EARTH SYSTEMS LABORATORIES

2023

Physical Science includes the sciences of earth systems, chemistry and physics that explore the nature and characteristics of energy and nonliving matter. The boundaries between the physical and life sciences are artificial. With the advancements in science today, one field overlaps into another and covers many of the same concepts from different perspectives. Earth Systems is an applied science based on many concepts from chemistry and physics. Because many of the activities in Earth Systems involve the application of chemistry and physics skills, teachers need to be aware of the risks involved.

Complete the Waste Disposal Form for removal of all waste (chemicals and broken glass) at the end of each semester. The Science/STEM Coordinator (Dr. Chaundra Creekmur; creekch@boe.richmond.k12.ga.us) will facilitate removal.

ERSYS 1: Required Materials for the High School Earth Systems Lab

1. Broken Glass Container
2. Fire Extinguisher
3. Spill Kit
4. First Aid Kit
5. MSDS Notebook
6. Chemical Waste Disposal Containers

ERSYS 2: Eye Protection

Teachers owe their students a duty of care. A teacher must reasonably address all foreseeable dangers inherent in any laboratory experiment or demonstration that will be performed in the science laboratory or classroom. A teacher must also instruct and ensure that students demonstrate the proper use of protective equipment.

ERSYS 2.1 What is your obligation?

An important obligation of science teachers is to provide students with appropriate eye protection. **Provision and Maintenance of PPE - 29 CFR §1910.132(d) Personal Protective Equipment, General Requirements Standard** requires a hazard assessment to determine PPE needs and teachers must be trained in use and care of goggles.

ERSYS 2.2 What circumstances require eye protection?

Eye protection is a must in any hazardous laboratory activity or demonstration in science. Protection of the eyes is essential in any laboratory activity. Eye protection is required (but not limited to):

1. When chemicals, glassware, or a heating source is being used
2. When working with solid materials or equipment under stress, pressure, or force that might cause fragmentation or flying particles
3. When an activity generates projectiles, or uses elastic materials under stress, or causes collisions
4. When dust or fumes are present
5. When using preserved specimens

ERSYS 2.3 Choosing the best eye protection

Only safety goggles provide the level of protection needed for your laboratory activities when dealing with hazardous liquids or solids. A safety goggle fits the face surrounding the eyes; it should have a soft pliable flange, which seals around the eyes snugly to protect the eyes. In addition, safety goggles, with side shields or without side shields, provide adequate protection for laboratory activities involving use of solids such as meter sticks, projectiles, etc. Safety goggles should also be the standard for eye protection when chemicals, glassware, a heating source, or preserved specimens are being used.

ERSYS 2.4 Disinfecting Goggles

1. When using the safety goggle cabinet, the ultraviolet light timer should be set for a minimum of ten (10) minutes. Sanitation of goggles is accomplished best by usage of a UV cabinet. Treatment with UV light will destroy the goggles over several years.
2. Hot soapy water and thorough drying between uses of shared goggles is also recommended by the ACS.
3. Chemical Disinfection: After student use, wash the goggles in soapy water followed by a ten (10) minute rinse in five percent bleach solution (10:1 ratio - 10 parts water to 1 part bleach). The goggles should be allowed to air dry.

ERSYS 2.5 What is the current recommendation for wearing contact lenses?

1. The American Chemical Society Committee on Chemical Safety states that contact lenses can be worn in the laboratory provided that approved eye protection is worn as required of others in the laboratory.
2. The National Institute for Occupational Health and Safety (NIOSH) recommends that workers be permitted to wear contact lenses when handling hazardous chemicals provided adequate face and eye protection is worn.
3. The Council of State Science Supervisors states that contact lenses can be worn provided "specially marked, non-vented safety goggles are available to contact lens wearers".
4. The Occupational Safety and Health Administration (OSHA) believes that contact lenses do not pose additional hazards to the wearer and has determined that additional regulation addressing the use of contact lenses is unnecessary.
    a. The agency wants to make it clear, however, that contact lenses are not eye protection devices. If eye hazards are present, appropriate eye protection must be worn instead of, or in conjunction with, contact lenses."
    b. Regulations (Preamble to Final Rules) Personal Protective Equipment for General Industry (Amended Final Rule, April 1994) Section 3- III Summary and Explanation of the Final Rule 1910.133 p.16343.

ERSYS 3: Glassware

ERSYS 3.1 Injuries from Glassware

Glassware is the number one source of injury in the laboratory setting. More students are cut by damaged glassware and burned by heated glassware that are harmed by any other object or circumstance in the lab. To ensure the safety of students in the middle school laboratory, substitute plastic lab ware for glassware where possible. New plastics like polycarbonate (Lexan®) have been successfully used for laboratory containers. While not useful for heating, the plastic is clear and extremely hard and can be used for almost all water-soluble compounds. Beakers, flasks, graduated cylinders, and thermometers now are available in plastic. Check with your science supply company.

ERSYS 3.2 General Cautions

ERSYS 3.2.1 Broken Glass

1. Use glassware that is without defect and has smooth edges.
2. One of the most important ways to prevent glassware related injuries is to check the pieces for chips or cracks. Any damaged glassware should be disposed of in the appropriate container.
3. Glassware should have no cracks, chips, or scratches. In particular, be wary of "star cracks" that can form on the bottom of beakers and flasks. Any glassware with such cracks should be properly disposed of immediately.
4. All glass tubing should be fire-polished.

ERSYS 3.2.2. "Frozen" Glass

Be careful with glassware that is "frozen." Only teachers, wearing goggles and gloves, should try to release the "frozen" glassware. If this fails, discard the glassware. Some common cases of "frozen" glassware are:

1. nested beakers that have been jammed together.
2. stoppers that cannot be removed from bottles.
3. stopcocks that cannot be moved.

ERSYS 3.2.3 Hot Glass

1. Use only Kimax® or Pyrex® brand glassware when heating substances. Common glass can break or shatter, causing serious injuries in the lab.
2. Use care when working with hot glass. Hot glass looks exactly the same as room temperature glass.
3. Do not leave hot glassware unattended, and allow ample time for the glass to cool before touching.
4. Check the temperature of the glassware by placing your hand near, but not touching, the potentially hot glass.
5. Have hot pads, thick gloves, or beaker tongs available for grasping hot glassware.
6. Never set hot glassware on cold surfaces or in any way change its temperature suddenly. Even a Pyrex® or Kimax® beaker will break if cold water is poured into a hot beaker.

ERSYS 3.2.4 Glass Tubing

1. Make sure that the tubing is without chips or cracks.
2. Use the appropriate diameter tubing for the task.
3. Make sure the ends of the tubing are fire polished.
4. When breaking tubing:
    a. Use gloves or towels to protect hands when breaking glass tubing. Use goggles to protect the eyes.
    b. Scratch the glass once with a file or score. Wrap the glass in a towel.
    c. Place the thumbs together opposite the scratch. Pull and bend in one quick motion.
    d. Fire polish the broken ends: hold the glass so that the sharp end is in the top of the flame of a gas burner. Rotate the tube so all sides are heated evenly, causing the sharp edges to melt and become smooth.
    e. Place the glass on insulating material to cool.

ERSYS 3.2.5 Bending

Bending glass tubing is often necessary. Follow these procedures:

1. Place a wing-top attachment on a gas burner and heat the area of the glass to be bent while holding it with one hand on each end, rotating to ensure even heating.
2. When the glass is soft and pliable, remove it from the flame and quickly bend to the desired shape.
3. Place on insulating material until cool.

ERSYS 3.3 Types and Appropriate Use of Glassware

To prevent glassware related injuries always use the correct type of glass for the task you are doing. For example, a graduated cylinder should be used to measure the volume of a liquid, not as a container in which to run chemical reactions. Likewise, a watch glass should not be used to mix chemical compounds, but as a cover over a heated reaction vessel.

ERSYS 3.3.1 Proper Use

Each type of glassware has its proper use and should be used for its intended purpose.

1. **For measuring volume**:

   pipets burets graduated cylinders

   dropper pipets volumetric flasks

2. **For storing solids and liquids:**

   bottles vials

3. **For containing reactive chemicals during experiments:**

   beakers flasks test tubes

   crucibles watch glasses test plates

4. **For transferring liquids and gases**:

   glass tubing funnels pipets

5. **For measuring temperature:**

   digital thermometers alcohol thermometers

ERSYS 3.5 Cleaning

1. Clean glassware immediately after use. The longer glassware sits, the harder it is to clean.
2. Use laboratory-grade detergents or liquid dishwashing detergent such as Dawn® for cleaning glassware.
3. When using brushes, make sure to use the appropriate size brush; make sure the metal part of the brush does not scratch the glass.
   Rinse glassware with deionized water.
4. Allow glassware to air dry on paper towels, drying pads, or drying racks.

ERSYS 3.6 Disposal

1. Defective glassware should be disposed of correctly.
2. Glassware should be disposed of in a separate container from normal trash. Such container should be clearly labeled **BROKEN GLASSWARE ONLY.**
3. When handling broken glassware, wear gloves or use a dustpan and broom. Do not pick up broken glass with bare hands.

ERSYS 4: Microscope Handling

1. **DO NOT ALLOW STUDENTS WITH ACTIVE EYE INFECTIONS TO USE MICROSCOPES!**
2. Provide students with alcohol wipes to clean lenses before or after use.
3. Microscopes must be carried upright, with one hand supporting the arm of the microscope and the other hand supporting the base. Nothing else should be carried at the same time.
4. Microscope must be positioned safely on the table, NOT near the edge.
5. After plugging the microscope into the electrical outlet, the cord should be draped carefully up onto the table and never allowed to dangle dangerously to the floor.
6. The coarse adjustment must NEVER be used to focus a specimen when the 40x or oil immersion lens is in place.
7. When finished with the microscope, the cord should be carefully wrapped around the microscope before returning it to the cabinet.
8. All prepared microscope glass slides are to be returned to their appropriate slide trays; wet mount preparations are to be disposed of properly.
9. Malfunctioning microscopes should be reported to the department chairperson/laboratory safety manager.

ERSYS 5: Mechanical Hazards

ERSYS 5.1 Disposal

1. Do not flush sand, silt, clay, rocks, and other earth materials down the drain.
2. These materials are not soluble in water and may clog the drain.
3. Dispose of them in a trash can or other suitable receptacle.

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ERSYS 5.2 Force Measuring Devices

1. Students must be careful when projecting objects (steel balls or marbles).
    a. In demonstrating the flight of any projectile, students should be kept clear of the path and impact area.
    b. The teacher should always pretest the projectile to determine the path it will follow and its range as well as the amount of variability to be expected.
    c. Sharp-pointed objects should not be used as projectiles.
    d. Use of safety goggles is mandatory.
2. A simple mechanical launcher (e.g., compressed spring, compressed air, stretched elastic) should be used.
    a. It should only be "loaded" at the specific time a flight is to be observed.
3. Springs
    a. Stretched or compressed springs contain mechanical potential energy.
    b. A stretched spring, unexpectedly released, can pinch fingers.
    c. A compressed spring, when suddenly released, can send an object at high velocity toward an observer.
    d. Care should be taken to avoid unexpected release of the spring's energy when working with dynamics carts, spring-type simple harmonic oscillators, and springs used in wave demonstrations.

ERSYS 5.3 Wind Generating Devices (Hair Blower, Electric Fan, etc.)

1. Take special care in using wind generating devices.
2. As these devices are often used with water, they present a risk of electric shock.

3. No one should disconnect, connect, or operate these devices with wet hands or while standing on a wet floor.
4. Devices having metal housings should be grounded.

ERSYS 6: Electrical Hazards

ERSYS 6.1 Burns and Shock

1. Many electrical devices become quite hot while in use.
   a. In addition, "shorted" dry cells and batteries can produce very high temperatures.
   b. Students should never grasp a recently operated device or wiring without first checking for excess heat.
2. Students must be warned of the high death potential present even when the voltage is low.
   a. The severity of an electrical shock depends primarily on the amount of current to which a person is exposed.
   b. Since the current is related to the resistance and voltage, these two factors, as well as the part of the body involved and the duration of the contact, determine the extent of injuries to the victim.
   c. If the skin is wet or the surface broken, the resistance drops off rapidly, permitting the current to flow readily through the bloodstream and body tissues.

ERSYS 6.2 Electrical Apparatus

ERSYS 6.2.1 Batteries

1. A battery is an unregulated source of current capable of producing large currents when resistance is low.
   a. When short-circuited, connecting wires can become very hot, raising the risk of burns. Short-circuited mercury batteries may even explode.

b. Chemical leakage from batteries is a potential hazard, especially in the case of wet cells that contain caustic chemicals such as sulfuric acid.

2. Certain types of batteries are rechargeable while others are not.
   a. Carbon-zinc and nickel-cadmium type batteries can be recharged.
   b. Do not, however, attempt to recharge a completely dead carbon-zinc battery, a leaking or corroded battery, or any battery that carries a warning against recharging.
   c. Such batteries can cause damage to the charger and may explode, causing personal injury. Lead-acid batteries can be recharged but produce explosive hydrogen gas during the process.
   d. They should only be recharged in a well-ventilated area with an appropriate charger.
3. Do not discard any battery in the trash.
   a. Contact Facilities and Maintenance for pick-up and disposal. Document the date of the request and the date the pick-up occurred.

ERSYS 6.2.2 Circuit Loads

1. Most school laboratory electrical circuits have a maximum power rating of 1,500 watts (if fuses are 15 amp) or 2,000 watts (if fuses are 20 amp).
2. The total power load on a circuit should not exceed these values.
3. The total load is the sum of the power ratings of all apparatus plugged into that circuit.
4. The individual power rating is usually found printed on a plate somewhere on the apparatus.

ERSYS 6.2.3 Extension Cords.

1. Use extension cords only when there is no convenient way to connect equipment directly to a receptacle.
2. If an extension cord must be used, it should be checked for damage, proper grounding, and electrical capacity.

3. An extension cord should be marked with its capacity in amperes and watts and the total load should not exceed these values.
4. If the cord is unmarked, assume that it is 9 amperes or 1,125 watts.
5. If an extension cord becomes very warm to the touch, it should be disconnected and checked for proper size.
6. In general, science laboratories should be equipped with sufficient receptacles to minimize extension cord use.

ERSYS 6.2.4 Fuses/Circuit Breakers.

1. Replace blown equipment fuses with fuses of the same amperage.
2. Replace fuses with the equipment unplugged.
3. Failure to use the correct fuse can cause damage to equipment and overheating.
4. Frequent blowing of circuit fuses or tripping of circuit breakers usually indicates that the circuit is overloaded or a short exists.
5. Circuit breakers and fuses that are tripped or blown should be turned on or replaced only after the cause of the short or overload is removed from the circuit.

ERSYS 6.2.5 Grounding

1. Use grounded 3-prong plugs when available.
2. If the outlet is 2-prong, use an adapter and secure the ground wire to the cover-plate screw on the outlet.
3. Any apparatus with a metallic case or exposed metal parts should be checked to make sure that the case is grounded.
4. Such ungrounded appliances should be retrofitted with a ground wire and three-pronged plug.
5. The use of ground-fault interrupters should be considered.

ERSYS 6.2.6 Power Cords.

1. Any power cord should be inspected periodically and replaced immediately if frayed or damaged.
2. Apparatus should be located to keep power cords away from student traffic paths.

3. When removing the cord from an outlet, the plug should be pulled, not the power cord.
4. Wet hands and floors present a hazard when connecting or disconnecting electrical apparatus.

ERSYS 7: Light Hazards

ERSYS 7.1 Magnesium Ribbon

1. Students should not look directly at the flame when a magnesium ribbon is being burned. The extreme brightness can damage the eyes.

ERSYS 7.2 Optics

1. Avoid the use of burning candles to obtain the image produced by mirrors and lenses. Use low wattage bulbs instead of burning candles.
2. Incandescent ultraviolet lamps present a minimal danger from their ultraviolet emissions, as the energy of this radiation is very low.
3. These bulbs, however, get extremely hot when in use and must be given plenty of time to cool before handling.
4. Intense sources of visible light are usually not hazardous due to the inability of the human eye to remain focused on an intense source.

ERSYS 7.3 Astronomy-Related Concerns

Astronomical events such as viewing a solar eclipse are a great opportunity for learning, but safety precautions for specific events such a solar eclipse must be addressed.

1. Eyepieces of shared telescopes and binoculars should be cleaned periodically to reduce the risk of the transmission of eye infections. Never observe the sun directly through a telescope or binoculars
2. Never look directly at the sun, including during a solar eclipse. Permanent eye damage is likely to take place.
3. Properly constructed pinhole viewers are a safe way to view the sun.
4. Never view the sun directly through binoculars or telescopes. This can cause blindness.

5. Never use sunglasses or exposed film to view the sun. They do not provide appropriate protection.

ERSYS 7.4 Ultraviolet Light

The use of ultraviolet light for mineral study can be dangerous and should be done only as a teacher demonstration.

1. Protect eyes and skin from exposure of ultraviolet transilluminators.
2. Special glasses (such as those coated with an ultraviolet absorbing film) should be used when examining mineral samples with an ultraviolet lamp. Only special goggles clearly designated for the purpose of absorbing ultraviolet light should be used.
3. Wear long sleeve shirts and lab coat with gloves.
4. Only use a ground-fault circuit interrupter (GFCI) protected electrical receptacle for the lamp.
5. Never operate the lamp near water sources.
6. Never disassemble the lamp when plugged in – this is a high voltage power supply device.

ERSYS 8: Special Concerns

ERSYS 8.1 Astronomy

Astronomical events such as viewing a solar eclipse are a great opportunity for learning, but safety precautions for specific events such a solar eclipse must be addressed.

1. Eyepieces of shared telescopes and binoculars should be cleaned periodically to reduce the risk of the transmission of eye infections. Never observe the sun directly through a telescope or binoculars
2. Never look directly at the sun, including during a solar eclipse. Permanent eye damage is likely to take place.
3. Properly constructed pinhole viewers are a safe way to view the sun.
4. Never view the sun directly through binoculars or telescopes. This can cause blindness.
5. Never use sunglasses or exposed film to view the sun. They do not provide appropriate protection.

ERSYS 8.2: Geology

ERSYS 8.2.1 Rock and Mineral Study:

1. Use the following precautions in working with rocks and minerals in the laboratory:
2. Use appropriate personal protective equipment such as chemical splash goggles, gloves and aprons.

ERSYS 8.2.1.1 Acid Tests

1. Most chemical experiments with naturally occurring minerals involve the application of dilute hydrochloric acid to the specimen (most often to identify calcium carbonate, marble, and limestone).
2. When using 10% or 1.0M hydrochloric acid for rock and mineral identification, students should use only a very small drop of acid, and should use care so as not to get the acid on the lab table, their skin, clothes, or in their eyes, or on any other student.
3. **ROCKS AND MINERALS MUST BE RINSED OFF WITH TAP WATER IMMEDIATELY AFTER THE ACID TEST, AND BLOTTED DRY using paper towels.**

4. When dilute hydrochloric acid is applied to mineral specimens, gases often result.
    a. Due to the varied composition of the minerals, it is not always possible to predict which gases will be involved.
    b. Such experiments should be performed in well-ventilated areas or in the fume hood.
    c. Gases should not be smelled directly.
5. Keep all table tops wiped or blotted dry.
6. Do not leave acid-covered specimens lying on the tables, and do not put acid-covered specimens back into the cardboard specimen trays.
7. If you suspect that you have acid on your hands, wash them immediately with soap and plenty of running water.
8. Report any acid spills to the instructor immediately.

ERSYS 8.2.1.2 Tastes Tests

1. When conducting a mineral taste test, the student should rinse the mineral in clean tap water BEFORE and AFTER the test.
2. Only taste specimens that you have good reason to suspect are HALITE on the basis of other evidence.
3. Do not taste specimens that you suspect may have hydrochloric acid on them.
4. Taste only specimens that you have personally rinsed off immediately prior to tasting.
5. Do not put any lab materials or specimens into your mouth.

ERSYS 8.2.1.3 Hardness Tests

1. Students must always be properly instructed on the proper technique used to determine hardness of a mineral.
2. When scratching one mineral sample against another, care should be taken not to cut or gouge fingers and hands.
3. Sharp, angular specimens should be handled with gloves.
4. If testing hardness by scratching a glass plate, students should not hold the glass plate in the palm of their hands.

5. The glass plate should be placed on a flat surface and scratched away from the body.
6. Goggles should be worn in case the glass breaks and splinters or a piece of the mineral chips away.

ERSYS 8.2.1.4 Cleavage/Fracture Tests

1. The wearing of safety goggles is essential when breaking rocks or mineral samples with a hammer.
2. Students should be told of the dangers from flying particles from a work group other than their own.
3. When breaking rocks, care should be taken to ensure that other students are not within range of flying particles.
4. Rocks should be held firmly with long-handled pliers to avoid injury to the fingers and prevent movement.
5. Students should not handle or be exposed to asbestos bearing minerals such as tremolite and chrysolite.

ERSYS 8.2.1.5 Crystallization

1. Students can observe the process of crystallization by examining the evaporating edge of an aqueous solution or the cooling edge of a pool of molten chemical on a glass slide with a microscope.
2. If solutions are used, be aware of the toxicity of the substances used and take adequate precautions.
3. If a molten chemical is used, care should be taken to avoid burns.

ERSYS 8.2.1.6 Ultraviolet Light Used for Viewing Fluorescent Minerals

1. Any radiation with a wavelength shorter than 250nm should be considered dangerous.
2. This includes the ultraviolet light (black light) used in some mineralogy laboratories.
3. Never remove the protective shield in front of a UV source.

4. Safety glasses with UV-absorbing lenses should be provided, and care must be taken that students do not get a painful sunburn from the ultraviolet light.

ERSYS 8.2.2 Geological Field Experience

Geological field experiences can be exciting and academically rewarding. The following safety precautions should be addressed in preparation for the trip:

1. Secure information relative to medical conditions in preparation for the field activity from the school nurse and parents. Plan for administration of medication as necessary.
   a. Make sure students wear appropriate clothing for the weather conditions.
   b. Make sure students use sun sense by wearing appropriate clothing and head gear.
   c. Make sure students use appropriate footwear such as boots or sneakers. Flip-flops and sandals are unacceptable.
   d. Make sure students wear safety glasses or goggles.
2. Caution students against throwing or rolling rocks and boulders on the field site.
3. Make sure students do not touch or try moving rotten trees.
4. Make sure students use caution when hammering rocks.
5. Make sure students use caution when standing near the base of a cliff.

ERSYS 8.3 Spectroscopic Analysis Using Flame Tests

1. The most common chemicals used when performing nichrome wire flame tests are recognized as toxic, and adequate precautions should be taken to ensure good ventilation of the experimental area.
2. When large numbers of students are performing flame tests, the potential exists for individual acute toxicity exposure or instructor chronic toxicity exposure.

ERSYS 8.3.1 Chemicals Often Used in Flame Tests

Table ERSYS 8.3.1.1

Health	Safety	Compound
1	0	Sodium Chloride (NaC1)
2	1	Strontium Chloride ($SrCl_2$)
3	1	Lithium Chloride (LiC1)
3	1	Copper Chloride ($CuCl_2$)
4	1	Barium Chloride ($BaC1_2$)

ERSYS 8. .1.2 Precautions

1. Goggles and lab aprons are required.
2. In poorly ventilated or confined laboratories, flame tests should be performed in a fume hood.
    a. The general nature of an unknown compound should be ascertained before performing a flame test.
    b. Students should never ingest the chemicals.
3. When performing flame tests, the nichrome wire or paper clip that is used should be held in a well-insulated holder or long-handled pliers.
4. The wire and holding device should be placed on an insulated mat and allowed to cool thoroughly before handling.
    a. An overloaded wire causes splattering and material can fall into the burner jets, causing blockage.
    b. Unknown chemicals should not be placed in the flame.
    c. It is recommended that teachers use spectrum tubes to show the properties of spectrum analysis.
    d. These spectrum tubes are safe and can be used in any classroom setting. Care should be used when changing tubes as they can get hot when used for a few minutes.

ERSYS 8.4: Erosion/Deposition

ERSYS 8.4.1 Diatomaceous Earth

DUE TO THE POSSIBLE INHALATION OF DUST, THE USE OF DIATOMACEOUS EARTH IS NOT ALLOWED.

ERSYS 8.5 Earthquakes/Volcanoes

1. Although some texts suggest an experiment involving ammonium dichromate that dramatically simulates the effects of a volcano, this experiment should never be performed in the classroom.
2. **AMMONIUM DICHROMATE IS HIGHLY TOXIC.**

ERSYS 8.6 Meteorology

ERSYS 8.6.1 Air Pressure

1. Air under pressure can cause explosions or make objects or parts of objects move suddenly and violently.
2. Containers that are to be pressurized or evacuated must be able to withstand the differences in pressure without violently shattering.
3. Glass containers should not be subjected to differences in air pressure unless they were designed for such purposes.
4. Students should always wear protective goggles when performing air pressure experiments.
5. Magdeburg Hemispheres are often used to demonstrate the force exerted on a surface by air pressure.
    a. If they are braced and pulling hard and the hemisphere gives way, they could go flying into objects behind them.
    b. Do not release the vacuum inside the hemispheres while students are pulling on them.

ERSYS 8.6.2 Barometers

1. **MERCURY BAROMETERS ARE NEVER TO BE USED IN CLASSROOMS.**
2. Use aneroid barometers to explain air pressure readings.

ERSYS 8.6.3 Sling Psychrometers

A sling psychrometer is used to measure relative humidity in a particular area. It is composed of two thermometers, a **WET BULB** and a **DRY BULB**. The dry bulb is the simple thermometer while the wet bulb comes with a cotton wick. This wick needs to be moistened with water at room temperature. Both the bulbs are with a screw to a dowel which allows them to be *spun in the air*. It works on the principle that evaporation is a process of cooling. It is important to know how to use a sling psychrometer in order to be able to read humidity accurately without errors. While learning how to use a sling psychrometer, here are a few pointers to keep in mind:

ERSYS 8.6.3.1 Set up

1. Use room temperature water in order to wet the cotton wick present in the wet bulb of the instrument. Distilled water is preferable.
2. The water should soak into the cotton wick with ease. If you face a problem with the soaking, you should replace the wick.
3. The barometer has to be cleaned after every use. Store it in a safe, cool place.

ERSYS 8.6.3.2 Measurement

1. Both the bulbs should be secure. This is very important and you should thus ensure they are stable and safe on the dowel before swinging them.
2. Swing the bulbs for about a minute. Make sure you have sufficient space to swing the instrument in order to avoid striking objects or people.
3. After a minute, note the temperature reading on both the bulbs. Do this at least twice to get the lowest reading possible. If the two readings are different, do it again.
4. If you see that the wet bulb is warmer than the dry, there is a problem with the instrument and it is most probably broken.
5. Record the difference between both the readings.
    a. Check a reliable relative humidity chart and take the dry bulb temperature on the y axis.

b. The result of the difference of both the readings should be taken on the x axis and see where both the points meet. This resource chart will help you calculate the dew point
c. To find out the relative humidity, you must check the chart again but the bottom chart on the resource chart will give you the reading of relative humidity. The readings to be taken are the same as above.
d. This resource chart is the standard chart used to measure humidity and dew point and is easily available.

ERSYS 8.6.4 Thermometers

1. **MERCURY FILLED THERMOMETERS ARE NOT ALLOWED IN RCSS SCHOOLS.**
2. Alcohol laboratory thermometers should be used in general laboratory activities.
3. For more advanced applications, a digital laboratory thermometer may be used.
   a. Care should be taken to choose a digital thermometer that contains a changeable battery; some are not changeable.
   b. The battery is a button cell battery and may contain 5-50 mg of mercury; it should be recycled through a battery collection program.

ERSYS 9: Chemical Safety in the Earth Science Laboratory

All teachers should be familiar with the RCSS Chemical Management policy that addresses how chemicals should be properly stored, labeled, and secured, as well as who should have access to these chemicals and chemical storage locations. The following guidelines are provided for teachers in order to reduce the risk of chemical accidents and ensure that chemicals and products in their schools are stored and handled safely.

ERSYS 9.1 Procurement of Chemicals

1. Prior to ordering, determine whether the chemical is in stock.
2. Order only quantities that are necessary for the project. Remember: **"Less is better**".
3. Upon receipt of the chemical, make sure the date received and the owner's initials are on the label.

ERSYS 9.2 Labeling of Chemical Containers

1. No unlabeled substance should be present in the laboratory at any time!
2. Use labels with good adhesive.
3. Use a permanent marker (waterproof and fade resistant) or laser (not inkjet) printer.
4. Print clearly and visibly.
5. Replace damaged, faded, or semi-attached labels.

ERSYS 9.2.2 Commercially Packaged Chemicals

1. Verify that the label contains the following information:
    a. Chemical name (as it appears on the MSDS)
    b. Name of chemical manufacturer
    c. Necessary handling and hazard information
    d. Add:
    e. Date received
    f. Date first opened
    g. Expiration or —use by date (if one is not present)

ERSYS 9.2.3 Secondary Containers and Prepared Solutions

1. When a material is transferred from the original manufacturer's container to other vessels, these vessels are referred to as —secondary containers.
2. Label all containers used for storage with the following:
    a. Chemical name (as it appears on the MSDS)
    b. Name of the chemical manufacturer or person who prepared the solution
    c. Necessary handling and hazard information
    d. Concentration or purity
    e. Date prepared
    f. Expiration or —use by date

ERSYS 9.2.4 Containers in Immediate Use

1. These chemicals are to be used within a work shift or laboratory session.
2. Label all containers in immediate use with the following:
    a. Chemical name (as it appears on the MSDS)
    b. Necessary handling and hazard information
    c. NFPA code

ERSYS 9.2.5 Chemical Waste

All containers used for chemical waste should be labeled with the following:

1. HAZARDOUS WASTE
2. Chemical name (as it appears on the MSDS)
3. Accumulation start date
4. Hazard(s) associated with the chemical waste
5. Date generated

ERSYS 9.3 Material Safety Data Sheets (MSDS)

1. There must be an MSDS on file for every chemical compound in use in the lab.
2. At a minimum, MSDS information should be located in all chemical storage rooms and cabinets and in a central place within the school (away from the chemicals), as well as a central location for the school district.
3. A copy must be kept in an area that is accessible to all individuals during periods of building operations.
4. If no MSDS is available for a product because 1) the manufacturer no longer exists; or 2) the manufacturer cannot be identified from the label that material should be considered hazardous waste and disposed of in a manner consistent with federal and state regulations.

ERSYS 9.4 Proper Chemical Storage

Guidelines for chemical storage must follow **O.C.G.A 45-22-2, O.C.G.A. 25-2, OSHA Standard 29 CFR 1910, and NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals** and **NFPA 30: Flammable and Combustible Liquids Code.**

1. Hazardous chemicals in schools should be stored in accordance with MSDS specifications
2. Chemicals should not be stored in areas that are occupied by or accessible to students, such as classrooms or restrooms; they should preferably be stored in a central, secure location.
3. Organize chemicals first by **COMPATIBILITY**—not alphabetic succession (refer to section entitled Shelf Storage Pattern). Store alphabetically within compatible groups.

ERSYS 9.5 Chemical Waste

According to EPA regulations, the following four characteristics define a waste as hazardous:

- Ignitability
- Corrosiveness
- Reactivity
- Toxicity

Management and disposal of laboratory waste in containers are regulated under RCRA regulations. These laboratory waste streams include used chemicals, residues from experiments, spill cleanup, expired or off-spec chemicals and other chemical waste. It is the school's responsibility to make a hazardous waste determination. This includes spent chemicals used in the lab, expired or unwanted chemicals, contaminated gloves, and any spill cleanup debris. Schools must ensure that a RCRA hazardous waste is safely accumulated and transported off-site for proper disposal. Depending on the quantity of waste generated by a school, additional requirements for storage, handling and emergency response may apply. Depending on the quantity of waste generated by a school, additional requirements for storage, handling and emergency response may apply.

ERSYS 9.5.1 Proper Storage and Disposal of Chemical Waste

The following guidelines are provided to schools and administrators and should be used for storing and disposing of hazardous waste:

ERSYS 9.5.1.1 Segregation and Storage of Waste

1. Separate waste containers are required to properly segregate waste for disposal. The following waste categories should be used.
    - Nitric Acid
    - Hydrofluoric Acid
    - Hexavalent Chrome
    - Cyanides
    - Oxidizers
    - Reducing Agents
- Sulfides
- Palladium
- High pH Alkaline Solutions
- Low pH Acidic Solutions
- Non-Chlorinated Solvents
- Chlorinated Solvents

2. Chemicals that are stored for disposal off-site should be placed in suitable closed containers and should be clearly marked with the contents. If the chemicals are a RCRA hazardous waste, the school must ensure that they are transported offsite for proper disposal.
3. Store all waste in containers that are in good condition and are compatible with their contents. Avoid using metal containers; certain chemicals can cause the metal to corrode and the container to leak.
4. Clearly and permanently label each container as to its contents and label as hazardous waste.
5. Store waste in a designated area away from normal laboratory operations and to prevent unauthorized access. Store waste bottles away from sinks and floor drains.
6. Do not completely fill waste bottles; leave several inches of space at the top of each waste container. Securely cap all waste bottles.

ERSYS 9.5.1.2 Disposal of Hazardous Waste

1. **THE USE OF SINKS FOR THE DISPOSAL OF CHEMICALS IS STRICTLY PROHIBITED!**
    a. When rinsing glassware that contained chemical, discard the first rinse volume into the appropriate waste container.
    b. Subsequent rinses can be discarded to the sink.
2. Water/air reactive wastes are restricted by waste disposal companies and must be deactivated prior to disposal.
    a. This is particularly true of materials which ignite or release gases on contact with air or water.
3. Dispose of chemically contaminated paper and disposable clothing in approved solid waste containers.
4. Do not treat hazardous waste on-site. Exception: Acids may be neutralized with sodium bicarbonate in a 50-50 ratio by weight.
5. Contact Facilities and Maintenance for pick-up and disposal. Document when pick-up was requested and when pick-up occurred.

Complete the Waste Disposal Form for removal of all waste (chemicals and broken glass) at the end of each semester. The Science/STEM Coordinator (Dr. Chaundra Creekmur; creekch@boe.richmond.k12.ga.us) will facilitate removal.

ERSYS 9.5.2 Record Keeping

1. Reassigned samples must be re-labeled with the new custodian's name and the date the waste was generated and stored.
2. A waste management log must be maintained and should indicate how and when the waste was generated, how and when it was isolated and stored, by whom it was generated and stored, and date and method in which it was disposed.

ERSYS 10: Fire Hazards

Fire is a real danger in any laboratory setting, and all teachers need to be aware of how to prevent fires. In the vent a fire does occur, teachers need to know how to respond appropriately. The following information is provided as guidance in preventing or combatting fires in the science laboratory.

ERSYS 10.1 Preventing Burns and Fires

ERSYS 10.1.1 When planning to heat materials or use open flames

1. Instruct students on STOP DROP AND ROLL in the event clothing catches fire
2. Make sure students know how to evacuate the classroom in the event of a large fire
3. Know the location of the nearest fire extinguisher and know how to use it.
4. Have a bucket of sand or a fire blanket nearby in the event that the nearest fire extinguisher too far outside of the classroom.

ERSYS 10.1.2 When heating materials

1. **DO NOT USE ALCOHOL BURNERS! T**hey are extremely hazardous. Safer alternatives to alcohol burners include candles and hot plates.
2. **DO NOT USE STERNO HEATERS!**
3. Make sure that the area surrounding a heat source is clean and has no combustible materials nearby.

4. Do not allow students to work with hot materials, such as very hot water.
5. Do not use household glass. Use only borosilicate laboratory glassware, such as Kimax™ or Pyrex™ when heating substances.
6. Do not heat common household liquids, such as alcohol or oil; these are flammable and should not be heated. Heat only water or water solutions.
7. Handle all hot materials using the appropriate type of tongs or heat resistant gloves (those made of asbestos or thick silicon rubber).

ERSYS 10.1.3 When Using Hot Plates

1. Do not use hotplates designed for use in home kitchens. Use only laboratory type hot plates. These are sealed against minor spills.
2. Do not place the hot plate on paper or wooden surfaces.
3. Place the hot plate in a location where a student cannot pull it off the worktop or trip over the power cord.
4. Never leave the room while the hot plate is plugged in, whether or not it is in use.
5. Keep students away from hot plates that are in use or still hot, unless you are right beside the students and have given them specific instructions.
6. Make sure that the hotplate is both unplugged and cool before handling a hotplate. You can check to see if a hot plate is still too hot by placing a few drops of water on the surface. If the water does not evaporate, it should be cool enough to touch.

ERSYS 10.1.4 When using open flames

1. Use only safety matches. Make sure the matches are stored in a secure place between uses.
2. Closely supervise students when they use matches. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
3. Closely supervise students when they use candles. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
4. Use tea candles that are short and wide, and cannot be knocked over in normal use.

5. Place all candles in a “drip pan,” such as an aluminum pie plate, that is large enough to contain the candle if it is knocked over.
6. Never leave the room while a flame is lit or other heat source is in use.

ERSYS 10.1.4 Bunsen Burner Safety Guidelines

Bunsen burners present fire hazards. They produce an open flame and burn at a high temperature, and as a result, there is potential for an accident to occur. For the safety and convenience of everyone working in a laboratory, it is important that the following guidelines be observed.

1. Remove all papers, notebooks, combustible materials and excess chemicals from the area.
2. Tie-back any long hair, dangling jewelry, or loose clothing.
3. Inspect hose for cracks, holes, pinch points or any defect and ensure that the hose fits securely on the gas valve and the burner. Replace all hoses found to have a defect before using.
4. Notify others in the laboratory that the burner will be in use.
5. Have the sparker/lighter available before turning on the gas.
6. Utilize a sparker/lighter with extended nozzle to ignite the burner. Never use a match to ignite a burner.
7. Adjust the flame by turning the collar to regulate air flow and produce an appropriate flame for the experiment (typically a medium blue flame).
8. Do not leave open flames unattended and never leave the laboratory while the burner is on.
9. Shut off gas when its use is complete.
10. Allow the burner to cool before handling. Ensure that the main gas valve is off before leaving the laboratory.

ERSYS 10.2 In the event of a large, uncontainable fire

1. Evacuate the classroom immediately.
2. Locate and pull the nearest fire alarm.
3. Notify public safety and/or administration about the fire. Make sure you include the location and source (chemical, paper, petroleum) of the fire.

ERSYS 10.3 In the event of a small, containable fire

1. Identify the type of fire. The table below lists the four classes of fires and methods for extinguishing them:

Class	To Fight Fires Involving	Method to Extinguish
A	wood, paper, cloth	Use water or dry chemical extinguisher.
B	gasoline, alcohol, paint, oil, or other flammable liquids	Smother by using carbon dioxide or dry chemical extinguisher.
C	fires in live electrical equipment	Cut off power to electrical equipment. Use multiple purpose (ABC) or carbon dioxide fire extinguisher.
D	metals (Na, K, Mg, etc.)	Scoop dry sand onto fire.

2. Use the appropriate method to extinguish the fire.
3. File an incident report.

ERSYS 10.4 In the event a student's clothes catch fire

1. Roll the child on the floor to smother the fire. Use a fire blanket if one is available. Do not direct a carbon dioxide (CO_2) fire extinguisher at an individual because such extinguishers produce dry ice that can cause frostbite. Periodically check on the location and condition of fire extinguishers.
2. **DO NOT ATTEMPT TO ADMINISTER FIRST AID TO ANY BURNS THE CHILD MAY HAVE SUSTAINED!** Immediately notify the school administrator, school nurse, and public safety.