

ACTIVITY #3
ENVIRONMENTAL CHEMISTRY

SREL Student HazMat Response Team is Called into Action

STEP 1: THE PROBLEM

You are an **Environmental Chemist** with the SREL Student HazMat Response Team. Your team has just been notified that a truck has overturned on Hwy. 278 in Aiken County, spilling an unknown white substance onto the roadway. This is of particular concern because the truck is overturned on the bridge crossing Upper Three Runs Creek, a blackwater stream known to have high biodiversity.

The members of your team on the scene of the accident have collected a sample of the unknown substance and are rushing it back to the student chemistry laboratory. Incomplete shipping records found in the ABC Delivery Company truck indicate that the unknown substance is one of 4 possible chemicals:

Chemical ID #	Chemical Formula	Chemical Name
1	$(C_6H_{10}O_5)_x$	Soluble starch
2	$C_{12}H_{22}O_{11}$	Sucrose
3	$NaHCO_3$	Sodium bicarbonate
4	$(CaSO_4)_2 \cdot H_2O$	Calcium sulphate hemihydrate

It is critical that the Environmental Chemists with the HazMat Response Team quickly identify and contain the spilled substance before a rainstorm washes it into Upper Three Runs Creek.

STEP 2: DATA COLLECTION

Before you can determine which of the 4 possible substances has spilled onto the roadway from the overturned truck, you must first learn all you can about the **properties** of these substances. Chemists use both **physical** and **chemical properties** to identify substances. Performing tests and carefully recording the results will allow you to distinguish these chemicals from one another and ultimately will enable you to identify the unknown substance.

SAFETY NOTE: Be sure to wear your safety goggles and a protective apron. These chemicals are safe to touch, but do not put your fingers in your mouth or eyes and be sure to wash your hands after class.

1. Physical Analyses

Working with a partner, sprinkle a small amount of each substance on a piece of black paper and use a magnifying glass to observe the **particles**. Record your observations of the physical nature of each substance in the space provided on your data sheet. Look for differences in:

- **color:** are all 4 substances the same color? Can you see differences among them? Describe the colors of the chemicals.
- **particle size:** use descriptions like large, small, crystals, rectangular, round, etc. if they apply.

- **texture:** rub each substance between your fingers—how does it feel? Use descriptions like gritty, smooth, soft, slippery, crunchy, silky, squeaky, etc. if they apply.

2. Chemical Analyses

Chemicals also differ from one another in how they **react** to heat, water, and other chemicals. Chemical analyses will allow you to further characterize each substance.

A) Heat—does it burn, melt, or just sit there?

The reaction of each known chemical to heat will be conducted as a demonstration. A small amount of each of the 4 chemicals will be heated in a foil tray. Be sure to record the results of the heat tests on your data sheet.

B) Solubility—how well does each chemical dissolve in water?

1. As a class demonstration, the solubility of each chemical will be tested. 5g of the chemical is placed into a beaker, 50 ml of deionized water (H₂O) is added to the beaker and the solution is stirred well.
2. Observe whether the chemical dissolves in water. Record your observations on your data sheet.
3. Note whether the chemical dissolves completely. Describe the resulting **solution**, using descriptions like clear, cloudy, milky, lumpy, gooey, etc if they apply.

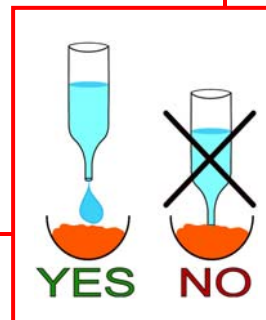
C) Chemical Reactivity—how does each chemical react with other chemicals?

1. Working with your partner, you will test the 4 known chemicals to determine their reactivity with various **chemical reagents**. Be sure to record your observations on your data sheet after each test.

REMEMBER TO USE GOOD LABORATORY TECHNIQUE!

Be careful not to contaminate the vials of chemicals by always using the numbered scoop that matches each chemical.

Do not let the tip of the dropper bottle touch the chemicals in the spot plate wells—this will contaminate your reagents.



2. Add a small amount of **Soluble Starch** (chemical #1) to the first column of wells in your spot plate (wells 1, 5, & 9—see diagram). You only need a small amount of chemical for each test. [do not fill the wells completely full!!]



- Now add a few drops of **Acetic Acid** to well 1. Mix with a clean toothpick and record your observations on your data sheet. Describe how **Soluble Starch** (chemical #1) reacted with the **Acetic Acid**. Use descriptions like dissolved, cloudy, clear, fizzes, bubbles, lumpy, gooey, cloudy, milky, etc. if they apply. Be sure to note any color changes that occur.
- Next, add a few drops of **Iodine Solution** to the **Soluble Starch** in well 5. Mix with a clean toothpick. Record your observations on your data sheet, using descriptive words. [Be careful—iodine will stain your clothes!]
- Finally, add a few drops of **pH indicator** to the **Soluble Starch** in well 9. Mix well with a clean toothpick. Record your observations on your data sheet. This **pH Indicator** turns **BRIGHT PINK** in acidic solutions (like lemon juice) and **BRIGHT BLUE** in basic solutions. What color did it turn when added to **Soluble Starch**?
- Now test the other 3 chemicals with all 3 reagents. Put a small amount of **Sucrose** (chemical #2) in wells 2, 6, & 10 and add a few drops of each test reagent as you did for the first chemical, making sure you use a clean toothpick to mix the contents of each well. Record your results on your data sheet.
- Put a small amount of **Sodium Bicarbonate** (chemical #3) in wells 3, 7, & 11 and test as above.
- Finally, put some **Calcium Sulphate Hemihydrate** (chemical #4) in wells 4, 8, & 12 and test with the 3 reagents.

STEP 3: TEST THE UNKNOWN SUBSTANCE

Now that you have determined the physical and chemical properties of the 4 known chemicals, you can test the unknown to see if you can identify which chemical has been spilled onto the roadway on Hwy. 278.

- The effect of **heat** on the **unknown substance** will be conducted as a demonstration. Be sure to record the results of the heat test on your data sheet.

2. Examine the **physical properties** of the **unknown substance** by sprinkling a small amount onto a piece of black paper. Observe with a magnifying glass and record your descriptions of the particles. Rub some of the unknown between your fingers; record your description of how it feels.
3. The **solubility** of the **unknown substance** will be tested as a class demonstration.
 - a. Observe whether the chemical dissolves in water. Record your observations on your data sheet.
 - b. Note whether the chemical dissolves completely. Describe the resulting **solution**, using descriptions like clear, cloudy, milky, lumpy, gooey, etc if they apply.
 - c. Note whether the chemical dissolves completely. Describe the resulting **solution**, using descriptions like clear, cloudy, milky, lumpy, gooey, etc if they apply.
4. Use a clean spot plate to test the **chemical properties** of the **unknown**. Be sure to use clean toothpicks to mix the reagents. Record the reactions of the unknown substance with **Acetic Acid**, **Iodine Solution**, and **pH Indicator**. Record the results.

Test Reagent	well 1	well 2	well 3	well 4
Acetic Acid	unknown			
Iodine solution	unknown			
pH indicator	unknown			
	well 9	well 10	well 11	well 12

STEP 4: IDENTIFY THE UNKNOWN SUBSTANCE

Compare the results of all tests for the unknown substance with those of the 4 known chemicals. Can you determine which chemical is spilled on the highway?

Based on the results of your tests, the unknown substance is [circle 1]:

Soluble Starch Sucrose Sodium Bicarbonate Calcium Sulphate Hemihydrate

Which test was most informative in helping you identify the unknown substance? _____

School: _____ Teacher: _____ Name: _____

	<i>TEST/ REAGENT</i>	Chemical #1 Soluble Starch	Chemical #2 Sucrose	Chemical #3 Sodium Bicarbonate	Chemical #4 Calcium Sulphate Hemihydrate	UNKNOWN SUBSTANCE
PHYSICAL PROPERTIES	COLOR					
	PARTICLE SIZE					
	TEXTURE					
CHEMICAL PROPERTIES	HEAT					
	WATER SOLUBILITY TEST					
	ACETIC ACID					
	IODINE SOLUTION					
	pH INDICATOR					