

# Chemical Bonding: Polarity of Slime and Silly Putty

*TN Standard 3.1: Investigate chemical bonding. Students will distinguish between polar and non-polar molecules.*

*Have you ever read the newspaper using silly putty?*

**N**ewsprint can be transferred to silly putty. This oddity is due to the chemical characteristic called polarity. Polarity is based on two primary factors, electronegativity and the shape of the molecule. Polarity is an important aspect of chemistry and it is everywhere. Loads of household substances are examples of both polar and nonpolar molecules. To explore polarity, let's experiment with two favorite toys—slime and silly putty!

## Introduction

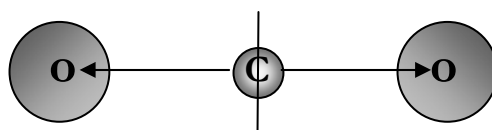
The root word for polarity is “pole”. There are strong attractions in a molecule that induce poles, similar to the North and South poles of the earth or of a magnet. A molecule can be polar too. Whether a molecule is polar or nonpolar is primarily based on its electronegativity and its shape.

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

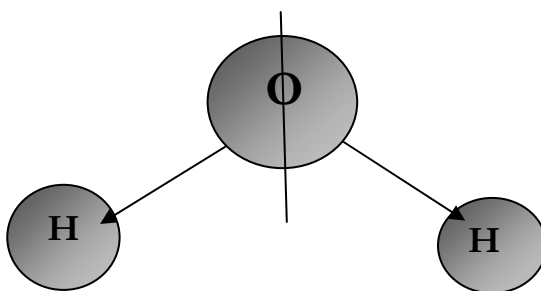
molecule. It has only carbon and hydrogen atoms. The electronegativities of carbon and hydrogen atoms are very similar. They have only a 0.4 difference in their electronegativity values.

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  $\text{CO}_2$ . 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 because the pull is 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 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.

## Objectives

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



**Name:** \_\_\_\_\_ **Date:** \_\_\_\_\_ **Period:** \_\_\_\_\_

## Pre-lab Questions

1. What two conditions are considered when determining whether a molecule is polar or non-polar?

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2. What determines if a bond is polar?

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3. List examples of polar molecules.

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4. List examples of non-polar molecules.

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5. What is the rule when using polar and non-polar solvents?

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## Procedure

### Part 1. Making Slime

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#### SAFETY FEATURES

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 Glassware

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Safety Goggles

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#### MATERIALS NEEDED

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❖ Borax solution (4%)

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❖ Guar gum powder

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❖ Silly putty

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❖ Notebook paper

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❖ Newspaper

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❖ Variety of inks: Uni-ball pens, Sharpies, Highlighters, and Dry erase markers

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❖ 10 and 100 mL Graduated Cylinder

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❖ 250 mL beaker

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❖ Filter paper

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❖ Stirring rod

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❖ Spatula

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❖ Balances

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❖ water

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❖ Zip lock plastic bag

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1. If slime is provided go to Part 2. If it is not provided, weigh out 0.5 g of guar gum powder into a 250 mL beaker.
2. Measure 100 mL of distilled water into a 100 mL graduated cylinder and pour it into the 250 mL beaker that contains the guar gum powder.
3. Rapidly stir the mixture with a stirring rod until the guar gum powder is dissolved. This will take a few minutes.
4. Measure 5.00 mL of a 4% borax solution into a 10 mL graduated cylinder and add it to the guar gum and water.
5. Stir the solution until it becomes slime. This will take a few minutes. If the slime remains too runny, add 1.0 mL of the 4.0% borax solution and continue to stir until the slime is the right consistency.
6. Once you are satisfied with the slime, pour it into your hands. Be sure not to drop any of it on to the floor.
7. Manipulate the slime in your hands. Write down observations made about how slime pours, stretches, breaks, etc. **CAUTION: Slime is slippery and if dropped it can make the work area slick.**
8. Place the slime back into the beaker and WASH YOUR HANDS.

### 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.

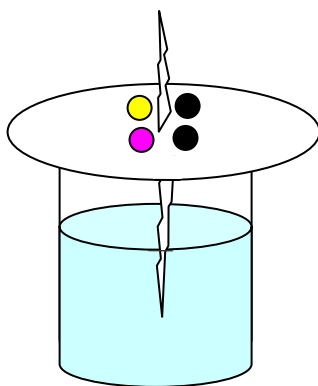


- o **Water insoluble inks** include a Sharpie pen/marker, newsprint, and a dry-erase marker.
2. Let the ink marks dry completely.
  3. While the inks are drying, select a passage or a picture in the newspaper to test with the slime.
  4. Break off a small piece that is 3-5 cm in diameter of slime. Gently place this piece on top of the newspaper ink, and then carefully pick it up again.
  5. Observe and record whether or not the ink was picked up onto the slime.
  6. 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.
  7. Observe and record which inks were picked up (dissolved) by the slime in Table 1. Repeat this ink testing two more times for accuracy.
  8. Store the slime in zip lock plastic bag.
  9. Before performing ink tests on silly putty, in the data section hypothesize which inks the silly putty will pick up.
  10. Perform ink tests on silly putty in the same manner as above.
  11. 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 1/2 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 3/4 full with 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  $\sim 1$  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**



Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

Lab Partner: \_\_\_\_\_

## 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 point 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 point 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 we conclude about the polarity of slime?

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

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

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