
Tools and Equipment in the PSAA Laboratory

Unit: Scientific Investigations

Problem Area: Tools and Methods of Scientific Investigation in Agriculture

Lesson: Tools and Equipment in the PSAA Laboratory

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

- 1** Explain the importance of tools and equipment in PSAA.
- 2** Identify common PSAA equipment.
- 3** Identify how to properly use a microscope.
- 4** Describe important activities in maintaining PSAA equipment.



List of Resources. The following resources may be useful in teaching this lesson:

- Carolina Catalog for Science and Math*. Burlington, NC: Carolina Biological Supply Company, latest edition.
- Catalog for Educational Products*. Jackson, MS: Forestry Suppliers, Inc., latest edition.
- Catalog for Forestry, Engineering, and Environmental Science*. Jackson, MS: Forestry Suppliers, Inc., latest edition.
- Jones, Allan, Rob Reed, and Jonothan Weyers. *Practical Skills in Biology*. New York, NY: John Wiley & Sons, Inc., 1994.
- Lee, Jasper S., Turner, Diana L. *AgriScience*. 3rd Edition. Upper Saddle River, New Jersey: Pearson Prentice Hall Interstate, 2003.
- Lee, Jasper S. *Program Planning Guide for AgriScience and Technology Education*. 2nd ed. Danville, IL: Interstate Publishers, Inc., 2000.
- Schraer, William D., and Herbert J. Stoltze. *Biology: The Study of Life*. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1993.
- Starr, Cecie, and Ralph Taggart. *Biology*. 7th ed. Belmont, CA: Wadsworth Publishing Company, 1995.

List of Equipment, Tools, Supplies, and Facilities

- ✓ Writing surface
- ✓ Overhead projector
- ✓ Transparencies from attached masters
- ✓ Copies of student lab sheets

Terms. The following terms are presented in this lesson (shown in bold italics):

- ▶ Apparatus
- ▶ Autoclave
- ▶ Balance
- ▶ Cleaning equipment
- ▶ Compound microscope
- ▶ Dissection equipment
- ▶ Glassware
- ▶ Heating equipment
- ▶ Lens
- ▶ Linear measurement
- ▶ Magnification power
- ▶ Maintenance
- ▶ Measuring equipment

- ▶ Microscope
- ▶ Objectives
- ▶ Objective lens
- ▶ Observation equipment
- ▶ Ocular
- ▶ Ocular lens
- ▶ Optical microscope
- ▶ PSAA equipment
- ▶ Safety equipment
- ▶ Scale
- ▶ Thermometer
- ▶ Tool

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Have several numbered laboratory tools on a table in front of the classroom. Give the students one minute to write down as many of the tools as they can identify. Once the minute is up, ask the students to name the tools that they observed. Explain why it is important in PSAA for students to know the names of the different tools and equipment that they will use to conduct their experiments in order to obtain accurate and reliable results.

SUMMARY OF CONTENT AND TEACHING STRATEGIES

Objective 1: Explain the importance of tools and equipment in PSAA.

Anticipated Problem: Why are tools and equipment used in PSAA?

- I. Tools and equipment are used to carry out experiments and perform jobs in PSAA. The distinction between tools and equipment is not precise.
 - A. A **tool** is any instrument that is used to do work. Tools often are known as equipment in PSAA. The tools and equipment used in PSAA are referred to as apparatus. **Apparatus** typically means all of the tools and equipment used together to perform a particular function. For example, all of the devices used in setting up a simple water distillation demonstration in a lab are the apparatus for water distillation.

1. **PSAA equipment** includes all of the implements used in laboratory work.
 2. The focus in this lesson is on tools used to perform science-based activities.
- B. PSAA equipment enables students to do things they could not do with their bare hands.
1. In some cases, bare hands would be injured by the materials or activities that are involved in the work. For example, the caustic chemicals used in some laboratory work would injure human tissues.
 2. PSAA equipment is strong and durable.
 3. PSAA equipment allows for precise measurements. When weighing materials in the laboratory, for instance, scales provide accurate measures.
 4. PSAA equipment makes it possible to use temperature to alter the state of material or to cause a reaction to occur.
- C. Tools and equipment allow students to do more work than they could do without them.

Achieving this objective should focus on clarifying the meaning of tools and equipment and listing reasons why they are used. Students may be called on to explain the meaning of the terms, tools, and equipment. The information may be summarized on the writing surface or presented using TM–A.

Objective 2: Identify common PSAA equipment.

Anticipated Problem: What equipment is commonly used in PSAA?

- II. PSAA experiments and research require the use of a number of different pieces of equipment.
- A. PSAA equipment may be classified by its use or by the materials used to manufacture it.
- B. **Glassware** is equipment that is made from glass. Examples include beakers, test tubes, and graduated cylinders. Glassware is available in different grades, with the best grades being used in research laboratories. The grades used in school laboratories are designed for student and teacher use and may lack some of the precision of the finer grades. Some glassware is heat-resistant and can be used when materials must be heated. Other glassware cannot be heated.
1. Some glassware is made out of plastic materials. This material resists breaking but often cannot be used with heat. If glassware is to be heated or placed in an autoclave, grades appropriate for this use should be selected.
 2. Safety is important with glass. Broken glass can result in cuts and injury.
 3. Common glassware items include: test tubes, beakers, graduated cylinders, flasks, funnels, sampling bottles, vials, jars, tubing, dropping bottles and droppers, and microscope slides and slide covers. Stoppers, lids, and other covering devices may be used with glassware containers. Racks and stands may be used to position glassware when it is in use or while it is being stored.

- C. **Measuring equipment** is apparatus used to determine quantity or dimensions. Most measuring equipment in PSAA uses the metric system, although the English system is widely used in agriculture. Some measuring devices report measurements in both the metric and English systems.
1. Thermometers are used in PSAA. A **thermometer** is an instrument for measuring temperature. The measurement is typically made using the Fahrenheit (F) scale or the Celsius (C) scale. Thermometers are used to measure the temperature of the air, liquids, soil, and other materials and environments.
 2. Balances and weighing scales are used in PSAA. A **balance** is an instrument that uses an equilibrium system for determining weight. Balances often are used in PSAA for precise measurements. Electronic balances are replacing pan and manual types of weighing devices. A **scale** is a device without an equilibrium system that is used to weigh materials. Systems of springs and dials often are used with scales to report weight in the metric or English system.
 3. Linear measurement is made with tapes, rulers, calipers, meter sticks, and electronic measurers that use light beams to determine distances to a target or location. **Linear measurement** is the distance between two points when measured in a straight line.
 4. Containers are used to measure the volume of a material. Graduated cylinders often are used for this purpose. Linear measurements can be used to determine the volume within a container, such as a box.
- D. **Dissection equipment** is the variety of devices used in dissecting organisms or their parts. Dissection equipment may be in a kit which contains dissecting scissors, dissecting forceps, scalpels, teasing needles, T. pins, ruler, and dropping pipette. Dissection equipment also includes a dissecting pan with a pad or wax. (The trend is toward dissecting pads which can be removed from trays for washing after use. Wax must be heated to restore a smooth surface and leaves deposits on T. pins.)
- E. **Heating equipment** includes devices that use electricity and a fuel of some type to provide heat. Hot plates are heated with electrical elements. Fuel sources of heat include alcohol lamps, Bunsen burners, stoves, and other sources. Heating equipment also includes autoclaves. An **autoclave** sterilizes devices used to perform PSAA work to assure that the devices do not harbor microbes that could contaminate work. (Caution: Use care with any device that produces heat to avoid burns and fires.)
- F. **Observation equipment** is used to magnify or otherwise prepare materials for observation. Microscopes, hand lens, and other devices are included. A **microscope** is an instrument that enlarges or magnifies a very small object, such as a cell, microbe, or solid particle of matter, so that it can be seen and studied. There are four kinds of microscopes that are used in the laboratory. The light or optical microscope is the one that is most commonly used. Electron, scanning probe, and ion microscopes have applications beyond the PSAA laboratory and classroom.
1. With an **optical microscope**, lens are used to observe a specimen that has been well illuminated. Good light and proper lens are essential for viewing the details of a cell or organism. (Optical microscopes are also known as light microscopes.)
 2. A **compound microscope** is an optical microscope that uses two or more sets of lenses. A **lens** is transparent material, usually glass, that is shaped to magnify objects. The

curvature of lens alters light waves so that they converge at a point that gives the viewer the illusion that the object being viewed is larger than actual size. The amount of magnification is based on the power of the lens. Two lenses used in combination give greater magnification.

3. **Magnification power** is the ability of a microscope to enlarge an object being viewed. It is based on lens power and combinations of lenses. It is written with a number and an X. The X stands for times. It is the amount that the lens increases the image of the object being viewed. For example, a 10X lens increases the viewing size of an object 10 times its actual size.
 4. Magnification or lens power in a compound microscope is a product of the two lenses. The **ocular lens** is the lens in the eyepiece. The **objective lens** is in the objectives which are attached to the nosepiece. Most compound microscopes have three objective lenses that can be used by turning the nosepiece. The magnification power in a compound microscope involves multiplying the power of the ocular lens by the power of the objective lens. For example, a 10X ocular lens and a 40X objective lens magnify an object 400 times its normal size. Most compound microscopes have three objectives, with powers of 4X, 10X, and 40X. (Refer to the next objective in this lesson plan for a description of the parts of a compound microscope.)
- G. **Safety equipment** is essential in any laboratory. It is used to prevent injury and respond to accidents that may occur. Safety equipment includes personal protective equipment as well as fire blankets, fire extinguishers, eye wash stations, and fume hoods.
- H. **Cleaning equipment** is used to routinely clean the laboratory area, as well as to clean up following spills of toxic or flammable materials and the breakage of glassware.
- I. Miscellaneous equipment is needed to complete a laboratory and enable students and teachers to work. The equipment ranges from pH and oxygen meters to increment borers, buckets, spatulas, dispensing bottles, and refrigerators and freezers.

The overall goal of this objective is to provide background information on the identification of the equipment used in PSAA work. Examples of items used in the local school lab should be on display and properly named. A tour of the lab and observation of storage areas may be used in teaching this area. Have students refer to the list of resources. The writing surface or TM-B, TM-C, and TM-D can be used to summarize the general areas of the objective. Students can refer to catalogs from suppliers of apparatus for grades, prices, and other details. One activity is to have students prepare posters depicting lab equipment. Out-of-date catalogs from suppliers may be cut apart to provide pictures of lab equipment. Place the names of equipment on the writing surface and have students keep notes to learn correct spelling. The identification and use of equipment will occur in learning activities throughout the duration of the class.

Objective 3: Identify how to properly use a microscope.

Anticipated Problem: How do you properly use a light microscope?

III. Proper use of a microscope is essential.

- A. Microscopes are delicate and expensive. If handled incorrectly, microscopes can be damaged and fail to work properly.
 - 1. Carry the microscope with one hand under the base and one hand on the arm. Place the microscope on a level table or desk.
 - 2. View the prepared specimen through the ocular and move it into the center of the field of view. **Ocular** is the lens near the viewer's eye. Magnification should be 10 times.
 - 3. Using the low power objective (40 times), turn the coarse/rough adjustment knob to focus on the specimen and then the fine adjustment knob to make the resolution better. **Objectives** allow for further magnification.
 - 4. If further magnification is needed, turn the nosepiece to the high power objective (100 times) and use the fine adjustment knob to focus on the specimen. Never use coarse/rough adjustment under high power.

TM-C and TM-D can be used to summarize the general areas of the objective. Students then can practice correctly handling a microscope and using the objectives.

Objective 4: Describe important activities in maintaining PSAA equipment.

Anticipated Problem: How is PSAA equipment maintained?

IV. Properly maintaining PSAA equipment will assure that it lasts and performs as it is supposed to.

- A. **Maintenance** is keeping equipment in good condition. It includes using equipment properly, cleaning equipment, and storing equipment when it is not in use. In some cases, such as fume hood or flow hood, proper installation is needed.
 - 1. Proper and safe techniques should be used with PSAA equipment. Using equipment incorrectly may create safety risks, damage the equipment, and result in incorrect findings from experiments and work. Never use equipment in an unsafe manner.
 - 2. Equipment that comes in contact with materials should be cleaned after use. In some cases, heat or cleaning solutions, like alcohol or chlorine solutions, may be needed. In many cases, washing with tap water and allowing equipment to dry is appropriate. If hard water is used, some spotting may occur during air drying. With some equipment, such as balances, special care must be taken so that it does not get contaminated.

3. All equipment should have an appropriate storage facility. This varies with the equipment. Some equipment may need special racks, safety storage cabinets or rooms, or temperature controls to prevent deterioration.
- B. Installation is needed with some equipment. This is to assure that it is set up and operates properly. Autoclaves, centrifuges, flow hoods, stoves, refrigerators, and similar larger equipment may need to be installed by a qualified installer.

This objective introduces PSAA equipment maintenance. The coverage is general in nature. Use the equipment in the school lab as the basis for this lesson. Additional and detailed instruction will be needed as students prepare to carry out individual experiments and demonstrations. Student activities should be carefully observed to assure that correct procedures are being used.

Review/Summary. Use the objectives for the lesson as the outline for reviewing and summarizing the content. Call on individual students to explain the content associated with each objective. Have students use the lab sheets to develop skill in using a microscope and identifying common laboratory tools and equipment. Observe student performance on the activities and provide additional assistance and instruction as needed to overcome deficiencies.

Application. Use the following transparencies and lab sheets to apply the information.

- ◆ TM–A: Tools and Equipment
- ◆ TM–B: Examples of PSAA Equipment
- ◆ TM–C: Uses of Microscopes
- ◆ TM–D: Microscope Parts and Definitions
- ◆ LS–A: Tools and Equipment in the Laboratory
- ◆ LS–B: Identifying Lab Tools
- ◆ TS–A: Tools and Equipment in the Laboratory

Evaluation. Evaluation should include student performance in class and a written test. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1. e
2. f
3. d
4. a
5. b
6. c

7. g
8. h
9. j
10. i

Part Two: Fill in the Blank

1. kit
2. autoclave
3. Fahrenheit, Celsius
4. Safety

Part Three: Multiple Choice

1. b
2. d
3. d
4. c

Part Four: Short Answer

1. The answer should contain at least two examples, such as a hot plate, alcohol lamp, Bunsen burner, and stove.
2. The items typically in a dissection kit include dissecting scissors and forceps, scalpels, teasing needles, .T. pins, ruler, and dropping pipette.



Test

Name _____

TOOLS AND EQUIPMENT IN THE LABORATORY

► Part One: Matching

Instructions: Match the word with the correct definition.

- | | | |
|-------------------|-------------------------|------------------------|
| a. Apparatus | e. Balance | i. Measuring equipment |
| b. PSAA equipment | f. Scale | j. Linear measurement |
| c. Glassware | g. Dissection equipment | |
| d. Thermometer | h. Maintenance | |

- _____ 1. An instrument that uses an equilibrium system for determining weight
- _____ 2. A device without an equilibrium system for determining weight
- _____ 3. An instrument for measuring temperature
- _____ 4. All of the tools and equipment used together to perform a particular function
- _____ 5. All of the implements used in PSAA work
- _____ 6. PSAA equipment primarily made out of glass, although sometimes made of plastic
- _____ 7. A variety of devices used in dissecting organisms or their parts
- _____ 8. Keeping equipment in good condition
- _____ 9. The straight line distance between two points
- _____ 10. Devices used to determine quantity or dimensions

► Part Two: Fill in the Blank

Instructions: Complete the following statements.

1. Dissection equipment is usually made available in a _____ that contains the commonly used tools.
2. An _____ is a device used to sterilize equipment using heat and steam.
3. Thermometers typically measure temperature using the _____ and _____ scales.
4. _____ equipment is used to prevent injury and to respond to an accident.

TOOLS AND EQUIPMENT

- ◆ **Tool:** Any instrument used to do work
- ◆ **Apparatus:** The tools and equipment used together to perform a particular job
- ◆ **PSAA equipment:** All implements used in PSAA experiments and demonstrations



EXAMPLES OF PSAA EQUIPMENT

- ◆ **Glassware**—equipment made out of glass (in some cases, plastic)
 - Examples: test tubes, beakers, graduated cylinders, jars, flask, slides, and slide covers
- ◆ **Measuring equipment**—apparatus used to determine quantity or dimensions
 - Examples: thermometers, balances, tapes and calipers, and containers
- ◆ **Dissection equipment**—devices used in dissecting organisms
 - Examples: dissecting scissors and forceps, scalpels, teasing needles, pins, and trays
- ◆ **Heating equipment**—devices used to provide heat
 - Examples: hot plates, alcohol lamps, Bunsen burners, and stoves
- ◆ **Observation equipment**—devices that magnify objects for viewing
 - Examples: microscopes and hand lenses
- ◆ **Safety equipment**—devices that protect from injury and property damage
 - Examples: goggles, fire extinguishers, eye wash stations, and fume hoods
- ◆ **Cleaning equipment**—devices used to clean equipment and the facility
 - Examples: test tube brushes, spill cleaning kits, and broken glass clean-up
- ◆ **Miscellaneous equipment**—an assortment of equipment needed in a lab
 - Examples: meters, buckets, bottles, refrigerators, and increment borers

USES OF MICROSCOPES

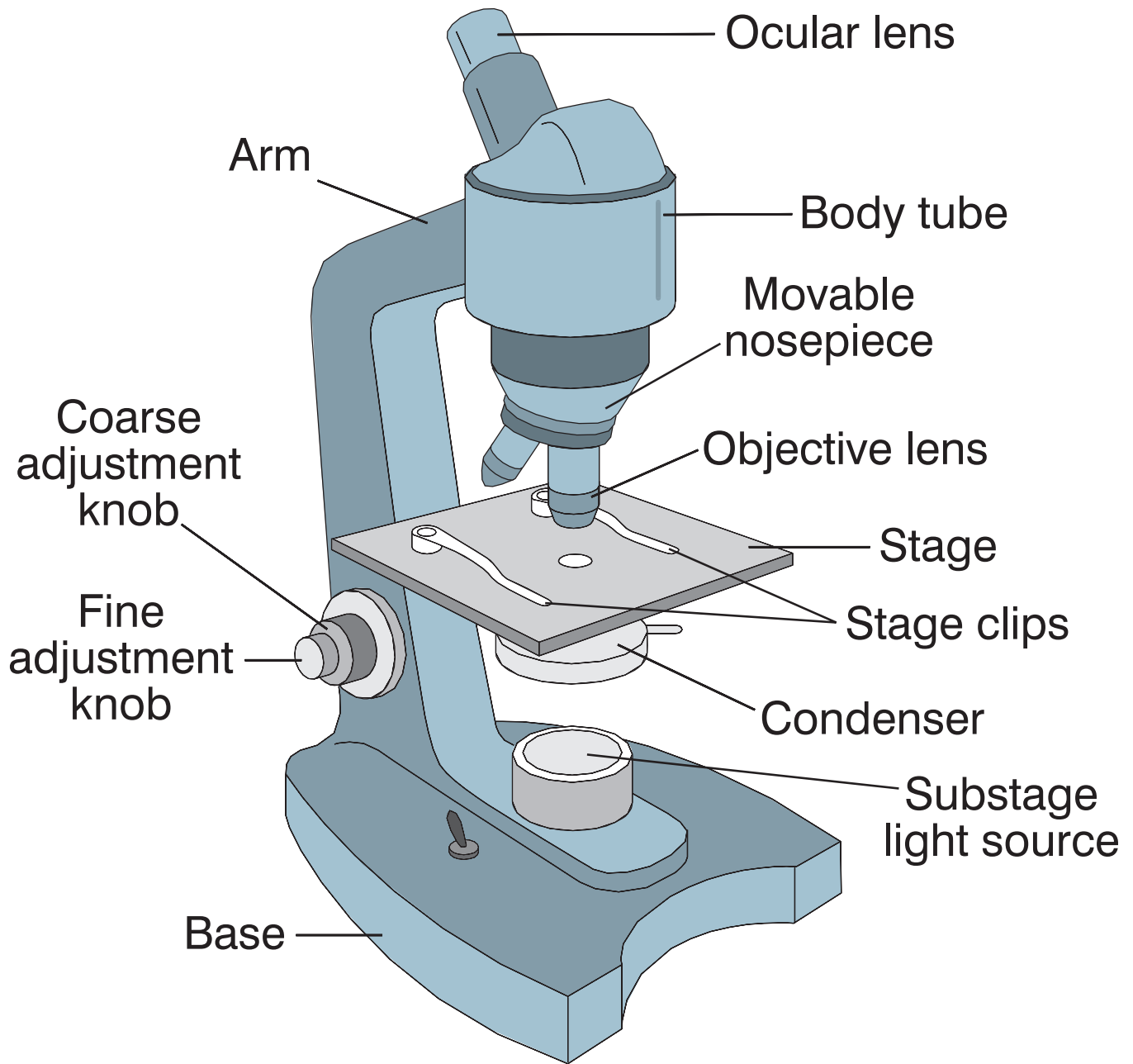
Microscope: an instrument that enlarges the image of very small objects for viewing

Uses:

- ◆ study cells
- ◆ identify disease pathogens
- ◆ assess semen quality
- ◆ perform in vitro fertilization
- ◆ identify microbes in water
- ◆ identify microbes that degrade wastes
- ◆ study blood health



MICROSCOPE PARTS AND DEFINITIONS



- ◆ **Ocular lens:** The lens contained at the superior end of the head or body tube through which observations are made
- ◆ **Body tube (or head):** Supports the objective lens system (which is mounted on the movable nosepiece) and the ocular
- ◆ **Nosepiece:** Generally, the nosepiece carries three objective lenses.
- ◆ **Objective lenses:** An adjustable lens system that permits the use of a low-power lens, a high-power lens, and an oil-immersion lens. The objective lenses have different magnifying and resolving powers.
- ◆ **Arm:** The vertical portion of the microscope that connects the base and head
- ◆ **Base:** Supports the microscope on the table
- ◆ **Stage:** The platform that the slide rests on for viewing. The stage has a hole that permits light to pass through it and the specimen. Most of our microscopes have a stage equipped with spring clips. A few of our microscopes have a clamp-style mechanical stage that can be moved by means of a knob-controlled gear system. The mechanical stage permits more precise movement of the slide than does the manual system. Both types hold the slide in position for viewing.
- ◆ **Substage light source:** Located in the base, the light source directs light upward through the microscope
- ◆ **Condenser:** Concentrates light from the substage light source on the specimen
- ◆ **Iris diaphragm lever:** An arm attached to the condenser that regulates the amount of light passing through the condenser. The iris diaphragm permits the best possible contrast when viewing the specimen.
- ◆ **Coarse adjustment knob:** Used to put the specimen in rough focus
- ◆ **Fine adjustment knob:** Used for precise focusing once the coarse focusing has been accomplished

TOOLS AND EQUIPMENT IN THE LABORATORY

Agricultural Applications and Practices

Experiments are one of the best ways for students to learn science concepts. Science concepts and principles can be explored, illustrated, tested, and verified with experiments. Students learn through experiments because they demand high student involvement and active learning. As a result, students' interest increases. Experiments provide the opportunity for students to develop thinking skills, such as designing, predicting, observing, comparing, inferring, interpreting, summarizing, analyzing, and model building.

Experiments cannot be successfully conducted without appropriate tools and equipment. It is important that students are able to identify common scientific tools and equipment that will be used during an experiment in order to ensure accurate and reliable findings. The more tools and equipment a student can identify, the less challenging the laboratory will be to set up and carry out.

Science Connections—Questions for Investigation

1. What is the importance of a laboratory?
2. What is the role of technology in the laboratory?
3. Why should you know the proper way to use laboratory tools and equipment?
4. Why is it important to maintain science tools and equipment?

Research Problem

What are some common tools and equipment used in PSAA?

Purpose of the Laboratory and Students' Performance Objectives

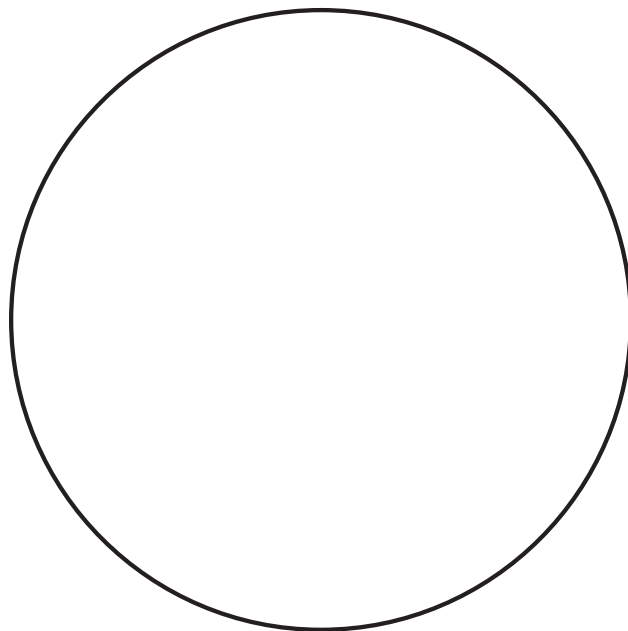
The purpose of this experiment is to demonstrate how to properly use a microscope, one of the most common tools used in scientific research. Through the laboratory and related discussion students will be able to:

1. Explain the importance of tools and equipment in PSAA.

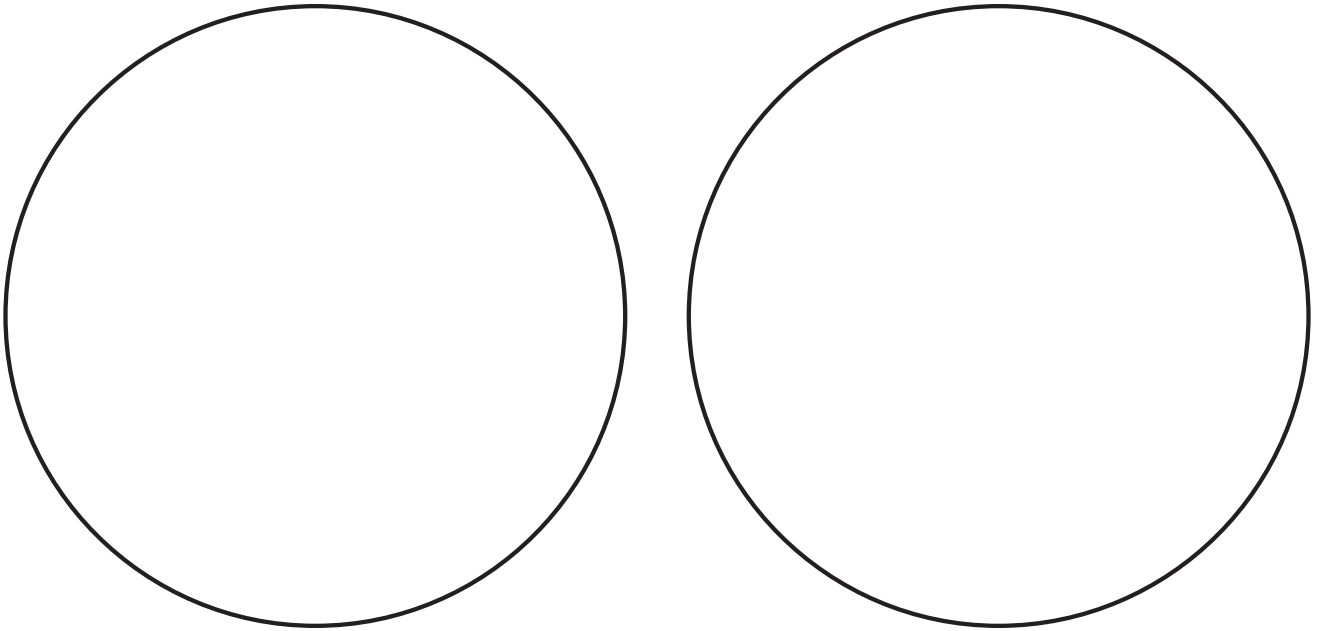
2. Identify common PSAA equipment.
3. Identify how to properly use a microscope.
4. Describe important activities in maintaining PSAA equipment.

MICROSCOPE LAB

1. Cut a piece of dark thread and a piece of light thread each about 1 cm long.
2. Place the two pieces of thread on a clean slide so they cross at right angles.
3. Use the dropper to place 1 drop of water on the thread.
4. Touch one edge of the cover slip to the drop of water and lower it over the threads so there are no bubbles.
5. Obtain a microscope, making sure to carry it with one hand on the arm and one hand under the base.
6. Put the microscope on low power.
7. Place the slide on the stage under the stage clips so that the place where the threads cross is in the center of the field of view.
8. Look through the ocular and adjust the diaphragm so the field of view is bright.
9. Use the coarse adjustment knob to focus the threads and then use the fine adjustment to sharpen the focus.
10. Make a drawing of what you see.



16. Make another slide with a letter from the newspaper using the same procedure as with the threads.
17. Make a drawing under low power and high power.



18. Make an observation about what the letter looks like with the naked eye compared to what it looks like under the microscope.

IDENTIFYING LAB TOOLS

Purpose of the Laboratory and Students' Performance Objectives

The purpose of this experiment is to identify common tools used in scientific research. Through the laboratory and related discussion students will be able to:

1. Explain the importance of tools and equipment in PSAA.
2. Identify common PSAA equipment.
3. Identify how to properly use a microscope.
4. Describe important activities in maintaining PSAA equipment.

Helpful Hints

After students complete the laboratory exercises, have them design a small poster showing several of the tools and equipment used in PSAA. Students can cut pictures from old science supply catalogs to add to their posters. Then display the posters in the classroom to constantly remind the students of the tools and equipment common to the science laboratory.

IDENTIFYING LAB TOOLS

Instructions: Observe the science equipment that has been set up in the classroom. Write the correct name by the number on the equipment. Be sure to spell correctly and provide a complete name.

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- 20.



Technical Supplement

TOOLS AND EQUIPMENT IN THE LABORATORY

1. What is the importance of a laboratory?

Laboratory experience is vital for success and understanding in science. The laboratory is the place where students learn by firsthand observation. Students achieve this firsthand observation by conducting hands-on experiments using scientific tools and equipment. After students have had opportunities to learn basic laboratory skills in a given area, inquiry-type labs using these skills will stimulate independent thinking, enhance problem-solving skills, and encourage further investigation.

2. What is the role of technology in the laboratory?

PSAA provides a great number of opportunities to integrate technology into the science curriculum. The technology used in PSAA ranges from simple test tubes to complex microscopes. These simple to more complex items allow students to conduct experiments and gain knowledge and understanding of science concepts.

3. Why should you know the proper way to use laboratory tools and equipment?

Following directions and using science equipment properly will ensure that test results are accurate and reliable.

4. Why is it important to maintain science tools and equipment?

Properly maintaining science equipment will assure that it lasts and performs as it is supposed to. The better shape the equipment is in, the more accurate and reliable results students will produce from their experiments.

