

Chemical Bonding: The Polarity of Slime and Silly Putty

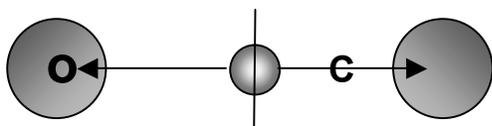
Introduction:

The root word for polarity is “pole”. There are strong attractions in a molecule that induce poles, similar to the North and South poles of the earth or of a magnet. A molecule can be polar too. Whether a molecule is polar or nonpolar is primarily based on its electronegativity and its shape.

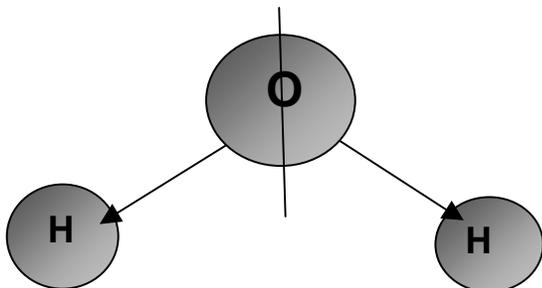
Electronegativity is a term that describes the attraction an atom has for electrons. Fluorine has the strongest attraction for electrons, and therefore has the greatest electronegativity. Elements on the right side of the Periodic Table close to where fluorine is located have larger electronegativities than elements located on the left side of the Periodic Table. If all of the atoms in a molecule have similar electronegativities, the molecule is non-polar. Hexane is an example of a non-polar molecule. It has only carbon and hydrogen atoms. The electronegativities of carbon and hydrogen atoms are very similar. They have only a 0.4 difference in their electronegativity values.

If there is a large difference between the electronegativities of two covalently bonded atoms, the bond is polar. For a covalent bond to be considered polar, the atoms bonded together must have an electronegativity difference between 0.5 and 1.9. But even if a molecule has a bond between two atoms that has this much electronegativity difference, it does not automatically mean that the molecule is polar. The shape of a molecule also has to be considered.

To understand how the shape of the molecule affects the polarity, imagine the atoms within a molecule playing tug-of-war. If there is an equal pull on each side, the rope does not move. Similarly, if there are two polar bonds that have equal electronegativity differences, they each pull with the same force, and the overall pull is zero.



An example of this is CO_2 . In this case, there are two polar bonds, but the molecule is non-polar because the overall pull is zero. If there is an unequal net pull, however, the molecule is polar. Water is an example of this. It has a bent shape causing the pull to be unequal.



Polar molecules such as water, vinegar, or ethanol dissolve other polar molecules. Non-polar molecules, such as oil or gasoline, dissolve other non-polar molecules. This trend is known as **“like dissolves like.”** Since sugar dissolves in water, is sugar polar or non-polar? If you said polar, you are correct. Sugar is a polar molecule since it is dissolved in water, a polar molecule.

Paper chromatography is a laboratory technique that uses **“like dissolves like”** to separate different chemicals. A sample is first spotted on an absorbent paper such as filter paper and allowed to dry. A solvent is then allowed to travel up the paper by capillary action. The components of the sample most like the solvent will stay dissolved in the solvent more than on the paper and travel the farther up the paper. The components that are least like the solvent will travel the least or not at all.

Some inks are polar while others are non-polar. A polar substance will pick up water soluble inks by dissolving the ink. Likewise a non-polar substance will pick up non-polar inks by dissolving the ink. In this lab you will use inks to identify slime and silly putty as polar or non-polar. You will also use paper chromatography to verify the inks are correctly identified as polar or non-polar.

Learning Objectives:

1. Compare and contrast the chemical bonding properties of slime and silly putty.
2. Demonstrate knowledge gained about polar and non-polar bonding through supporting or rejecting his/her hypothesis about which inks will be absorbed.
3. Learn about the technique of chromatography and how it is often used to separate the components of a mixture based on their polarity.

Materials:

- Borax Solution (4%)
- White Glue
- Distilled Water
- 50 mL and 100 mL (or 250 mL) graduated cylinder
- 250 mL beaker
- 500 mL beaker
- Silly Putty
- Notebook Paper
- Newspaper
- Variety of Inks: Uni-Ball Pens, Sharpies, Highlighter, and Dry Erase Markers
- 250 mL Beaker
- Filter Paper
- Stirring Rod
- Spatula
- Zip Lock Plastics Baggies (for storing slime)

Hazard Information:

Chemical Name	Health Hazards	Physical Hazards	Environmental Hazards
Borax	Slight skin and eye irritant Severe exposure/rapid absorption may cause reproductive effect	None	Products of degradation are non-toxic
White Glue	None	Slight fire hazard	None

Waste:

Description of Material (include concentration)	Quantity per student	Hazard	Disposal Method
Slime	About 5 grams	None	Trash

Procedure:**Part 1. Making Slime**

1. If slime is provided go to Part 2. If not, weigh out 4.0 grams (1 teaspoon) of borax into a 250 mL beaker.
2. Measure out 235 mL of distilled water and pour into the 250 mL beaker that contains the borax.
3. Stir the mixture for at least 3 minutes or until the borax has dissolved.
4. Measure out 115 mL of distilled water and 115 mL of white glue (about ½ cup) and pour into a 500 mL beaker. Stir the mixture.
5. Pour the borax solution from the 250 mL beaker into the diluted glue mixture in the 500 mL beaker and stir the solution until it becomes slime.
6. Record observations about the slime.
7. Wash your hands before moving on to the next part!

Part 2. Slime and Silly Putty Ink Tests

1. On a piece of notebook paper make one 20-25 mm long mark of each of the inks you are testing. Space the marks at least one inch apart. Use a pencil to label each mark with its description.
 - o Water soluble inks include a highlighter and a Uni-ball pen.
 - o Water insoluble inks include a Sharpie pen/marker, newsprint, and a dry-erase marker.
2. While the inks are drying, select a passage or a picture in the newspaper to test with the slime.
3. Break off a small piece that is 3-5 cm in diameter of slime. Gently place this piece on top of the newspaper ink, and then carefully pick it up again.
4. Observe and record whether or not the ink was picked up onto the slime.
5. Break off another small piece of slime. Gently place it on top of the first dried ink on the notebook paper, and then carefully pick it up. Repeat this for each of the inks.
6. Observe and record which inks were picked up (dissolved) by the slime in Table 1. Repeat this ink testing two more times for accuracy.
7. Store the slime in zip lock plastic bag.
8. Before performing ink tests on silly putty, in the data section hypothesize which inks the silly putty will pick up.
9. Perform ink tests on silly putty in the same manner as above.
10. Record results in Table 2.

Part 3. Chromatography of Ink Samples

1. Use a pencil or scissors to poke a small hole in the center of a piece of filter paper (see Figure 1).
2. Spot the filter paper evenly spaced ~3 cm from the small hole with the two insoluble inks and the two soluble inks that were used in Part 2.
3. Obtain a ½ piece of filter paper. Fold the paper in half several times so that it makes a narrow wick.
4. Insert the wick into the hole of the spotted paper so that it is above the top of the filter paper by ~2 cm.
5. Fill a 250 mL beaker ¾ full with distilled water.

6. Set the filter paper on top of the beaker so that the bottom of the wick is in the water. The paper should hang over the edge of the beaker with the spotted side up.
7. Allow water to travel until it is ~1 cm from the edge of the filter paper. Remove the filter paper from the beaker.
8. Observe which inks moved from where they were originally spotted. Record your observations in Part 3 of Data.

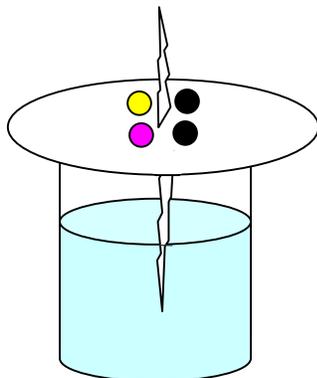


Figure 1: Chromatography Apparatus

Data:

Part 1.

Observations for Slime (if slime is made):

Part 2.

Table 1. Results of Ink Testing for Slime

Name of Ink	Picked up (dissolved)			Did not pick up (dissolve)		
	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3
Newsprint						
Highlighter						
Uni-ball pen						
Sharpie marker						
Dry-erase marker						

❖ Hypothesis of which inks silly putty will pick up:

Table 2. Results of Ink Testing for Silly Putty

Name of Ink	Picked up (dissolved)			Did not pick up (dissolve)		
	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3
Newsprint						
Highlighter						
Uni-ball pen						
Sharpie marker						
Dry-erase marker						

Part 3.

- Observations of inks following chromatography:

Post Lab Questions

1. Did the slime pick up water soluble or water insoluble inks? From these results what can you conclude about the polarity of slime?

2. Explain how you determined your hypothesis about whether or not silly putty would pick up water. Was your hypothesis correct?

3. Were the inks you used properly classified as soluble and insoluble? Explain your answer.

References:

Henrie, Sally. "Chemical Bonding: The Polarity of Slime and Silly Putty." *Green Chemistry Lab Manual*. Union University, 2002.