EDUCATOR VERSION

STEM WITH LM

The U.S. Department of Energy Office of Legacy Management STEM with LM presents:

NUCLEAR SCIENCE WEEK

OCTOBER 21-25, 2024

THINK CLEAN. THINK SOLUTIONS. THINK NUCLEAR.

Introduction Letter

Dear educators,

Thank you for your participation in **Nuclear Science Week 2024** with the U.S. Department of Energy Office of Legacy Management's STEM with LM program.

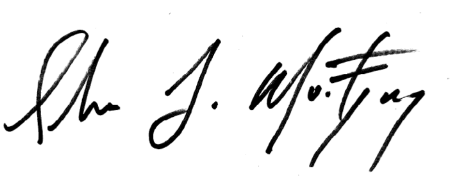
Nuclear Science Week (NSW) is an international, weeklong celebration of the innovations and careers in nuclear science. Communities are encouraged to get involved and host local events during the third week of October. NSW explores the five pillars of nuclear science: carbon-free energy, global leadership, transformative health care, innovation and technology, and space exploration.

This year, STEM with LM encourages all students and their teachers to "Get to Know Nuclear" through an online Radiation & You: Energy in Motion program. Radiation is an emission of energy that is everywhere and serves as the foundation of nuclear science.

Visit the STEM with LM website (energy.gov/lm/programs/stem-lm) and watch the "Radiation & You: Energy in Motion" video with your students. While viewing the video, your students can answer the questions on page 3 of the packet. In addition to the video and questions, students may complete the Nuclear Science & Radiation activity sheet independently or with small groups (pages 4-7). Also included is a sample NSW activity and lesson plan (pages 8-9) titled "Making Atoms Visible - Electroscope" created by the American Nuclear Society. This is an easy and fun activity for your class to participate in NSW. LM encourages you to also explore the NSW website where you can find other lesson plans, free virtual content, and resources for the week's national events.

LM can also connect educators with subject-matter-experts in a wide range of academic fields, including chemistry, ecology, geology, engineering, and history. These experts are available for classroom support as guest speakers or student resources. For more information, contact the Atomic Legacy Cabin at atomiclegacycabin@lm.doe.gov.

We look forward to building community partnerships with you and your school.



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For more information, visit: nuclearscienceweek.org.
For more information about STEM with LM, visit: energy.gov/lm/programs/stem-lm.

Nuclear Science Week 2024

NUCLEAR SCIENCE WEEK

National Event, October 21-25

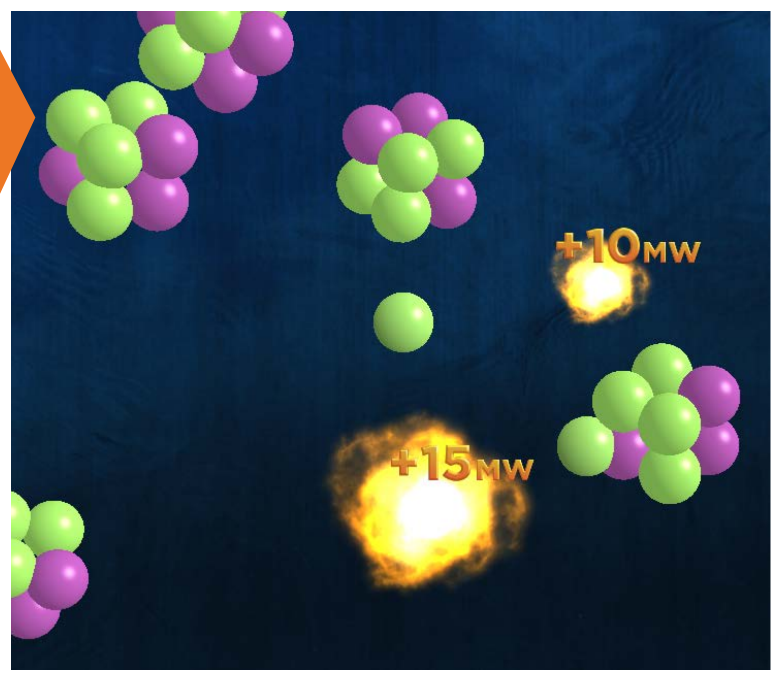
To learn more about how nuclear technologies positively impact American lives, visit nuclearscienceweek.org/watch and explore free content during NSW. New 30-minute episodes feature the unique aspects of nuclear technology, kid interviews, and science shorts with STEM professionals. Also, students can play a fun, interactive video game to learn how fission works.

NUCLEAR SCIENCE NETWORK

WATCH 30-MINUTE EPISODES THAT EXPLORE THE POSITIVE IMPACTS OF NUCLEAR SCIENCE.

LIGHT UP YOUR WORLD VIDEO GAME

TAKE THE "MISSION FISSION CHALLENGE" TO SPLIT AS MANY ATOMS AS FAST AS YOU CAN.



RADIATION & YOU—
Energy in Motion

Visit the STEM with LM webpage (energy.gov/lm/activities-home-and-classroom) and click the videos tab to watch the video and learn about radiation.

1. Radiation is ENERGY **in motion.**

2. What emits more radiation?

- ☒ You
- ☐ Your cellphone

3. Draw a line to match the examples to the correct type of radiation.

Radio waves
X-rays
Microwaves
Gamma rays
Ultraviolet light

Ionizing
Non-ionizing

4. True or False: Radiation is the release of energy from the unstable nucleus of an atom.

5. Match the four types of ionizing radiation to the correct shield that can stop them.

Alpha Particle
Beta Particle
Neutron Particle
Gamma Ray

Water
Lead
Concrete
Steel
Paper
Protective Clothing
Plastic
Metal

Nuclear Science & Radiation Activity Sheet

All About Atoms

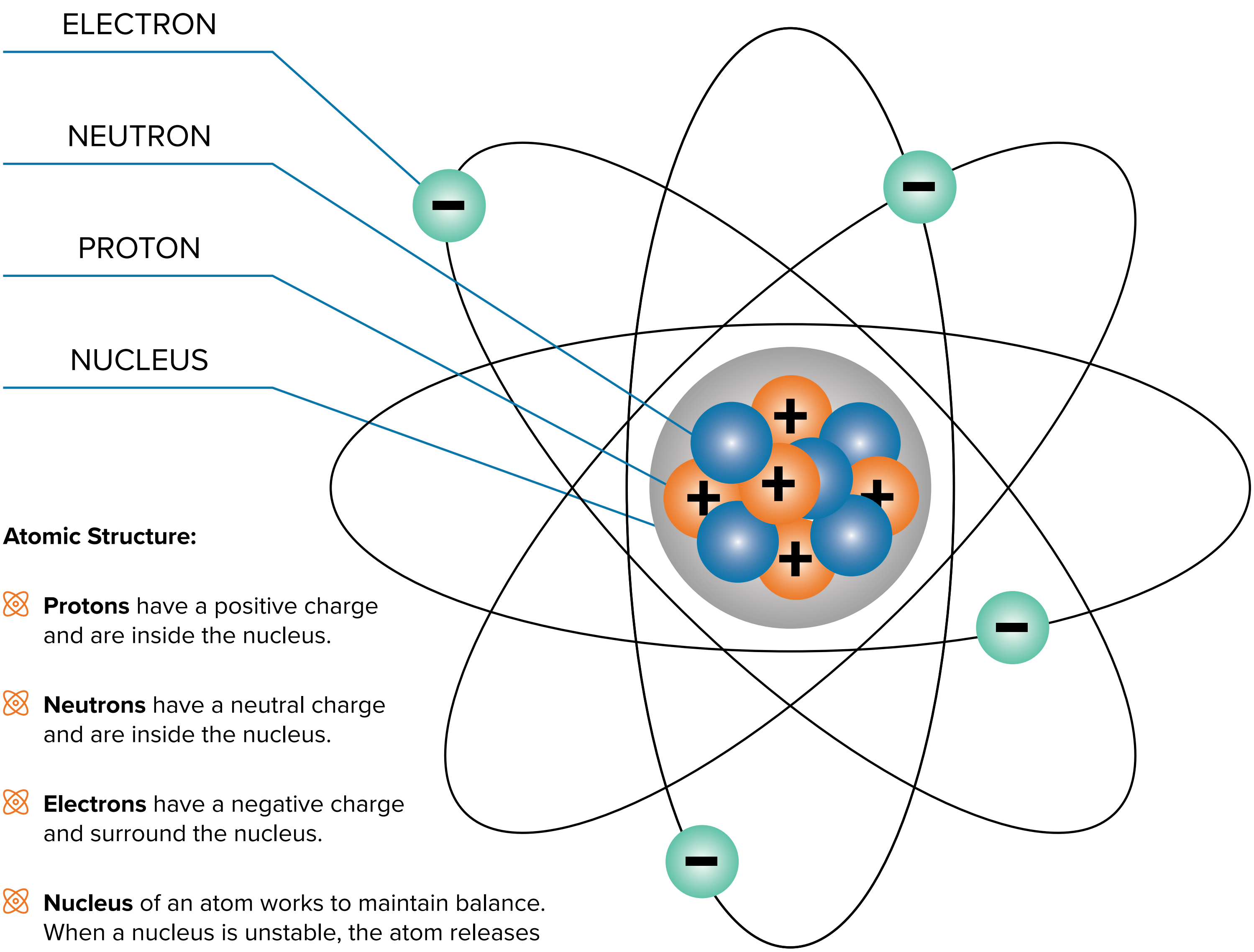
Age Level: 10-11 (elementary school).

Key Definitions: atom, protons, neutrons, electrons, radiation, alpha, beta, gamma, radiation frisker.

Objective: To understand the basics of radioactive science and radiation control.

In order to understand radiation, you must know the basics of atoms. Atoms are the building blocks of all matter. Just like blocks, atoms fit together to make everything we see — even us! However, atoms are extremely tiny — so much so that we can't see them, even with a microscope.

There are three basic parts to an atom: protons, neutrons, and electrons. Identify the parts of an atom on the illustration below.



Atomic Structure:

- **Protons** have a positive charge and are inside the nucleus.
- **Neutrons** have a neutral charge and are inside the nucleus.
- **Electrons** have a negative charge and surround the nucleus.
- **Nucleus** of an atom works to maintain balance. When a nucleus is unstable, the atom releases energy in the form of radiation to achieve stability.

Nuclear Science & Radiation Activity Sheet

What is Radiation?

Radiation is energy in motion. There are two main categories used to classify the source of radiation: naturally occurring and human-made. Naturally occurring radiation comes from natural sources, which can range from the soil, water, and vegetation, as well as a wide variety of events occurring in the universe, like a supernova. Human-made radiation, as its name plainly states, comes from human activity, such as medical procedures involving computerized tomography (CT) scans or X-rays.

Determine whether the following items produce naturally occurring or human-made radiation. For naturally occurring, circle and for human-made, circle .

X-RAYS

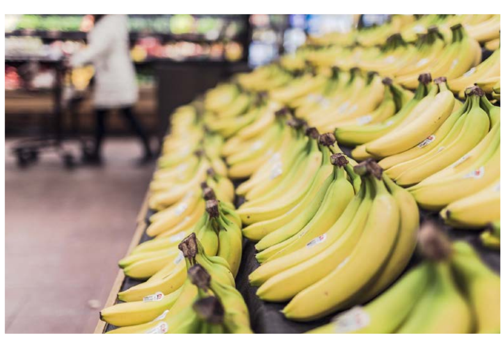
SUN

URANIUM GLASS

URANIUM ORE

BANANAS

BUILDING MATERIALS



Nuclear Science & Radiation Activity Sheet

Four Main Types of Radiation

It might surprise you that we are surrounded by naturally occurring radiation. For instance, bananas, the sun, and even you are radioactive.

Daily, we receive very low levels of radiation that are not harmful to us. However, too much radiation can be harmful. Therefore, it is important to know the basics of radiation safety: **time, distance, and shielding**. First, we should limit our exposure time to a source of radiation. Next, we should also maintain a safe distance from the radioactive material. Finally, we should use the appropriate materials that will shield us from the three types of radioactive emissions:

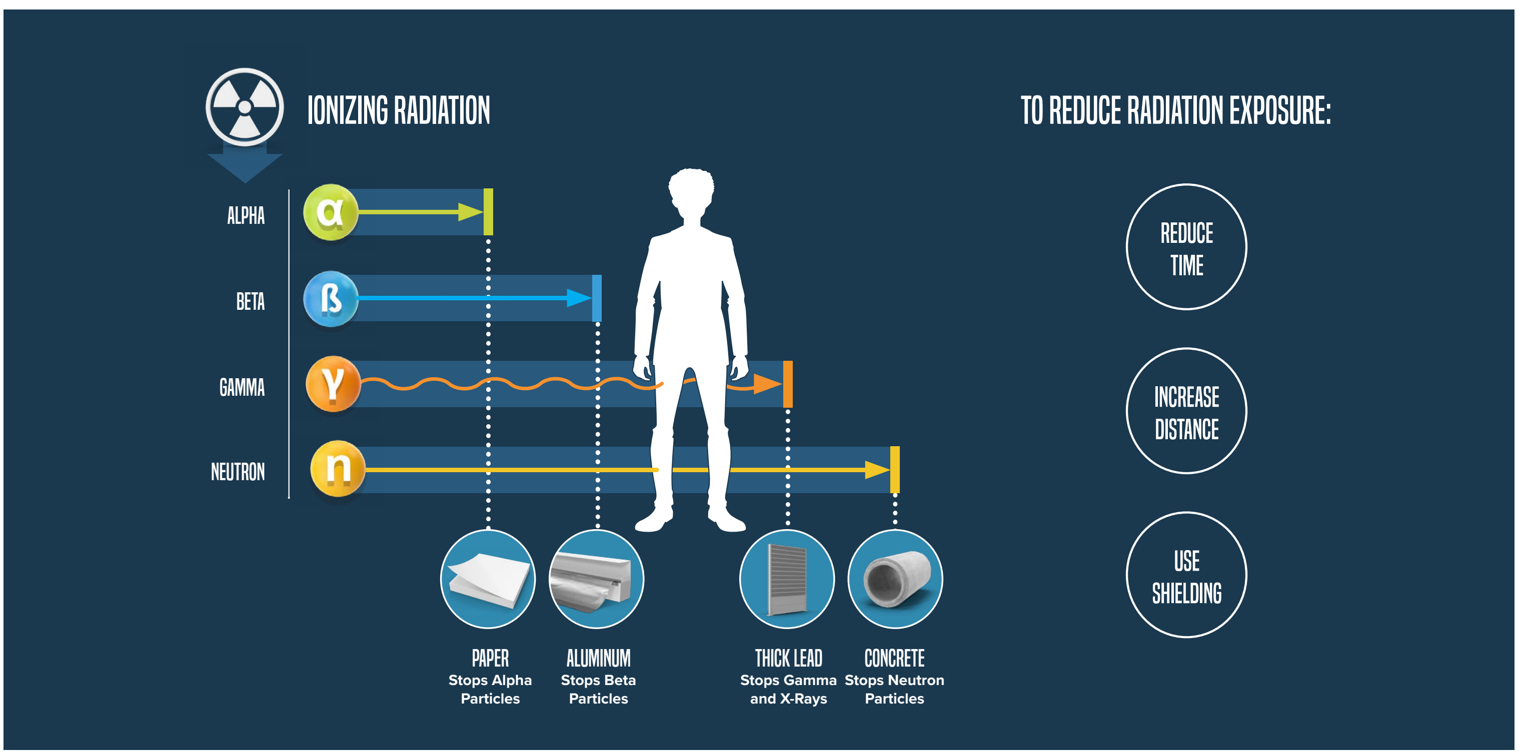
1. **Alpha radiation** occurs when an atomic nucleus releases two protons and two neutrons. Thin plates of material, like aluminum, can stop stop these light, fast-moving particles.

2. **Beta radiation** occurs when an atomic nucleus releases an electron. These light, fast-moving particles can be stopped by thin plates of material, like aluminum.

3. **Gamma radiation** involves a high-energy photon escaping the nucleus and damaging surrounding material. These particles are fast moving with no electrical charge. Thick material, such as lead, can capture these particles, though they are harder to stop.

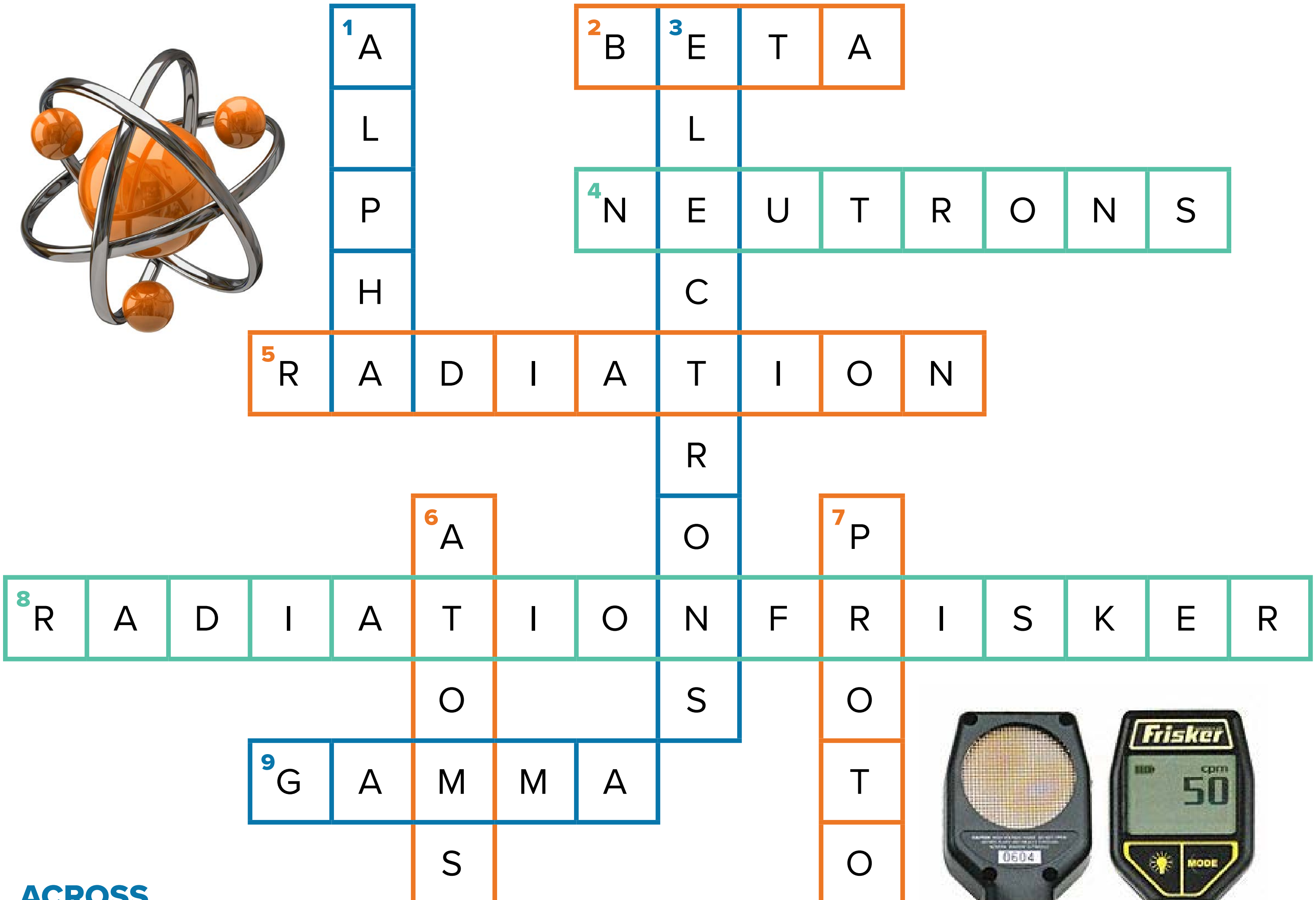
   ***X-rays emit a form of gamma radiation, which is why we wear lead aprons during the procedure.**

4. **Neutron radiation** is created when an uranium or plutonium atom fissions, producing nuclear energy. Since neutrons can travel great distances, thick materials, such as concrete or water, are required to stop them.



Nuclear Science & Radiation Activity Sheet

Key Terms Crossword Puzzle Key



ACROSS

2. A type of radiation that can be stopped by aluminum.
4. The part of an atom that has a neutral charge.
5. The emission of energy from a substance.
8. A tool used to measure radiation contamination.
9. A type of radiation that can damage surrounding material.

DOWN

1. A type of radiation that releases two protons and two neutrons.
3. The part of an atom that has a negative charge.
6. The building blocks of all matter.
7. The part of an atom that has a positive charge.

Radiation cannot be detected using our five senses, which is why we use tools, like the radiation frisker, to locate and measure radiation contamination.

Making Atoms Visible - Electroscope

This content is published and available on the Nuclear Science Week website, in the Teacher Resource Guide published by the American Nuclear Society. It is included as an optional addition to your lesson plan. Find the guide here: "Making Atoms Visible - Electroscope"

OBJECTIVE: *Make a simple instrument to detect static electricity and radiation.*

GRADE: 5-12

DISCIPLINARY CORE IDEAS (DCI, NGSS):
5-PS1-1, MS-PS1-1, MS-PS1-4, HS-PS1-8, HS-PS4-2, HS-PS4-5

TIME FOR TEACHER PREPARATION:
30-60 minutes (to gather materials and set-up)

ACTIVITY TIME: 30-60 minutes

SAFETY:

- Students should use care when handling aluminum foil.
- Students should use care when handling glue.

SCIENCE AND ENGINEERING PRACTICES (NGSS):

- Ask questions and define problems.
- Use Models.
- Plan and Carry out investigation.
- Analyze and interpret data.
- Using mathematics, information and computers.
- Argue from Evidence.
- Obtain, evaluate and communicate information.

CROSS CUTTING CONCEPTS (NGSS):

- Patterns.
- Cause and Effect.
- Scale, Proportion, and Quantity.
- Systems and System Models.
- Energy and Matter: Flows, Cycles, and Conservation.
- Structure and Function.
- Stability and Change of Systems.

MATERIALS:

- Pen, Marker, or Pencil
- Balloon
- Foam plate
- Foam cup
- Drinking straw
- Glue
- Aluminum pie pan
- Thread
- Aluminum foil
- Masking tape
- Wool fabric
- Comb
- Plastic ruler
- Student Data Collection Sheets

BACKGROUND:

An electroscope is a very simple instrument that is used to detect the presence and magnitude of electric charge on a body such as static electricity. The type of electroscope detailed in this experiment is called a pith-ball electroscope. It was invented in 1754 by John Canton. The ball was originally made out of a spongy plant material called pith. Any lightweight neutrally conductive material, such as aluminum foil, can work as a pith ball. The pith ball is charged by touching it to a charged object. Since the ball is neutrally conductive and the electrons are not free to leave the atoms and move around the ball, when the charged ball is near a positively charged body, or source, the negatively charged electrons are attracted to it and the ball moves towards the source. Conversely, a negatively charged source will repel the electrons, and therefore the ball. Electroscopes can also be used to detect ionizing radiation. In this case, the radiation ionizes the air to be more positively or negatively charged depending on the type of radiation, and the ball will either be attracted or repelled by the source. This is how electroscopes can be used for detecting x-rays, cosmic rays, and radiation from radioactive material.

Making Atoms Visible - Electroscope

Teacher Lesson Plan

TRADITIONAL

1. Lecture students on background.
2. Provide them with materials and procedure.
3. Provide balloons and radiation sources to test the electroscopes with.

NGSS GUIDED INQUIRY

1. After students construct electroscopes, have them experiment with charged and neutral sources to experiment.
2. Have students analyze radioactive sources with electroscopes.

STUDENT PROCEDURE

1. Make two holes near the bottom of a foam cup on opposite sides.
2. Push a plastic straw through the holes in the cup.
3. Turn the cup upside down and glue it onto the bottom of an aluminum pie pan. Make sure that the cup is right at the edge so that the straw sticks out over it. If you don't want to wait for the glue to dry, tape the cup to the pan.
4. Cut a piece of thread about 8 inches long and tie a few knots in one end of the thread.
5. Cut a one-inch square of aluminum foil.
   Use it to make a ball around the knots in the thread. The ball should be about the size of a marble. It should be just tight enough so it doesn't fall off the thread.
6. Tape the end of the thread to the straw so that the ball of foil hangs straight down from the straw, right next to the edge of the pan.
7. Tape the straw to the cup so it doesn't move around when you use the electroscope.
8. To test the electroscope, create some static electricity. An easy way to create static is by rubbing a balloon on a foam plate. When you do this, you "charge" the plate, which means you cause a buildup of electrons on one side. Even though the plate is charged, the electrons don't move because foam doesn't conduct electrons.
9. Once you've created some static electricity, place the electroscope on top of the foam plate. Be sure to hold the electroscope by the foam cup and not the aluminum pan, otherwise it won't work.
   Electrons move easily through metal, so when you put the pie pan onto the foam plate, the electrons travel into the pan and the foil ball. When the electroscope detects static electricity, the foil ball pushes out from the pan.
10. Try charging different objects, like a comb or ruler, with static electricity. Test them on the electroscope and record your results on the data sheet.

DATA COLLECTION

- Attached Student Data Collection Sheets
- Students should record which objects hold a charge and which do not.

POST DISCUSSION/EFFECTIVE TEACHING STRATAGIES

Questions provided on the Student Data Collection Sheets.

QUESTIONS

1. Which objects hold an electric charge? Which don't?
2. Why is the ball attracted or repelled by different objects?
3. How is using an electroscope similar to testing the charge of a balloon with your hair?
4. How is the electroscope able to detect radioactivity?

ASSESSMENT IDEAS

Have students use electroscopes to discern between radioactive sources and nonradioactive sources.

DIFFERENTIATED LEARNING/ENRICHMENT

Have students compare radioactivity of different sources?

ENRICHMENT QUESTION

Why did John Canton invent the first electroscope and what did he use it for?

Making Atoms Visible - Electroscope

Student Data Collection Answer Sheet

OBJECTIVE: *Make a simple instrument to detect static electricity and radiation.*

DIRECTIONS:

1. Make two holes near the bottom of a foam cup on opposite sides.
2. Push a plastic straw through the holes in the cup.
3. Turn the cup upside down and glue it onto the bottom of an aluminum pie pan. Make sure that the cup is right at the edge so that the straw sticks out over it. If you don't want to wait for the glue to dry, tape the cup to the pan.
4. Cut a piece of thread about 8 inches long and tie a few knots in one end of the thread.
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10. Try charging different objects, like a comb or ruler, with static electricity. Test them on the electroscope and record your results on your data sheet.

Making Atoms Visible - Electroscope

Student Data Collection Answer Sheet

NAME: ______________________ DATE: ______________

QUESTIONS:

1. Which objects hold an electric charge? Which don't?

Objects that conduct electricity very well, such as metals and other compounds hold an electric charge. Covalent compounds do not conduct electricity very well, thus not allowing them to hold an electric charge.

2. Why is the ball attracted or repelled by different objects?

It is electrostatically charged.

3. How is using an electroscope similar to testing the charge of a balloon with your hair?

Both deal with electrostatic charges to attract or detract objects.

4. How is the electroscope able to detect radioactivity?

The radioactive particles are charged particles, and are affected by the electrostatic charges of the electroscope.

ENRICHMENT QUESTION: Why did John Canton invent the first electroscope and what did he use it for?

Students need to research background on John Canton.
Answers may include that he was trying to make magnets without using natural magnets.

ATOMIC LEGACY CABIN

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