LAB SPILL!: TEACHER GUIDE

Subject: Physical Science
Grade Level: Middle School
Last Updated: 2/21/06

Case Summary

Talia and DeAndre join their classmates for physical science class, but to their surprise, their classroom has been cordoned off by a Haz-Mat team. As they look in from the hallway, they see a big mess on the floor, and two troublemakers from a higher grade being detained! The Haz-Mat team must figure out how to separate this mixture of solids and figure out what each substance might be, and they need to do it fast in case the student body needs to be evacuated or hospitalized for exposure. The clock is ticking, and the sooner they figure out if any of the substances are hazardous, the better!

Credits

This case was adapted by Bethany L. Turner (PhD student, Department of Anthropology, Emory University, Atlanta, GA) and Katherine Shamsid-Deen (science teacher, Columbia Middle School, Decatur, GA), fellows of the Emory University PRISM program (http://www.prism.emory.edu). The case was adapted from *Lab Spill at Milton High School* (Mo, Thompson, & Schaefer, 2003). Authors may be contacted at blturne@emory.edu

Mo, S.J., Thompson, A. L., Schaefer D., & Beam, M. (2003). Chemical spill at Milton High School. Retrieved from PRISM Year 1 print archives at the Emory College Center for Science Education, Fall 2004.

Learning Objectives

1. At the end of this case, students should know:
    a. The difference between physical and chemical properties of substances.
    b. The difference between an element and a compound.
    c. The physical and chemical properties of common substances.
    d. Common separation techniques for unknown mixtures of solids.
    e. The chemical symbol/formula for each unknown substance.
2. At the end of this case, students should be able to:
    a. Research common physical (states of matter, color, texture, size, etc.) and chemical (solubility, magnetism, acidity, etc.) properties of several substances unknown to them in textbooks and online.
    b. Complete a separation lab activity using all of the non-hazardous unknown substances, exercising safe laboratory behavior retained from a previous case involving lab safety[1].
    c. Make hypotheses about what each unknown substance might be, based on physical and chemical properties and research in textbooks and online.

[1] Turner, B. L., & Shamsid-Deen, K. K. (2005). What happened?!?!. Retrieved January 30, 2006 from Emory University, CASES Online Web site: http://www.cse.emory.edu/cases/casedisplay.cfm?case_id=2

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Georgia Performance Standards

SCSh3. Students will identify and investigate problems scientifically. (NSES Content Standard A).

S8P1. Students will examine the scientific view of matter. (NSES Content Standard B)

a. Distinguish between atoms and molecules.
b. Describe the difference between pure substances (elements and compounds) and mixtures.
c. Distinguish between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).
d. Distinguish between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).
e. Recognize that there are more than 100 elements and some have similar properties as shown on the Periodic Table of Elements.

Assessment

Students will complete a mock Haz-Mat report (*see **Guidelines for Haz-Mat Report**, and the **Hazardous Materials Response Team Report** in the Student Materials document*), designed by the authors and based on actual Hazardous Materials online guidelines. The report must contain a concise description of the spill, the individuals responsible for the spill and what must be done to clean it up. It will also include a concise summary of how the substances were separated, and an identification of each unknown substances, with reasons and support for their ID described on a separate sheet of paper. The students will further have an opportunity for bonus points if they can correctly list any hazards posed by one or more of the substances.

Grading will be based on a 5-point scale (5=excellent, 4=very good, 3=good, 2=fair, 1=poor) for each of three criteria:

- Accuracy and depth of descriptions
- Individual contribution/participation within the team
- Individual research ability and effort – online, print, investigative questioning

The second and third criteria (participation, individual effort) will be judged not only by facilitator observations, but also by student evaluations to be completed at the end of the case. *See the **Self Evaluation Worksheet** in the Student Materials document*.

Implementation Strategy

This case is designed to take place over one 60-minute class session and four 90-minute class sessions. It has two scripted scenes; the second scene includes additional handouts of a Haz-Mat substance inventory and the mock transcript of an interrogation. Students work in groups of 4-5 individuals. This case can be facilitated by one or two facilitators, because rather than

placing a facilitator with every group, the students spend time brainstorming with their group and then as a whole class.

The brainstorming session described below involves students reading, discussing and taking notes in their groups in 10 minute blocks (totaling about 25 minutes per scene), then reconvening as a whole class to volunteer their observations, questions, hypotheses and learning issues (learning issues are things that students say they need to know or look up to define unknown terms, answer their questions, and/or test their hypotheses) at the end of every 10-minute block. During the group brainstorming, the teacher/facilitators float from group to group, checking progress and helping students with any stumbling blocks they may have. During the whole-class volunteering time, a facilitator takes notes on an overhead or with a Smart Board. In this way, students can learn to work as a team while still benefiting from sharing their information as a whole class or even competing with other groups for volunteering, while the teacher can make sure that all students are at the same point in the case at each step.

Day 1(Monday):

Read scenes 1 and 2 (includes interrogation transcript and HazMat descriptions) and brainstorm; fill out box charts for each.

Homework: Reread scenes and finish box charts

Day 2 (Tues/Wed):

Computer Lab – Students will work in groups exploring pre-selected Web sites linked from the PRISM Columbia Middle School Case Resource Page at http://www.prism.emory.edu/columbia_middle/case2

Homework: continue research; outline separation strategy, due at beginning of next class.

Day 3 (Thurs/Fri):

Lab day – students will examine samples of several of the unknown substances in class and experiment with separation techniques.

Weekend Homework: Begin research on identifying the unknown substances

Day 4 (Monday):

Continue identification, start Haz-Mat report.

Day 5 (Tues/Wed):

Complete and turn in Haz-Mat report, fill out case evaluations and wrap up. Optional: a demonstration with Substance 6.

Case Notes

Things that went well:

- Group discussion. The students were still adjusting to a student-driven, investigative learning strategy, and stumbled in their brainstorming at first. Thus we found it useful to have periods in which the students brainstormed in groups, punctuated by group discussion to make sure all of the groups were on the same page.
- The Resource Web site. Jordan Rose and Bethany L. Turner built a Web page that is part of the PRISM Web site, featuring links to useful Web sites and brief blurbs about them. When the students were scheduled to do research in the computer lab, Ms. Turner pulled up the Web site on all of the computers while Ms. Shamsid-Deen recapped the case with the students. This maximized the time that the students had to spend in the computer lab and directed their research so they could get what they needed within the allotted time. Students with online access could copy the address and access the webpage at home.
- The lab. The students really enjoyed the separation lab, in which they were given trays containing a mixture of substances from the case. They completed the lab on time, and then we had a discussion of what they'd done, making sure that everyone

took notes and understood the process. It drove the concepts home and helped everyone understand and retain what they had been reading.

- The nitrogen! The classes loved the liquid nitrogen demonstration, in which Ms. Turner poured some out of a jug onto the floor. They needed to be warned several times to stay far enough away from the stream before it was poured, but they were really excited and it was a great way to motivate them to get their lab completed on time.
- The cabinet inventory: We ended up not using this component of the case because the students began to independently research what the unknown substances might be. We also wanted to wrap the case up in a reasonable amount of time (see first bullet below), which would not have been possible had we made the students research the properties of the cabinet substances. However, providing a cabinet inventory would be very useful in a class that needs more structure in investigating what the unknown substances could be, or one where there is more time.

Things that could have gone better:

- Time management! As with the first case, we were always wishing for more time, especially with the class that went to lunch during the 60-minute class periods on Mondays. The hurricane days and standardized testing day also messed with our schedule and drew out the case longer than it would have been otherwise.
- Computer lab: Facilitating the kids while they do online research can be difficult if it's just the two of us. In the future, we might get extra people in the room to help out. Keeping the students on task was occasionally an issue, mostly due to chatter.
- More background: Some of the students found the Web site hard to work with, or still had a lot of trouble researching their learning issues while we were in the computer lab. They might have benefited from spending more time doing background reading and taking notes from their textbooks.

Resources

Assembling the most useful of the following online sources as links on a Web page that the students can access in the computer lab or at home is a very efficient way to structure group or independent research. Also, the students should be encouraged to utilize their textbooks and other print resources. These are some helpful resources; a selection of these was included on the "Lab Spill!" page of the PRISM Web site at http://www.prism.emory.edu/columbia_middle

A great online source for lots of information about melting points, boiling points, atomic number/mass, some physical properties and lots more about all of the elements in the periodic table!

Bender, Y. (2004) An online, interactive periodic table of the elements. Retrieved September 20, 2004 from http://chemicalelements.com/

Identifying unknown substances:

Michigan Reach Out! (2004). Identification of an unknown substance. Retrieved September 20, 2004 from http://www.reachoutmichigan.org/funexperiments/quick/csustan/unknown.htm

The Shodor Education Foundation, Inc. (2003). Identifying unknown substances. Retrieved September 20, 2004 from http://www.shodor.org/succeed/forensic/substance.html

Chemistry Tutor. (2003). Common laboratory tests. Retrieved September 20, 2004 from http://library.thinkquest.org/2923/tests/html

Separation of mixtures:

Park, J. L. (2003). Section 2.6: Separation of mixtures. Retrieved September 20, 2004 from http://dbhs.wvusd.k12.ca.us/webdocs/Matter/2.6SeparationOfMixtures.html

BBC-GCSE Bitesize. (2004). GCSE SOS teacher: Chemistry. Retrieved September 20, 2004 from http://www.bbc.co.uk/schools/gcsebitesize/chemistry/sosteacher/chemistry/38786.shtml

A nice activity for teachers to incorporate if they want a more complex lab activity:

Riley, P. A., Henson, V., & Doyle, P. (2004). Separation of mixtures and compounds for K through 12. SMILE Program Chemistry Index. Retrieved September 20, 2004 from http://www.iit.edu/~smile/ch9130.html

What the heck does Haz-Mat mean?

PHMSA. (2004). Office of hazardous materials safety. Retrieved September 20, 2004 from http://hazmat.dot.gov/toc.htm

States of Matter:

Andrew Rader Studios. (2004). States of matter. Retrieved September 20, 2004 from http://www.chem4kids.com/files/matter_intro.html and http://www.chem4kids.com/files/matter_states.html

Very Cool Animation:

Harcourt School Publishers. (2004) States of matter. Retrieved September 20, 2004 from http://www.harcourtschool.com/activity/states_of_matter/

Carpi, A. (2004). Matter: States of matter. Visionlearning, Inc. Retrieved September 20, 2004 from http://www.visionlearning.com/library/module_viewer.php?mid=120

Kurtus, R. (2003). States of matter. Retrieved September 20, 2004 from http://www.school-for-champions.com/science/matterstates.htm

Acids and Bases:

Andrew Rader Studios. (2004). Chemical reactions: Acids and bases are everywhere. Retrieved September 20, 2004 from http://chem4kids.com/files/react_acidbase.html

The Basics of Stoichiometry:

Andrew Rader Studios. (2004). Chemical reactions: Stoichiometry. Retrieved September 20, 2004 from http://chem4kids.com/files/react_stoichio.html