polar molecule that has bond dipoles.
- Have students read section C followed by a whole class review content using the powerpoint.
- Have students read section D followed by a whole class review content using the powerpoint.
- Students will answer the embedded question on their own.
- Take up the answer as a class.

7. Water Polarity Group Activity

a) Adhesive & Cohesive Properties of Water

Objectives:
Students will experiment with the adhesive and cohesive properties of water

Teacher Information:

Although a water molecule has an overall neutral charge, the actual structure of a water molecule makes it a polar molecule. The polarity of the water molecule causes it to be attracted to other water molecules as well as molecules of other substances. The attraction between water molecules is called **cohesion**. The attraction of water molecules to other substances, like soil or glass, is called **adhesion**. The cohesive force that occurs between water molecules is so strong that when comes in contact with another medium, such as air, the water creates a "sticky skin", which is known as **surface tension**. These bonds are so strong that they can support insects, you may have seen this before demonstrated by a water strider.

Procedure:

1. Divide students into teams of two. Give each pair a coin, an eyedropper, a cup or beaker of water, and paper towels.

2. Have the teams predict how many drops of water they will be able to put on the coin.

3. Allow the students to slowly begin to place drops of water on the coin. Tell the students to add the drops one drop at a time for better results. Students will count the drops, and continue to add drops until the surface tension breaks, the water drop collapses, and spills over the side on the coin.

4. Have the students record the number of drops they were able to successfully place on the penny before the water drop collapsed.

5. Allow the other student on the team to repeat the activity.

6. Students report their team's data to the class.

Analyze the data in groups. Each group will then present their analysis followed by a group discussion. The following questions may help prompt the students' analysis:

- Did the number of drops change with the size of the coin?
- Did the number of drops change by using the "heads" side versus the "tails" side of the coin?

- Did using a new coin differ from using an older (more used and worn down) coin? Why?

Extension:
Complete the same activity with salt water, sugar water, or other liquids. Compare those results with those collected from using plain water. Are there any differences? Why?

b) Adhesive & Cohesive Properties of Water

Objectives: Students will experiment with the adhesive and cohesive properties of water

Materials:

- plastic cups or beakers to hold water
- paperclips
- forks
- paper towels
- copies of the "Sticky Water" worksheet

Teacher Information:

Although a water molecule has an overall neutral charge, the actual structure of a water molecule makes it a polar molecule. The polarity of the water molecule causes it to be attracted to other water molecules as well as molecules of other substances. The attraction between water molecules is called **cohesion**. The attraction of water molecules to other substances, like soil or glass, is called **adhesion**. The cohesive force that occurs between water molecules is so strong that when comes in contact with another medium, such as air, the water creates a "sticky skin", which is known as **surface tension**. These bonds are so strong that they can support insects, you may have seen this before demonstrated by a water strider.

Procedure:

1. Divide students into teams of two. Give each pair paperclips, a fork, a cup or beaker of water, and paper towels.

2. Have the teams predict how many paperclips they will be able to float on top of the water.

3. Have the students attempt to place a paperclip on the surface of the water in the cup. (Hint: Have the students place the paperclip on the prongs of the fork, and gently lower onto the water.)

4. Have the students place as many paperclips as possible onto the surface of the water. Record the number of paperclips.

5. Allow the other student in the team to repeat the activity.

6. Students report their team's data to the class.

Assessment:
Analyze the data. The following questions may help prompt the students' analysis:

- Why do you think the paperclips "float"?
- Could the method used to place the paper clips in the water change the results? Why?

Extension:
Complete the same activity with salt water, sugar water, or other liquids. Compare those results with those collected from using plain water. Are there any differences? Why?

c) Dissolving

Objectives: Students will be able to demonstrate the ability of water to dissolve solids and liquids

Materials:

- containers with lids
- water
- sugar
- sand
- graduated cylinders
- rubbing alcohol
- vegetable oil
- dissolving worksheet

Background:

The structure of a water molecule causes it to be polar, that is, there is a negatively charged end and a positively charged end. Due to this polar nature, water molecules act as tiny magnets, constantly attracting other water molecules, or other substances.

When substances are dissolved into water, like sugar, the sugar is known as the **solute**, and the water is known as the **solvent**. Water has the ability to dissolve many solids and liquids. That is why water is commonly called the "universal solvent".Because water is attracted to other substances, it has the ability to dissolve many materials. An example of one solid that water can dissolve is sugar. Sugar molecules also happen to be polar molecules, so the negative ends of sugar molecules are naturally attracted to the positive ends of water molecules, which will disperse the sugar and water molecules within a container. For example, if you were to place a teaspoon of sugar into a glass of iced tea, and stir, the sugar would eventually dissolve, making each sip of tea sweet, not pockets of "sweetness" within the glass.

When two materials are put together, it is called a mixture. There are different types of mixtures, homogeneous or heterogeneous. When sugar and water are mixed, and the sugar seems to "disappear", it is known as a **homogeneous mixture** because it possesses the same properties throughout the mixture. A **heterogeneous mixture** consists of two or more regions that differ in properties. There are mainly two types of heterogeneous mixtures, colloidal dispersions and suspensions. The main difference is only the size of the items being mixed. A mixture of sand and water is an example of a **suspension**. When in suspension, the two or more properties do not settle quickly. In the case of sand and water, the particles of sand are constantly being "bumped" by water molecules and continue to stay in suspension for a while. Eventually, the sand will settle out, therefore, it is known as a suspension. A **colloidal dispersion** is a mixture in which the dispersed molecules are very small. So small that they may appear to have mixed together, but will eventually separate and settle out from the solvent.

Procedure:

Dissolving Solids

1. Divide students into teams of two. Give each team two containers, one labeled A, containing sugar and water, and one labeled B, containing sand and water.

2. Teams will make visual observations about the contents of each container. Then the students will shake each container vigorously for 10 seconds. Once shaken, put the containers down and observe and record the changes in the mixtures over the next five minutes.

Dissolving Liquids

1. Have the teams of students fill two graduated cylinders with 25 ml of water in each cylinder. To one cylinder, add 25 ml of rubbing alcohol. Add 25 ml of vegetable oil to the other cylinder.

2. Observe and record what happens in each cylinder.

Assessment:

Have students answer the following questions:

- Distinguish the differences between a solvent and a solute.

- Distinguish between suspensions and solutions.

Consolidation

1. **1-5D: Molecular polarity simulation.** This activity allows students to further explore polarity using a simulator and handout. This should be completed individually in class or at home. Answers should be taken up as a class the following day.

2. **1-5E: Molecular Polarity Challenge Problems** – To be completed individually, in class or at home. It is advised to do one example with the whole class to help practice how to answer these questions. Take up the answers together the following day.

3. **Exit Card Question**: Print the following question on a sheet of paper and have students answer at home and bring in their responses the following class. Use the responses to lead a class discussion.

Exit Card: "If one day, magically, water became a non-polar molecule, what are some of the effects this could have on our day-to-day lives? List at least 3 consequences and try to predict the long-term effects of this change in the properties of water."

4. **1-5F: Molecular Shapes & Polarity Assignment -** This is a graded activity. Review the expectation with the whole class before the students attempt the assignment. Emphasize where the marks are allocated and review proper naming convention and file formats.

****Refer to Differentiation Resources for additional practice worksheets, and to enrich your classroom teaching using different tools. ****