



Starting the Year Out Right

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Grade Level:
3-12

Starting the Year Out Right

(A Beginning of the Year Inquiry Activity)

Purpose:

To help students gain practice in making observations and inferences and to give students an opportunity to experience a simple inquiry activity at the very beginning of the school year. Although this activity is designed for students entering high school chemistry with some laboratory experience, it can be easily modified for most students in grades 3 through 12.

Objectives:

Students will be able to:

- design and conduct a scientific investigation.
- use technology and math to communicate their findings.
- formulate and revise their findings using logic and evidence.
- practice good graphing skills
- communicate their findings to others.
- distinguish between an observation and an inference.

Materials:

- water
- vinegar
- ammonia
- mineral oil
- colorless detergent
- baking soda dissolved in water
- ice
- thermometers
- graduated cylinders (or other liquid measuring device)
- balance
- pH paper
- litmus paper
- liquid indicators
- rulers
- beads or marbles
- test tubes
- stop watches, any other measuring devices that you might want to make available to your students
- poster board
- markers
- graph paper
- a container or sink of warm soapy water.

I would recommend that students work in teams of three or four. Amounts needed are up to the instructor and will depend on how much of the material you are willing to allow

each group to have. Assigning jobs to the students may make this activity flow more smoothly and will help set the tone for the remainder of the school year. I suggest that all materials be placed on a cart or other central location that the students can easily see, but over which you will have control so that they are not tempted to set up their experiment before they have a plan. If students are not familiar with the concept of density you may wish to dispense the liquids in equal size amounts such as 20 mL in small graduated cups. Dispensing the liquids in predetermined amounts may also give you more control over chemical use.

Procedure

Day 1 (45 minutes)

1. To get things started, prepare a bottle with a large question mark label on it. Fill the bottle with water or any other clear liquid you wish. Ask the students, "What information would be helpful for you to know if you needed to determine the identity of the liquid in this bottle?" Help the students to generate a list of information that might help them determine the contents of the bottle.
2. Go over basic safety information---wearing a lab apron, wearing goggles, wafting, not tasting any chemicals, safe ways to handle thermometers. If you choose to do heating you will also have to go over safety with burners or heating plates and safe handling of hot glassware. Students can easily complete this activity without resorting to heating.
3. Students will be told that they will receive five or six colorless household liquids and that their job is to design at least two tests that will allow them to distinguish between the liquids. At least one of the tests must involve a measurement. More tests may be conducted if time allows.
4. During the planning stage, students will be encouraged to look through the materials list or look at the supply cart.
5. No test can be conducted or material checked out until the experiment has been approved and the following items prepared --- purpose, materials, procedure, data chart. (During the experiment, a member of the team can transfer this information to the poster board if the group is not comfortable writing on the poster board from the beginning).
6. Visit each lab group to make sure that they are on task and that they are not frustrated. They may need help with remembering things that they can measure or determine (possible ideas --- density, time for a bead to drop (viscosity), mass of a particular volume, odor, pH, effect on an indicator, etc.). As an inquiry practice, questions should lead them to some of these ideas but avoid telling them what to do. It will be better if they don't get too elaborate. Encourage them to watch their time. They will need to have all of their observations made and recorded before they leave class the first day. Be sure to leave time for students to clean up before the period is over.
7. For homework, ask the students to think about ways that they can organize/present their data to make it most meaningful to others in the class.

Day 2 (1 hour)

1. Students will be encouraged to share their ideas for organizing and presenting data with the class. (Hopefully this will lead to a discussion of graphing)
2. Briefly remind students of types of graphs and good graphing techniques. If this is an area where your students have had no experience you will need to extend this section and the activity will probably take more than one hour.
3. Have the groups get back together and complete their posters with organized presentation of data and at least one graph. In addition, they should develop a conclusion that explains how they would use the information they gathered to determine which of the liquids was in the unlabeled bottle if they could test the contents of the bottle. If they were unable to do this, how they would modify their experiment so that they could determine the identity. (This information can either go on the poster front, poster back, or on a separate piece of paper).
4. Students will present their posters, briefly, to the class. Have each team member be responsible for presenting a part of the poster. A grading rubric is included. It is helpful to allow the students to grade each other's posters.
5. After all posters are presented, generate questions from the students, discuss design problems, good lab practice, variables, controls, etc., and discuss differences between observations and inferences.

Safety Issues:

Be sure to remind students of the safe way to smell liquids, and also that they should not taste any of the substances, even if they seem like a food. Students should wear safety goggles and lab aprons. There is no danger involved if students choose to mix the chemicals with each other. If you plan to allow your students to heat the liquids you will need to give them instructions on the use of burners or hot plates and the safe handling of hot glassware. This activity can be easily done without heating.

Questions to Ask:

During **experimentation** phase:

1. As students are trying to determine testing methods, help them to think of ways that they have determined what something is at home (How would you determine the identity of a glass of liquid on your kitchen counter at home without tasting it?).
2. What lab techniques have you done in *previous* classes?
3. How do you make observations? (What senses do you use to make observations?)
4. What measurement could you make using the materials available on the cart?

During the **discussion** phase:

1. What is the difference between an observation and an inference? (An observation is only what the student's see or measure directly (color, mass, volume, smell, etc). An inference involves coming to conclusions about what has been observed (the liquid is water)).
2. What is the difference between mass and density? (Mass is a measure of how much matter is present and density is a measure of mass per unit volume.)

3. Which, mass or density, would make it easier to identify a liquid? (The liquid can be identified by using density (which is an intensive property meaning it does not depend on how much is present)).
4. Why can't you just use mass to identify the liquid? (Mass depends on the amount of material present (an extensive property) and would change with differing amounts of liquid.)

Where to Go From Here:

This activity could be used in several ways depending on the previous experiences of your students. If they already have experience in laboratory work than this is really a good beginning of the year activity with very little prompting by the teacher. If the students are unsure of themselves in the lab, this can still be used at the beginning of the year but your expectations for "elaborate" tests will be lower. Students do not have to measure density. In fact, measuring the mass of a volume of liquid can be very useful and lead to a wonderful discussion of density and the difference between mass and density. Regardless of the level of your students, the experiences from this lab can be used later in the year to begin discussions of physical properties, intensive versus extensive properties, pH and indicators, viscosity, etc.

References:

1. National Research Council. (1996) *National Science Education Standards*. Washington, DC: National Research Council.
2. Rezba, R.J., Giese, R.N., and Cothron, J.H. (January 1998). Graphing is a Snap. *Science Scope* 22(1): 20-23.
3. South Carolina Department of Education. (1998) *South Carolina Science Curriculum Standards*. Columbia, SC: South Carolina Department of Education
4. Textbooks on physical science, chemistry, physics often contain information on graphing and general physical properties that can be measured.

Suggestions for Assessment:

Poster presentations of experiments, results, graphs, and conclusion statements can be graded. A rubric can be developed assigning points to each section. If you want to insure future student participation, points can be included on group behavior and cooperation, as well as participation in the presentation process. Information about this grading should be made available to the students. An additional assessment might involve asking the students to design a graph using data generated during another lab. Students can also participate in the grading by grading other lab groups. This will make them much more aware of the components of good communication.

A Sample Student-Graded Rubric

Directions: Rate the group's poster presentation on the following scale. Use the score values found on the bottom of the page.

The poster was neat.	0 1 2 3 4 5
The poster was easy to see.	0 1 2 3 4 5
The team was easy to hear and understand.	0 1 2 3 4 5
The group's hypothesis was clearly stated.	0 1 2 3 4 5
The group's procedure was easy to understand and reproduce.	0 1 2 3 4 5
The data table was easy to read.	0 1 2 3 4 5
The graph was easy to read and understand.	0 1 2 3 4 5
The conclusion(s) was/were clear.	0 1 2 3 4 5
The conclusion(s) made sense in light of the data.	0 1 2 3 4 5

Team being graded: _____

Legend

0=not included

1=poor

2=needs some work

3=average

4=good work

5=excellent

Starting the Year Out Right (an inquiry lesson)

Student Activity Sheet

Purpose:

Design and conduct an experiment that will allow you to distinguish between five or six colorless liquids in at least two ways. At least one of the ways must involve a measurement.

Materials available: (you do not have to use everything)

- five or six different colorless liquids
- graduated cylinders
- balance
- pH paper
- litmus paper
- liquid indicators,
- rulers
- beads or marbles
- test tubes
- stop watches
- (poster board, markers, graph paper---for display)

Procedure:

1. Carefully look over the materials list. As a group think of ways that will help you distinguish between the liquids. Be sure to include at least one characterization that requires a measurement. Think back to previous science classes and previous experiences to come up with ideas. Settle on two or three ideas. You may not do any heating or tasting of anything. (See the instructor if you have an idea but can't find the equipment).
2. On poster board (or paper, if you would rather transfer to poster board later), list the following information --- purpose, materials, procedure, data chart. Put your names on the poster or paper.
3. Bring this information to the instructor to get your experiment approved.
4. Once your plan has been approved, get the materials you need from the supply cart. Only get one sample of each of the liquids. If you need more later ask the instructor.
5. Before beginning any experimentation, put on your goggles and lab aprons.
6. Conduct your planned experiment. If you discover during the course of your experiment that you need to modify your experiments, get the change approved by the instructor. Plan on finishing your experiments before the period is over.
7. Have one of the members of your group copy the information in your plan onto the poster board. Be sure your group member's names are on the poster.
8. Leave yourselves enough time to clean up your lab area. Use the soapy water located at your lab station. You can throw away the plastic cups.

Homework: Think of ways that you could organize the data that you collected to make it most meaningful to your classmates.

Day 2

9. Complete your poster by organizing your data into a table or chart, preparing a graph of the numerical data, and writing a conclusion. Your conclusion should include an explanation of how you can use your data to determine the identity of the mystery liquid. If you do not feel that you could determine which liquid was the mystery liquid, explain how you would modify your experiment.
10. You will be asked to present this to the class today. Decide which member of the group will present what information. Keep it short and simple. Everyone must talk.
11. Be prepared to judge other group's posters on a grading sheet.