# Laboratory Safety and Skills

**Strand** Scientific Investigation

**Topic** Investigating safety

**Primary SOL** CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include

a) designated laboratory techniques;
b) safe use of chemicals and equipment;
c) proper response to emergency situations;
d) manipulation of multiple variables, using repeated trials;
e) accurate recording, organization, and analysis of data through repeated trials;
f) mathematical and procedural error analysis;
g) mathematical manipulations including SI units, scientific notation, linear equations, graphing, ratio and proportion, significant digits, and dimensional analysis;
h) use of appropriate technology including computers, graphing calculators, and probeware for gathering data, communicating results, and using simulations to model concepts.

**Background Information**

This standard provides an introduction to chemistry skills and safety procedures in the chemistry lab. It introduces students to scientific vocabulary for chemistry, mathematical manipulations, and techniques for experimentation involving the identification and proper use of chemicals and equipment. Students become familiar with the recommended statewide standards for high school laboratory safety. It is intended that students actively develop scientific investigation, reasoning, and logic skills in the context of the key safety concepts presented in this standard.

The mixture for the "Percent Sand, Salt, Iron Filings, Mystery Substance in a Mixture" lab activity must be prepared prior to the beginning of the activity. Because the purpose of the activity is to practice safe techniques in the laboratory, exact measurements for the mixture are not necessary. When creating the mixture, keep in mind that you want students to be able to separate the mixture and retrieve enough of each substance to be massed. The mystery substance should be an insoluble substance, such as small plastic pellets. Students should be able to separate the various materials by different densities.

**Materials**

- Safety posters displayed throughout the lab
- Lab manual of safety procedures for each student
- Lab safety equipment (e.g., eye wash, safety shower, fire extinguisher, fire blanket) with appropriate signage
- Electronic slide presentation on lab safety (http://www.chem.unl.edu/safety/hslabcon.html)

- Copies of the "Percent Sand, Salt, Iron Filings, Mystery Substance in a Mixture" activity sheet (attached)
- Materials listed on the activity sheet

**Vocabulary**

*filtrate, solutes, solvent, solution*

**Student/Teacher Actions (what students and teachers should be doing to facilitate learning)**

1. Design a demonstration that provides students an opportunity to observe and identify laboratory safety violations. Instruct students not to disclose any of the violations until the completion of the demonstration. After the demonstration, have students work in pairs to identify the violations and the possible consequences of not following safety procedures.
2. Have students set up a KWL chart like the one shown below. Have students first list what they Know about appropriate lab safety procedures, and then have them list what they Want to know about lab safety. After they have completed their charts, have them share what they know and what they want to know, and list them on a class KWL chart.

| **KWL Chart—Topic: Lab Safety** | | |
|---|---|---|
| What I **Know** | What I **Want** to Know | What I **Learned** |
| | | |

3. Show the electronic slide presentation on lab safety. Discuss with the class the most important points.
4. Assist the class in developing a safety guide to be used in the laboratory.
5. Present a set of lab scenarios to students, and review in relation to each scenario the prevention of accidents in the lab and proper responses to accidents when they happen. These scenarios should include
   - acid splashing into eyes
   - hair catching on fire
   - broken glass cutting the skin and resulting bleeding
6. At this point, you may wish to have students act out violations of the various rules in the class safety guide to demonstrate their knowledge and understanding.
7. Have students complete their KWL charts by filling in the "What I Learned" column. Then, have them share their responses to fill in the class KWL chart.
8. Have students complete the attached "Percent Sand, Salt, Iron Filings, Mystery Substance in a Mixture" activity. The activity may be modified, based on the materials available.

**Assessment**

- **Questions**
  - Why is it important that the laboratory procedures be followed during laboratory investigations?
  - How can students help each other stay safe in a laboratory setting?
  - What should you do first if your lab partner spills hydrochloric acid?

- **Journal/Writing Prompts**
  - While completing an investigation, you notice another pair of students using materials in an incorrect manner. Describe how you would handle this situation.
  - Write about an experience in which lab safety procedures were not followed by students and how this situation could have been corrected or avoided.

**Extensions and Connections (for all students)**

- Have each student make a safety-related poster that focuses on one of the main safety topics, such as the use of goggles during a lab. The poster should include the rule and a visual depiction of the rule, such as a cartoon, sketch, or photograph.

**Strategies for Differentiation**

- Have students use copyright-free pictures from the Internet and/or visual picture communication symbols to create pictures of various types of equipment.
- Have students use graphic organizer software or a word processing program to create organizers to help pair equipment with procedures.
- Have students use software to create a flow chart to organize the steps in the procedure.
- Have students complete KWL and safety charts with visual picture communication symbols.
- Have students use highlighters or highlighting tape to flag key vocabulary and/or procedures.

# Percent Sand, Salt, Iron Filings, Mystery Substance in a Mixture

**Name:** _____ **Date:** _____

**Objectives**

In this activity you will practice techniques while separating mixtures, transferring solids and liquids quantitatively, filtering and washing solutes, and evaporating salt solutions to dryness.

**Safety**

1. You will use a variety of equipment and techniques in this activity. Make sketches of the equipment on the back of your activity sheet, and describe precautions you should be aware of before you work with them in the laboratory.
2. Read the procedure carefully. Write safety rules and precautions beside the steps in the procedure to highlight these before beginning the activity.
3. Obtain your teacher's approval on steps 1 and 2 before beginning the activity.

**Materials**

Electronic balance
Mixture in a cup
Magnet with material to cover
Erlenmeyer flask
Filter paper
Safety goggles
Funnel
Pipette
Ring stand
Pipe stem triangle
Hot water
Hot plate and/or burner
Graduated cylinder
Wire gauze
Evaporating dish
Wash bottle

| Procedure | Safety Rules and Precautions |
|---|---|
| 1. Mass the cup containing the mixture, two separate sheets of filter paper, and a clean, dry Erlenmeyer flask. Record these masses on your table. Use the wrapped magnet to remove the iron filings. Record the mass of the iron filings. | |
| 2. Prepare a filtering funnel with one sheet of filter paper, properly folding the paper. You may use a few drops of water to help position the paper in the funnel. This will be used to filter a water solution of the mixture. The flask will be used to capture the filtrate. Use a ring stand and pipe stem triangle to hold the funnel. Be certain the ring is cooled before use. | |
| 3. As you rotate the funnel, add the mixture into the dampened funnel. Try to cover the bottom half of the funnel with the mixture. Place the funnel in the ring, and position the flask to capture the filtrate. | |

| Procedure | Safety Rules and Precautions |
|---|---|
| 4. Place the graduated cylinder in the sink, and carefully pour about 60 mL of hot water into it. Wrap the graduated cylinder with several layers of paper towel to insulate it so you can transport it to your station safely before it cools. | |
| 5. Make sure the flask is underneath the funnel, and pour 5 to 10 mL of the hot water into the funnel. IMPORTANT: Pour small amounts of water into the funnel several times, because it is more efficient to wash a system several times with small amounts of water than once with a large amount. To save evaporation time, do not use more than 40 mL of water. | |
| 6. Devise a method for separating the sand from the mystery substance. You must separate the two substances and remove all the water—both the sand and the mystery substance must be completely dry before massing. Filtration will not work because both substances are insoluble in water. Remember to mass any piece of equipment prior to its use. If you need equipment that is not at your station, ask your teacher. | |
| 7. Place the flask on wire gauze on the ring stand. Place the remaining filter paper on top of the flask to prevent splattering. (Place it on the flask when about 1/2 the liquid has been evaporated). *CAUTION! Be careful not to allow the filter paper to catch on fire.* As you remove most of the liquid, the small amounts of liquid still present may generate steam, which can splatter large amounts of salt out of the dish when applying direct heat. Heat to complete dryness, and then stop heating immediately. Check with your teacher before discontinuing the heating. | |
| 8. Allow the dish and salt to cool to room temperature before massing. You should also find the masses of the sand and filter paper when they are completely dry. Complete all calculations, and answer the questions assigned at the end of the sample data sheet. Complete a full lab report. | |

**Data Table**

| Measurements | Mass in grams (g) |
|---|---|
| Mass of cup and mixture | g |
| Mass of two sheets of filter paper | g |
| Mass of Erlenmeyer flask | g |
| Mass of the recovered iron filings | g |
| Mass of sample cup | g |
| Mass of filter paper (evaporation) | g |
| Mass of filter paper (filtration) | g |
| Mass of filter paper and sand (dried) | g |
| Mass of recovered sand | g |
| Mass of flask, filter paper, salt (dried) | g |
| Mass of recovered salt | g |
| Mass of recovered mystery substance | g |

**Calculations**

Percent total mixture recovered:

(total mass of sand, salt, Fe filings recovered ÷ mass of total original mixture) × 100 =

Percent recovery of individual components:

(mass of sand recovered ÷ actual mass of sand) × 100 =

(mass of salt recovered ÷ actual mass of salt) × 100 =

(mass of Fe filings recovered ÷ actual mass of Fe) × 100 =

(mass of mystery substance recovered ÷ actual mass of mystery substance) × 100 =

**Lab Questions**

On a separate sheet of paper, answer the following questions:

1. Define *filtrate, solution, solvent,* and *solute.* Which substances in this lab acted as each of these?
2. Describe the appearance of the filtrate during the evaporation phase. Try to explain what you saw.
3. What effect would using far too much water to dissolve the salt have on the results?
4. What new procedure would you follow if you discovered that the filter paper had torn and some bits of sand and paper were in the evaporating dish along with the filtrate?

5. What are the possible cause(s) for a sand recovery greater than 100% and a related salt recovery of less than 100%?
6. What might be the explanation for a salt recovery greater than 100% with a sand recovery at or very near 100%?
7. Which acts to dissolve the salt more completely: one large rinse of water or several small rinses of water? Why? What are the effects of hot versus cold rinse water?
8. What other errors or poor techniques might result in incorrect results?
9. If you were to redo this experiment, how would you change the procedure?
10. What might the mystery substance be?