Lesson Title	Lab Safety - Part 2
Length of Lesson	90 min
Created By	David Wilson
Subject	Chemistry / Physical Science
Grade Level	9-12
State Standards	None / 1a
DOK Level	DOK2
DOK Application	Develop, Use, Generalize
National Standards	9-12: B: Physical Science, F: Science in Personal and Social Perspectives, and G: History and Nature of Science
Graduate Research Element	Safety in the laboratory is essential for survival in any research laboratory.

Student Learning Goal:

State Standards: (Physical Science)

1) Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK2)

National Science Standards: (9-12)

B: Physical Science: Chemical Reactions.

- Chemical reactions occur all around us, for example in health care, cooking, cosmetics, and automobiles. Complex chemical reactions involving carbon-based molecules take place constantly in every cell in our bodies.

- Chemical reactions may release or consume energy. Some reactions such as the burning of fossil fuels release large amounts of energy by losing heat and by emitting light. Light can initiate many chemical reactions such as photosynthesis and the evolution of urban smog.

F: Science in Personal and Social Perspectives: Personal and Community Health

- Hazards and the potential for accidents exist. Regardless of the environment, the possibility of injury, illness, disability, or death may be present. Humans have a variety of mechanisms—sensory, motor, emotional, social, and technological—that can reduce and modify hazards.

G: History and Nature of Science: Historical Perspectives

- In history, diverse cultures have contributed scientific knowledge and technologic inventions. Modern science began to evolve rapidly in Europe several hundred years ago. During the past two centuries, it has contributed significantly to the industrialization of Western and non-

Western cultures. However, other, non-European cultures have developed scientific ideas and solved human problems through technology.

Materials Needed (supplies, hand-outs, resources):
Be Careful and always read the Materials Safety Data Sheet (MSDS) written for chemicals you use. Federal Law requires the vendors of chemicals to provide MSDS sheets for all their chemicals

(All quantities specified here are for approximately one class.)

1) Ira Remsen Demonstration

- 1- penny
- 10 milliliters of concentrated nitric acid
- 2- 500-600 milliliter Erlenmeyer flasks
  - one rubber stopper to fit one of the flasks well
  - one short (long enough to poke out ~1 inch above and below the rubber stopper ends when inserted into the rubber stopper.)
  - ~1-1.5 feet of rubber tubing into which the glass tubing can snuggly be inserted.
- ~ 400 milliliters of water in one of the flasks (the one without the stopper)

2) Cooking Oil Video

- A very good PSA video about kitchen grease fires exists, and can be found on youtube: http://youtu.be/X6ezSxxwM3U
- Other good safety videos can be found there as well.

3) Magic Candle

- 3-4 candle sticks
- one large glass mug.
- BE VERY CAREFUL!! Jam the candles down into the mug, and light them. Allow the wax to melt down into the mug. When this is done, you should have one big candle mug with several wicks. When these wicks are all lit, there is a larger potential for the candle to develop into a moderately sized grease fire. So, 1) have some way to put out the fire if it becomes uncontrollable (i.e. a lid for the cup or an extinguisher.) 2)When you put out the candle each time, get rid of the excess, melted wax.
- What to do: Lit the candles. Allow them to remain lit for 10-15 seconds, then bow them out. Before blowing them out, have a match lit and ready. Once you blow them out, the smoke will turn white (this is wax vapor, not smoke.) While there is still lots of white vapor immediately after blowing the candles out, wave the lit match through the white vapor (not too near the wicks) and the wicks will relight by themselves. This is because the vapor is flammable - - not the liquid wax. The function of a wick is to liberate the vapor so it will burn.

4) Fire Trail

- 1, angle iron (Anything of this shape will work, but angle irons work very well since they are sturdy and NOT FLAMMABLE. There should be no holes in the angle iron. The iron should be ~5 feet long to add drama to the demo…or longer.)
- ~ 50 mL of petroleum ether. (READ THE MSDS on the storage of this. It will probably tell you to store it at 4^{o}C in a refrigerator and to not store it for more than about 3 years since it becomes more and more terribly harmful over time.)

5) Fire Extinguisher Training - - This should be given by the Local Fire Department Educators.

- Fire extinguishers (Ask your local fire department to help you determine how many you'll need. Your school district's maintenance department can tell you where to rent the extinguishers from.)
- Some large open space available outside your building. (The fire department can help you locate a safe one.)
- (The rest should be provided by your local fire department.)

6) Lab Map Quiz

- Copy a map of the chemistry lab. See below for a description

Lesson Performance Task/Assessment:

Students will

- Recite and discuss lab safety protocols
- Gather experiences needed to critically think about how to improve their own safety in the lab.
- Learn to use a fire extinguisher.
- Observe the effect of an acid splashing on a cow eye (a model human eye).
- Identify the location of safety equipment in the lab.
- Explain how the lab safety equipment is properly used.
- Evaluate the mistakes made during Ira Remsen's experience with a lab accident.
- Observe the effect of a flame near solvent vapors.
- Describe the fire triangle.
- Demonstrate what should be done in the event of a fire of several different types.

Lesson Relevance to Performance Task and Students:

This lesson will prepare students to work safely in the laboratory. This lesson will also give students a broader understanding of the purpose of safety protocols and warnings and the very real consequences of not following those protocols. This lesson will encourage students to be mindful of their personal health and safety outside the lab as well.

Anticipatory Set/Capture Interest:
The Ira Remsen demonstration should be the first thing presented to the class at the beginning of day. The chemical reaction is dramatic. Once finished, the students will identify what Dr. Remsen did unsafely with respect to his first chemical investigation, and they will propose a correction to the unsafe behavior.

Guided Practice:
The teacher will lead the students in several broad discussion of various safety scenarios, beginning with Ira Remsen's experience, including the flam trail, the kitchen fire PSA, magic candle, etc. The teacher and firefighters will demonstrate and instruct students on how to properly put out a fire.

Independent Practice:
Students will demonstrate their understanding of lab safety by drawing a map detailing the location and purpose of all the safety equipment in the laboratory. Students will put out a small, chemical fire with a fire extinguisher, under the supervision and direction of the firefighters. Students will finish the lesson by taking a short safety quiz.

Remediation and/or Enrichment:
Remediation: Individual IEP.
Enrichment: Because of the nature of the demonstrations and activities, there will be no time for enrichment activities. The entire class will explore safety together.

Check(s) for Understanding:
Understanding will be evaluated by the ability of a student to extinguish the small, chemical fire, the results of the safety map and quiz, and the participation in the class discussions.

Closure:
The teacher will ask the students to relate what they learned about lab safety in response to proposed problems. For example, Question: "If I came to school with a long sleeve button down shirt, what would I have to do before going to lab?" Answer: "Fold the sleeves up."

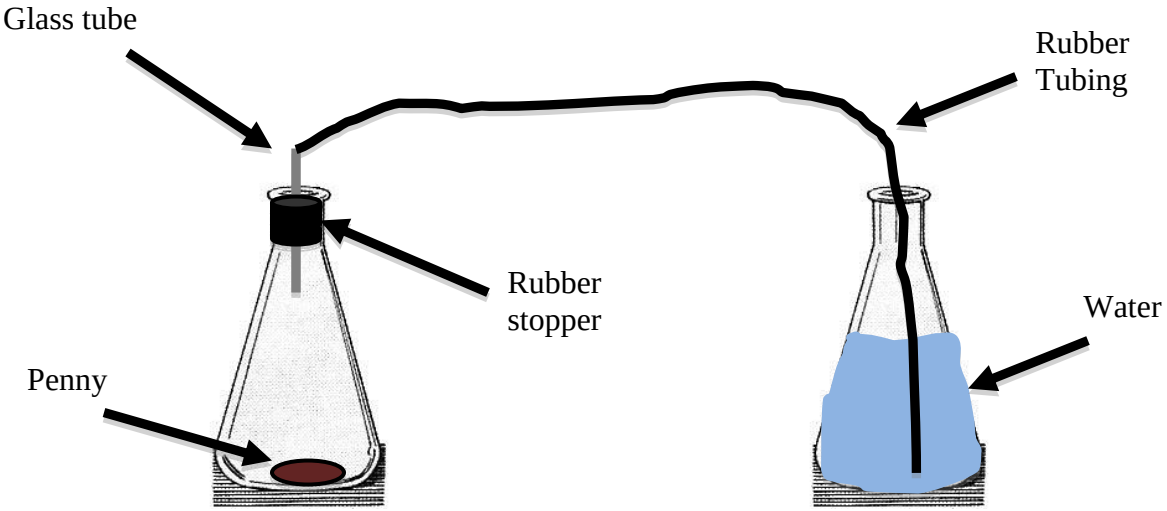
Possible Alternate Subject Integrations:
Biology. An investigation into the effects observed on the eye after the acid spill. Why did the effect happen? What biomolecules might be responsible for the change in physical and chemical properties of the eye? -or- Predominately, what biomolecule was effected by the acid, and how did the biomolecule respond?

Teacher Notes:
1) Ira Remsen Demonstration

There are many different way the chemistry teachers do this demonstration. There are many different styles and apparatuses as you can see if you google the demonstration. Also, there are a few good videos on youtube.com, which might help you in your preparation. PLEASE, do this demonstration a few times by yourself first.

Something to remember, nitric oxide (a brownish red vapor) is produced in this demonstration. This is a noxious, toxic gas, so be careful that your apparatus properly contains this gas. The apparatus I prefer is shown below in a crude graphic. You can see a similar apparatus here:
http://www.chemmybear.com/demo.htm

Please note, the bubbling of the gas into water is sufficient to confine it. The gas is very soluble in water. You simply need to add nitric acid to the copper penny, stopper the flask, and read the associated story titled "Nitric Acid Acts Upon Copper." Then, discuss what safety protocols Ira Remsen did not follow.



If you let the flask with the penny cool after the reaction, the reaction flask will draw water from the water flask and the solution produced will be a nice blue color. Also, to clean up, just put the reaction flask in the hood, and unstopper it with the fume hood on. Then, pour water into the reaction flask.

2) Fire Trail

First, do not pour the petroleum ether liquid…only pour the vapor (the vapor is very dense, and will flow like a liquid from the container, even though you can't see it – YOU WILL smell it.) It is the vapor above a liquid which burns, not the liquid. That is what you will demonstrate with this demonstration. Why is hairspray a bad idea in a chemistry lab? Because it can catch fire 3 feet from a flame.

So, light a candle at one end of the angle iron, and lift the other end and support it with a ring stand (~3 feet high). Pour the vapor of the petroleum ether from a

small-mouthed flask, not a beaker. See this video for a demonstration: http://youtu.be/PsaWg20mBXE

3) Fire Extinguisher Training
You will not do this on your own. That could be illegal. The fire educator at your local fire department will do this training for you and your students, so work with him/her on this.