Lesson Summary:
The purpose of this lesson is to teach students to develop scientific habits of mind as they choose appropriate tools and relevant safety procedures to complete scientific investigations. Using a graphic organizer, students draw lab tools used in earth, physical, and life science experiments, and explain their uses. Students also explore safety rules for the experiments. Comparison of tools and safety rules allows students to understand the importance of safe practices in the science lab.

Estimated Duration: One hour and 30 minutes

Commentary:
Success in the laboratory requires student familiarity with tools and safety procedures. The pre-assessment is designed to test student knowledge while capturing their attention, as students try to identify the safety procedures that the teacher purposefully violates. The body of the lesson tests the observational and thinking skills of the students as they visualize the procedures that would be employed in real laboratory experiments. The lesson is best used at the beginning of the year as an introduction to laboratory safety, but can be used multiple times throughout the year.

This lesson was pilot-tested by teachers across the state of Ohio. Some of the teacher comments about this lesson follow:

- "I would recommend this lesson to others. This lesson really helped the students see the importance of lab safety."
- "Students enjoyed the lesson- it was challenging for them and really required them to use their knowledge of safety rules and tools."
- "The answers (to questions in this lesson) are not black and white…allow plenty of opportunity for higher-level thinking."
- "This will be the lesson that I use at the beginning of the year to introduce science safety procedures."
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Pre-Assessment:
• Model unsafe lab practices, while performing a simple experiment in front of the class.
• Try to break 10 safety rules, using the following list as a template.

1. Hair is down and in front of eyes.
2. Teacher drinks from beaker.
3. Safety glasses are on top of head.
4. Science equipment is mixed with books, pop can, book bag, textbooks, etc.
5. Chemical bottles have no labels.
6. Burner is left on unattended.
7. Chemicals (colored water labeled poison) are touched without gloved hands.
8. Safety rules poster is thrown in the trashcan.
9. Live animal is not in cage.
10. Chair is placed in front of classroom door.

• Have students record what the teacher does incorrectly on a sheet of notebook paper.
• Assess student understanding of safety issues using the following rubric.

Scoring Guidelines:

<table>
<thead>
<tr>
<th>Depth of Understanding</th>
<th>Level 4 Excellent</th>
<th>Level 3 Good</th>
<th>Level 2 Needs Improvement</th>
<th>Level 1 Unacceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 safety violations listed</td>
<td>9 safety violations listed</td>
<td>8 safety violations listed</td>
<td>7 and below not an acceptable level</td>
</tr>
</tbody>
</table>

Post-Assessment:
• After instruction, have students read about one earth, one life and one physical science experiment, in Attachment A, Post-Assessment Reading.
• Have students complete the chart in Attachment B, Post-Assessment Table, referring back to the labs in Attachment A.

Students complete the chart by listing the tools used, what safety rules apply and why these tools are appropriate.
• Score the post-assessment.

Scoring Guidelines:
See Attachment C, Post-Assessment Answers and Attachment D, Post-Assessment Rubric for judging student performance on the post-assessment table.
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**Instructional Procedures:**
1. After the pre-assessment, have an overhead entitled: Common-Sense Safety Rules. See Attachment E.
2. Have students take notes on the basic safety rules presented. Ideally, students will put these notes on a sheet of paper and permanently affix it to their laboratory notebook. If the teacher uses a laboratory safety contract to assure that students understand safety issues, this would be an opportunity to have these contracts signed.
3. Have science experiment tools at a demonstration area. See Attachment F, *Tool Safety Chart*, for a list of common laboratory tools. The tool list may be adjusted to reflect the tools that students will encounter in a specific laboratory.
4. Distribute the Tool Safety Chart to students.
5. Hold up a tool or picture of a science tool and have the students name it, draw a picture of it, tell how it is used and describe an appropriate safety rules in an interactive class discussion.
6. Have students enter the information into their charts. Refer to Attachment G, *Tool Safety Chart Answers*, to help guide the discussion.

**Differentiated Instructional Support:**
Instruction is differentiated according to learner needs, to help all learners either meet the intent of the specified indicator(s) or, if the indicator is already met, to advance beyond the specified indicator(s).
- Students working beyond the standards could research tools and safety related to college-level science labs.
- Lesson provides many opportunities for students to engage in hands-on activities and modeling of safety procedures.

**Extensions:**
- Safety, tools and scientific investigation will vary with each lab experiment. Real-life relationships will be made for each lab. Students will gain experience choosing tools and practicing safety in real-life situations.
- With prior permission, students may choose an activity that extends safety and tools and demonstrate their expertise on paper or in demonstrations to the class.

**Homework Options and Home Connections:**
- Research a scientific investigation or discovery and try to determine what tools or instruments were used and what safety procedures were addressed.
- Have students watch or prepare dinner for their families, draw a picture of tools used, define their use, record a safety issue with the kitchen tool and explain why the tool and safety issue is appropriate.
- Investigate appropriate Web sites, textbooks or other sources to learn more about safety procedures used during scientific investigations.
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Materials and Resources:
The inclusion of a specific resource in any lesson formulated by the Ohio Department of Education should not be interpreted as an endorsement of that particular resource, or any of its contents, by the Ohio Department of Education. The Ohio Department of Education does not endorse any particular resource. The Web addresses listed are for a given site’s main page, therefore, it may be necessary to search within that site to find the specific information required for a given lesson. Please note that information published on the Internet changes over time, therefore the links provided may no longer contain the specific information related to a given lesson. Teachers are advised to preview all sites before using them with students.

For the teacher:  Beaker, pan balance, safety goggles, microwave oven, microscope, thermometer, magnifying lens, heat resistant mitts, timer, scissors, or additional lab equipment that is regularly used in science classrooms at your school.

For the students:  Beaker, pan balance, safety goggles, microwave oven, microscope, thermometer, magnifying lens, heat-resistant mitts, timer, scissors, additional lab equipment that is regularly used in science classrooms at your school.

Vocabulary:
• balance
• beaker
• magnifying lens
• microscope
• safety goggles
• thermometer

Technology Connections:
Have students evaluate tools for online experiments or online science fair projects, and cite applicable safety rules if the experiment were to be completed in the laboratory.

Research Connections:

Nonlinguistic representations or imagery mode helps students think about and recall knowledge. This includes the following:
• Creating graphic representations (organizers);
• Making physical models;
• Generating mental pictures;
• Drawing pictures and pictographs;
• Engaging in kinesthetic activity.
General Tips:

- This lesson is easily modified to meet particular classroom equipment, tools and safety standards.
- The Web site http://csss.enc.org will provide more information on laboratory safety. On the Web page, go to the section entitled Science Safety.

Attachments:
Attachment A, Post-Assessment Readings
Attachment B, Post-Assessment Table
Attachment C, Post-Assessment Answers
Attachment D, Post-Assessment Rubric
Attachment E, Common Sense Safety Rules
Attachment F, Tool Safety Chart
Attachment G, Tool Safety Chart Answers
Attachment A

Post-Assessment Readings

After reading this Physical Science Experiment, on the Post-Assessment Table list the tools needed to test the hypothesis: “For every force, there is an equal and opposite force.” List applicable safety rules and evaluate why these are appropriate.

Objective: Newton’s Third Law of Motion is demonstrated with escaping air as the action force.

Description: In this experiment, students construct a balloon-powered rocket car that rolls across the floor because air is forced to escape through a plastic straw.

Procedure:

1. Using a ruler, marker, and drawing compass, draw a rectangle about 7.5 cm by 18 cm and four circles 7.5 cm in diameter on the flat surface of a foam tray or cardboard. Cut out each piece.
2. Inflate a balloon a few times to stretch it. Slip the nozzle over the end of the flexi-straw nearest the bend. Secure the nozzle to the straw with tape and seal it tightly so that the balloon can be inflated by blowing.
3. Tape the straw to the top of the rectangle.
4. Push one pin into the center of each circle and then into the edge of the rectangle. The pins become axels for the wheels. Do not push the pins in snugly because the wheels have to rotate freely. It is ok if the wheels wobble.
5. Inflate the balloon and pinch the straw to hold in the air. Set the car on a smooth surface and release the straw.
After reading this Life Science Experiment, on the tool Post-Assessment Table, list the tools needed to test the hypothesis: “How do you think the temperature of water affects the breathing rate of fish?” List the applicable safety rules and evaluate why these safety rules are applicable.

Objective: Determine if changing the temperature of the water affects the respiration rate of fish.

Description: In this experiment, students measure the temperature of the water inhabited by a goldfish by placing the fish in a beaker and setting the beaker in a larger container of water. The temperature of the larger container adjusts the temperature of the small beaker. Students will record the number of breaths taken by the fish at room temperature, at 14-20 °C and 5-9 °C. Students will graph the results.

Procedure:
1. Start with a goldfish in a beaker with room temperature water. Record the temperature of the water and record the number of breaths the fish takes at room temperature.
2. Use an empty bowl and add icy water. Place the fish beaker in the ice bath.
3. Place the thermometer in the fish’s beaker and watch as the temperature slowly changes. When the temperature in the fish’s beaker is in the 5-9 °C range, record the respiration rate again. Do not cool the water lower than 5 °C.
4. Using a microwave, heat water in the bowl, place the fish’s beaker in the warm-water bath and record the respiration rate again when the fish beaker reaches 14-20 °C. Do not heat the water above 20 °C. After the experiment, immediately return the fish to water that is room temperature.
After reading this Earth Science Experiment, on the Post-Assessment Table, list the tools needed to test the hypothesis: “Why are rocks that are found in rivers and streams smooth?” List the applicable safety rules and evaluate why these rules are applicable.

Procedure:

1. Select a brick or cinder block and a hammer.
2. Wearing safety goggles, break the block into pieces with sharp blows of the hammer. Roll the bricks in fabric or newspaper to prevent chips from injuring the student breaking the brick as well as other students in the room.
3. Pick up the brick pieces and examine how sharp its edges are by feeling it. You may also examine it with a magnifying lens. Weigh the brick pieces on the pan balance. Make a table to record your findings. The table should include the shape of the brick pieces and their weight.
4. After examining the piece of brick, put all of the pieces inside a plastic jar, fill it with water and seal the lid.
5. Taking turns with teammates, each of you shake the jar about 100 times.
6. After everyone has had a turn shaking the jar, remove the pieces of brick and re-examine and reweigh them for any differences. What happened? Record your findings.
Name____________________

<table>
<thead>
<tr>
<th></th>
<th>Earth Science Experiment</th>
<th>Physical Science Experiment</th>
<th>Life Science Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Considerations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluate why these tools appropriate</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Write the name of the experiment in the first box in each row. Compare the tools and safety rules for two of the experiments. How are they similar? How are the tools and safety considerations different?

<table>
<thead>
<tr>
<th></th>
<th>Alike</th>
<th>Different</th>
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</thead>
<tbody>
<tr>
<td>Science Experiment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science Experiment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Name____________________

<table>
<thead>
<tr>
<th>Tools</th>
<th>Earth Science Experiment</th>
<th>Physical Science Experiment</th>
<th>Life Science Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnifying lens</td>
<td></td>
<td>Four pins</td>
<td>Beaker</td>
</tr>
<tr>
<td>Pan balance</td>
<td></td>
<td>Styrofoam meat tray</td>
<td>Large container</td>
</tr>
<tr>
<td>Plastic jar</td>
<td></td>
<td>Tape</td>
<td>Thermometer</td>
</tr>
<tr>
<td>Four pins</td>
<td></td>
<td>Flexi-straw</td>
<td>Microwave</td>
</tr>
<tr>
<td>Styrofoam meat tray</td>
<td></td>
<td>Balloon</td>
<td></td>
</tr>
<tr>
<td>Tape</td>
<td></td>
<td>Scissors</td>
<td></td>
</tr>
<tr>
<td>Flexi-straw</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balloon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scissors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beaker</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large container</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermometer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microwave</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Safety Considerations

**Earth Science**
- Wear apron and safety goggles.
- Don’t set the pan balance too near the edge of the workspace.
- Make sure the seal on the plastic jar is tight before shaking the brick pieces.

**Physical Science**
- Wear apron and safety goggles.
- Be cautious when using sharp instruments, scissors and pins.

**Life Science**
- Wear apron, gloves and safety goggles.
- Use heat-resistant mittens to remove hot water from microwave.
- Don’t put ice in your mouth.
- Handle the fish carefully.

**Explain why these tools are appropriate.**

**Earth Science**
- Magnifying lens will make the drawing more detailed.
- Pan balance is an accurate measuring tool.
- Plastic jar will not break.

**Physical Science**
- Pins are makeshift axles. Tape is a lightweight adhesive. Flexi-straw and balloon demonstrate escaping air is an action force.
- Scissors are an appropriate cutting tool.

**Life Science**
- Beaker allows visibility for experiment data.
- Large container holds hot/ice to measure fish respiration.
- Thermometer accurately measures temperature changes.
- Microwave safely heats without an open flame.
## Earth Science Experiment

<table>
<thead>
<tr>
<th>Alike</th>
<th>Different</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tools that measure:</strong> Pan balance measure weight</td>
<td>Magnifying lens enlarges Safety</td>
</tr>
<tr>
<td><strong>Tools that contain:</strong> Plastic jar</td>
<td>Pan balance in a secure location</td>
</tr>
<tr>
<td><strong>Safety:</strong> Follow directions</td>
<td>Jar lid secure to prevent spills</td>
</tr>
<tr>
<td>Wear apron, safety goggles</td>
<td></td>
</tr>
</tbody>
</table>

## Life Science Experiment

<table>
<thead>
<tr>
<th>Alike</th>
<th>Different</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tools that measure:</strong> Thermometer measures temperature</td>
<td>Microwave heats Safety</td>
</tr>
<tr>
<td><strong>Tools that contain</strong> Beaker and large container</td>
<td>Mittens are needed for holding hot water container</td>
</tr>
<tr>
<td><strong>Safety:</strong> Follow directions</td>
<td>Never put any science experiment ingredient in your mouth unless instructed to do so.</td>
</tr>
<tr>
<td>Wear safety goggles</td>
<td>Live animals need special care.</td>
</tr>
</tbody>
</table>
Safety, Tools and Scientific Investigation Rubric

Student’s name _______________________

<table>
<thead>
<tr>
<th>Level 4</th>
<th>Level 3</th>
<th>Level 2</th>
<th>Level 1</th>
<th>Level 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three earth, six physical and four life science tools were correctly identified. (May have included more.)</td>
<td>A combination of twelve tools were correctly identified in the earth, physical and life science experiments.</td>
<td>A combination of eleven tools were correctly identified in the earth, physical and life science experiments.</td>
<td>A combination of ten tools were correctly identified in the earth, physical and life science experiments.</td>
<td>No judgment can made about the student’s ability to detect tools used in science experiments.</td>
</tr>
<tr>
<td>Has a complete understanding of four earth, three physical and five life science experiment safety rules.</td>
<td>Has a combination of eleven safety rules from the earth, physical and life science experiments.</td>
<td>Has a combination of ten safety rules from the earth, physical and life science experiments.</td>
<td>Has a combination of nine safety rules from the earth, physical and life science experiments.</td>
<td>No judgment can be made about the student’s ability to understand safety in science experiments.</td>
</tr>
<tr>
<td>Proper tool information is accurately and thoughtfully explained.</td>
<td>Proper tools information is explained but not in detail.</td>
<td>Incomplete tool information is explained.</td>
<td>Proper tool information is poorly understood.</td>
<td>No judgment can be made about the student’s ability to understand safety in science experiment.</td>
</tr>
</tbody>
</table>
Common Sense Safety Rules

1. Read and sign lab safety contract.
2. Science experiments can be dangerous. Things can spill, break or even catch fire. Be prepared.
3. Read and follow directions for each experiment and be careful.
4. Stay in your area and walk from place to place.
5. Respect live plants or animals.
6. Carefully handle chemicals or hot things.
7. Wear appropriate protective equipment.
8. Use specified amounts accurately.
9. Never put anything in your mouth unless instructed to do so.
10. Secure hair, clothing, glasses, etc., so as not to interfere with experiment.
11. Keep workspace and floor clean.
12. Dispose of supplies according to specified directions.
Tool Safety Chart

Student Name_____________________

<table>
<thead>
<tr>
<th>Tool and Drawing</th>
<th>Use</th>
<th>Safety Rule(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pan Balance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Goggles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microwave Oven</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Tool Safety Chart

<table>
<thead>
<tr>
<th>Tool and Drawing</th>
<th>Use</th>
<th>Safety Rule(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microscope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermometer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnifying Lens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tool and Drawing</td>
<td>Use</td>
<td>Safety Rule(s)</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----</td>
<td>---------------</td>
</tr>
<tr>
<td>Timer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scissors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Tool Safety Chart Answers

<table>
<thead>
<tr>
<th>Tool and Drawing</th>
<th>Use</th>
<th>Safety Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaker</td>
<td>To hold liquid and pour</td>
<td>Handle carefully. Do not drop or strike.</td>
</tr>
<tr>
<td>Pan Balance</td>
<td>To measure weight</td>
<td>Set on a secure surface.</td>
</tr>
<tr>
<td>Safety goggles</td>
<td>To protect eyes</td>
<td>Always wear in the lab.</td>
</tr>
<tr>
<td>Microwave Oven</td>
<td>To heat, cook, thaw and dehydrate</td>
<td>Use heat-resistant mitts to remove hot items.</td>
</tr>
<tr>
<td>Microscope</td>
<td>To examine minute objects with an enlarged, well-resolved image</td>
<td>Set on a secure surface.</td>
</tr>
<tr>
<td>Thermometer</td>
<td>To measure temperature</td>
<td>Handle carefully. Do not drop or strike.</td>
</tr>
<tr>
<td>Magnifying Lens</td>
<td>To produce a larger visual image of small objects</td>
<td>Handle carefully. Do not drop or strike.</td>
</tr>
<tr>
<td>Heat-Resistant Mitt</td>
<td>To handle hot or cold items</td>
<td>Wear to protect hands.</td>
</tr>
<tr>
<td>Timer</td>
<td>To measure time increments</td>
<td>Set according to experiment directions.</td>
</tr>
<tr>
<td>Scissors</td>
<td>To cut thin materials</td>
<td>Never run with scissors in hand. Use for intended purpose only.</td>
</tr>
</tbody>
</table>