Introductory

Introduction

These introductory experiments are some of the laboratory experiments and demonstrations designed to grab students' attention, pull their minds from predictable everyday classroom activities, give them something to look forward to, and teach them some simple principles and properties used by materials scientists. The experiments range from the corn starch experiment (thixotropy/dilatancy), messy but exciting, and the water-lock demonstration, to the free exploration with properties of metals experiments. The demonstrations and experiments are meant to be high-motivation experiences, high visibility, showing the fun of scientific experiments and that's it! Some theory of scientific principles can be taught here, but that is not meant to be the purpose of these experiments.

Guest speakers, field trips, and video tapes can be used with these introductory activities or with any of the experiments to help keep student interest and expectations elevated. There may be times when dissolving polystyrene in acetone or crunching on a marshmallow cooled by liquid nitrogen could be interjected into the agenda because you decide students need a change—a break in the routine. The activity may not have anything to do with the current course of study, but simply be a change.

Many other introductory or "grabber" labs have been developed that are not written up in this section but will be demonstrated during the Institute. It will be your responsibility to record these activities in your journal. This will put you in the position of student and learner. It will help you practice using a journal, giving it importance and relevance, and help you have a sympathetic attitude toward your students as they write up labs during the school year.

Before you immerse yourself in MST experiments and projects, remember that science and technology are not history. They are not meant to be taught from a textbook as if they were history. Similarly, experiments are not meant to be followed as recipes; use them as a means to solve problems students encounter in their projects or as they study a material. Materials research is conducted to find out what is not known. For students, some materials are unknowns. Use experiments as a way to let students discover, make mistakes, and learn about new or better ways to perform a procedure or process. Remember, in science there are no bad results, only poorly designed experiments and another chance to learn!

Water Lock
Instructor Notes

Reliability

This demonstration always works.

Estimated Time for Activity

One class period.*

Teacher Tips

1. Source of sodium polyacrylate: *Flinn Scientific*
2. Sodium polyacrylate (water lock) is a superabsorbent polymer. This powder can instantly absorb more than 800 times its weight in deionized water. The more ions present in the water, the more sodium polyacrylate will be needed to absorb the liquid. This material is commonly used as the absorbent material in disposable diapers. It is also used in potted plants to help the soil store water.
3. The quantity of sodium polyacrylate needed to demonstrate the application of this material depends on the size of the beaker of water. Before the demonstration, determine the amount of water lock necessary to perform this demonstration. Simply add known amounts of water lock, and stir until the liquid gels.
4. Note how such a simple idea is of such large commercial value. You could include a discussion of the economics of engineering, i.e., how much money was spent last year on disposable diapers, paper towels, and newsprint.
5. You may also want to consider the “cradle-to-grave” history of this material. Where does it come from? How do we dispose of it? Can it be recycled?
6. Use this as a journal write activity. Have students write possible uses they think this material is good for.
7. In a class or small group discussion, have students share their ideas about this material. They can hypothesize about how the water lock works. Have the students compare their hypotheses to what actually happens when you explain the scientific principle that applies to this demonstration in a classroom discussion at the end of this activity.

* One class period is approximately 1 hour.

Demonstration: Water Lock

Student Learning Objectives

At the end of the activity students will be able to:

- record observations in their journals
- discuss observations
- suggest explanations.

Materials

- Water
- 400-mL beaker

Equipment

- Spoon or scoop
- Sodium polyacrylate

Procedure

1. Show the class the beaker of water and have someone verify that it is water.
2. Take a small amount of sodium polyacrylate (Use about 1/2 teaspoon for a 400-mL beaker of water) and stir it quickly into the water.
3. Almost immediately, invert the beaker to show that the water is “all tied up.” (You might even try inverting the beaker over a student once you have developed some confidence in the demonstration.)
4. Pass the beaker around the classroom to allow students to observe and/or touch. Record their observations and thoughts in their journal.

Classification of Materials
Instructor Notes

Reliability

This activity involves all students and will begin to establish students' concepts of materials, their characteristics, and how this relates to function.

Estimated Time for Activity

One class period.*

Background

1. There are many places to get samples of materials. You can use old appliances, or go to junk yards, flea markets, or various industries. Materials are all around us. Know what the samples you have selected are. Be sure to include fibers like Kevlar, glass wool, fiberglass, and composite materials. Mylar and reflective mylar can be used to give students something to think about in classifying them.
2. Metals have identifying characteristics such as shine, hardness, ductility, and they conduct heat and electricity.
3. Ceramics tend to be hard, but brittle, stiff, and do not conduct heat or electricity as a rule.
4. Polymers are usually flexible, have a low density, are insulators, and burn.
5. Composites are combinations of any of the above materials. In some cases, no material by itself (metal, ceramic, or polymer) has the characteristics required for a particular use, so a combination of materials (composite) is used.
6. Classification is a higher level thinking skill. As students justify their placement of materials into certain categories, it gives them a chance to reinforce their ability to think critically about choices.
7. If you use pieces of glass or other objects with sharp edges, it may be wise to dull the edges using an abrasive. Warn students to be care-ful of sharp edges.
8. Once you have gathered samples, keep them in a box to ensure you retain good samples for next year. As you obtain different material samples, you can add them to the box, as appropriate.

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* One class period is approximately 1 hour.

Activity: Classification of Materials

Student Learning Objectives

At the end of the activity students will be able to:

- place a randomly selected material(s) into one of three categories: metal, ceramic, or polymer
- give the rationale for placing their material(s) into the category selected.

Materials

- An assortment of different materials taken from various sources in the environment. Examples include parts of appliances, fabrics, bottle fragments (both glass and plastic), nails, wires, fiberglass, and insulating materials. Be sure to include a few items that are composite materials so students will have to ponder where to place them. It is best to have at least one sample per student.

Procedure

1. Display the materials on a table or desk in front of the classroom.
2. On the table or desk, set aside space for three areas labeled metals, polymers, and ceramics where students may place an object after they have identified the material.
3. Have students, one at a time, select an object of their choice and place it in the category they feel is appropriate.
4. After students have categorized all objects, select various samples and have the students who classified those objects justify why they were placed in certain categories.

Material Systems
Instructor Notes

Estimated Time for Activity

Approximately two class periods.

Teacher Tips

1. This activity may seem very elementary, but it is designed to stimulate the students' thinking in areas of handiness, creativity, and the knowledge of materials.
2. Stress and strain are two terms that are often confused. Stress is defined as the resistance offered by a material to an external force. Although this is correct, stress is usually defined as the applied load. It is measured in terms of force exerted per unit force (N/M^2 or Pa in the metric system or lb/in^2 in the English system). Strain is the amount of deformation (binding, twisting, stretching) resulting from the stress. When a stress-causing force is applied, a strain results. If the strain exceeds the elastic limit of the material, the material has permanent deformation (bends, stretches, breaks).
3. Appliances of 20 or 30 years ago can be compared to modern appliances to evaluate changes in equipment design. One way to do this is to disassemble appliances that have 20- to 30-year differences in manufacturing time, and then compare the materials categories for any changes in types of materials used. You