Case File 7

Drug Tests: Identifying an unknown chemical

Use quantitative and qualitative analyses to identify the powder in Mr. Orlow's car.

Police Report

Patrol officers pulled over Mr. Yuri Orlow for reckless driving last night at 8:50 p.m. A preliminary Breathalyzer test showed that Mr. Orlow was intoxicated. Mr. Orlow consented to a search of the vehicle, in which the officers found traces of a white powder that seemed to have leaked across the leather of the passenger seat. The officers think that Mr. Orlow might have thrown a bag of the unknown substance out the open passenger-side window before pulling over. A search of the snowy road has revealed nothing. The powder has been sent to the lab for testing.

Mr. Orlow has been charged with driving recklessly and awaits a second charge pending the results of the tests on the white powder.

Enclosed are two photographs of Mr. Orlow's car and an evidence vial containing a sample of the powder.

About the Lesson

- This lab uses the identification of an unknown "drug" to demonstrate the differences between chemical and physical properties and between qualitative and quantitative observations.
- Teaching time: one or two 45 minute class periods

Science Objectives

- Distinguish between physical and chemical properties.
- Distinguish between qualitative and quantitative observation.
- Identify an unknown powder using physical and chemical properties.

Activity Materials

- TI-Nspire™ technology
- *Case 7 Drug Tests.tns* file
- *Case_7_Drug_Tests_Student.doc* student activity sheet
- Vernier EasyLink™ or TI-Nspire Lab Cradle
- Vernier pH Sensor
- Vernier Conductivity Probe
- vinegar
- 5 known "drug" samples (5g of each)
- 1 unknown "drug" samples (5g)
- distilled water
- spoons or weighing paper (one per sample)
- stirring rod
- disposable pipettes or droppers
- wash bottle (with distilled water)
- magnifying glass
- balance
- lint-free tissues or lens paper
- goggles (1 pair per student)
- filter paper
- six 50 mL beakers

TI-Nspire™ Navigator™

- Send out *Case 7 Drug Tests.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Teacher Notes and Teaching Tips

- The student activity sheet and .tns file contain the complete instructions for data collection. All assessment questions are also included in both places giving you the flexibility to either collect the .tns files with student data/answers using TI-Nspire Navigator or to collect the handwritten version of the answers.
- Be sure to demonstrate the pH Sensor cleaning sequence for students during the pre-lab.
- The procedure has students record pH values from the live meter (without actually pressing "start' on the DataQuest page).
- Conductivity readings are normally reported in microsiemens per centimeter, or µS/cm. This SI derived unit has replaced the conductivity unit, micromho/cm.
- Students are instructed to rinse the probe with distilled water between samples. They are told to blot the probe tip dry—however, the directions also remind them that they do *not* need to blot dry the inside of the hole containing the graphite electrodes. It is cumbersome to do so, and leaving a drop or two of distilled water does not significantly dilute the next sample.
- The procedure has students record conductivity values from the live meter (without actually selecting "start" on the DataQuest page)
- If you wish to calibrate the Conductivity Probe to improve conductivity readings at low concentrations, follow these directions:

  First Calibration Point

  a. Set up the data-collection software to calibrate the Conductivity Probe.
  b. For the first calibration point, the Conductivity Probe should simply be in the air (out of any liquid or solution).
  c. Type **0** in the edit box as the conductivity value (in µS/cm).
  d. Wait until the voltage stabilizes, then *Keep* the point.

  Second Calibration Point

  a. Place the Conductivity Probe into a standard solution that is equivalent to 10,000 µS/cm. **Note:** This standard can be prepared by dissolving 5.566 g of solid sodium chloride, NaCl, in enough distilled water for 1 liter of solution.
  b. Type **10000** in the edit box as the conductivity value for the second calibration point (in µS/cm).
  c. Wait until the voltage stabilizes, then *Keep* the point. Then select either *OK* or done depending on the software. This completes the calibration

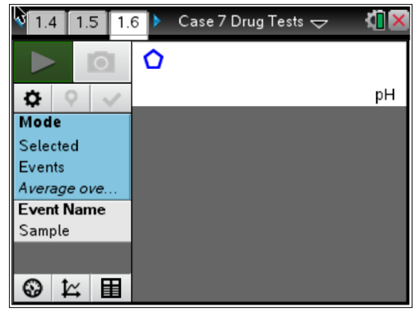
.

Allow students to read the forensics scenario on the first page of their student activity sheet.

Procedure

Part 1 – Teacher Preparation (Prior to the Lab)

Move to page 1.2–1.3.



1. The following powders work well as samples and unknowns: flour, powdered (ground) salt (NaCl), powdered sugar ($C_6H_{12}O_6$), baking powder ($NaAl(SO_4)_2$ or $NaHCO_3$ + $KHC_4H_4O_6$), baking soda ($NaHCO_3$), talcum powder, baby formula, plaster of paris ($CaSO_4 \bullet ½H_2O$), cornstarch ($C_6H_{10}O_5$), chalk ($CaCO_3$), and Epsom salts ($MgSO_4 \bullet 7H_2O$).
2. You can use small containers to distribute the unknowns. The lab will go faster if the correct amount of each sample is measured beforehand and given to each group. If you do measure samples in advance for student groups, students will need to skip Step 1.

Part 2 – Preparing the Solutions

Move to page 1.4.

Students will need to follow the directions on page 1.4 to prepare the solutions for testing.

Part 3 - 5 – Collecting Data : pH, Conductivity, and Reaction with Vinegar

Move to page 1.5-4.1.

Students will need to follow the directions on pages 1.5-4.1 to collect data on the samples. Students will record their data on the Evidence Record on the student worksheet. Students may also record data on page 4.1 in the .tns file, if you plan to collect the .tns files.

Resources

Although the powders being tested in this lab are not illegal drugs, the procedures used by the students are similar to some used by professional forensic chemists. The sites listed below provide information about procedures and techniques for the identification of real drugs.

This site of the Scientific Working Group for the Analysis of Seized Drugs provides information about processes and procedures that are used in the analysis and identification of unknown (presumably illegal) drugs.

http://www.swgdrug.org/approved.htm

This extensive database of prescription and nonprescription drugs, organized alphabetically or by drug classification (such as analgesic or antipsychotic), provides chemical composition and structure, physical properties, and analytical results.

http://chrom.tutms.tut.ac.jp/JINNO/DRUGDATA/00database.html

This comprehensive Web site discusses characteristics, sources, and effects of various street drugs.

http://www.streetdrugs.org/index.htm

Modifications/Extensions

If you wish, you can use this activity to introduce or explain heats of reaction to your students. Several of the possible “drugs” will show measurable temperature changes when they react with or dissolve in water or vinegar. Have the students measure the temperatures of the water and the vinegar before they are added to the solids in Steps 3 and 9. Have them continue to measure the temperatures as the various powders are added and dissolve in and/or react with the liquids. You can have the students use a Vernier Stainless Steel Temperature Probe to monitor the temperatures. In order to observe a significant change in temperature, it may be necessary to increase the amount of solid added to solution. Be sure to test before running the lab with your students.

Evidence Record

SAMPLE DATA

Sample	General Appearance	Water Observations	pH	Conductivity (μS/cm)	Reaction to Vinegar
Flour	Fine white powder - dull	Did not dissolve	6.5	345	No reaction
Baking Soda	Fine white powder	Partially dissolves	8	13900	Fizzed vigorously
Baking Powder	Fine white powder	Fizzed vigorously	6.9	9049	Fizzed vigorously
Salt	Fine white crystals	Dissolved	6.7	17600	Nearly dissolved
Sugar	Fine white crystals	Dissolved	7.2	0	Nearly dissolved
Unknown					

Case Analysis

Have students answer the following questions in the .tns document, on their activity sheet, or both.

Q1. Based on your observations, which known sample do you think was most similar to the unknown powder found in Mr. Orlow's car? Do you think the unknown was an exact match to that known sample? Explain your answer.

Answer: Answers will vary. Students should describe what properties led to the choice for the unknown. For the sample data, Mr. Orlow's powder appears to be baking powder (with similar pH, conductivity, and reactions with water and vinegar).

Q2. Explain the difference between physical and chemical properties. Give two examples of physical properties and one example of a chemical property that you measured in the lab.

Answer: Physical properties are properties that you can measure without changing the substance. When chemical properties are measured, the substance is altered. The physical properties measured here included solubility, pH, and conductivity. The chemical properties measured were the reactions with water and vinegar.

Q3. Explain the difference between qualitative and quantitative observations. Give one example of a qualitative observation and one example of a quantitative observation that you made in the lab.

Answer: In a qualitative observation of a substance, you use one of the five senses without taking a measurement. A quantitative observation requires a numerical measurement of some property of the substance. Qualitative observations included dissolution or no dissolution in water and reactions with water and vinegar. Quantitative observations included pH and conductivity.

Q4. Identify two tests, other than those that you carried out in this investigation, that forensic scientists might use to identify a suspected drug.

Answer: Forensic scientists can use gas chromatography (GC), mass spectroscopy (MS), infrared spectroscopy (FTIR), column chromatography, electrophoresis, titration, precipitation reactions, redox reactions, and other chemical reactions.