HOW TO SEE

RADIATION

GRADES 3 - 5

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HOW TO SEE

SNC - Plant Farley

LESSON PLAN

RADIATION

Lesson Title: How to “See” Radiation

Lesson Description: Students will construct alcohol-based cloud chambers out of common materials to view trails produced by nuclear particles. The exercise is designed to complement discussion of basic types of nuclear/ionizing radiation. The exercise could also be modified to view tracks produced by cosmic radiation sources.

Grade Level: 9-12

Subject Area(s): Physical Science, Chemistry, Physics

Objectives: Students will:
- gain an understanding of the concept of ionizing radiation.
- learn basic terms relating to radiation.
- construct an alcohol based cloud chamber and use it to view trails produced by subatomic particles.
- become familiar with some properties of basic forms of ionizing radiation.
- make inferences between atomic nuclear structure and ionizing radiation.

Materials:
- wide mouth pint jars with lids
- black felt cloth
- flashlights with strong beams
- anhydrous ethyl or isopropyl alcohol
- quick-dry glue or epoxy that is not dissolved by alcohol
- heavy black velvet (or heavy black blotter paper)
- blocks of dry ice (about 6 x 6 x 2)
- pans large enough to hold blocks of dry ice
- small, unlicensed radioactive sources
- activity sheets
- pens or pencils
- unruled paper (for drawing)
- latex or vinyl gloves
- goggles (Z87 compliant) and lab aprons
- dry cloth hand towels or pot holders
- scissors

Unlicensed radioactive sources

Correlations (NSES):

- Content Standard A – Science as Inquiry
  - develop abilities necessary to do science inquiry
  - develop understandings about scientific inquiry
- Content Standard B – Physical Science
  - develop an understanding of the structure and properties of matter
  - develop an understanding of motions and forces
  - develop an understanding of interactions of energy and matter
- Content Standard E – Science and Technology
  - develop understandings about science and technology

Curriculum Integration:

- Earth/Space Science (cosmic radiation)

Process Skills:

- Observation
- Collection of data
- Comparison
- Measurement
- Counting
- Research
- Investigation/experimentation
- Inference
- Analysis of findings/data
- Illustration
- Interpretation of data
- Communication of ideas
- Description of findings
- Prediction

Background Information:

- Main Ideas
  - principles of alpha, beta, and gamma decay; especially those relating to ionization, penetrating properties, mass and charge
  - there are many kinds of radioactive decay; the three basic types include alpha, beta, and gamma
  - principles related to type of decay and ionization/penetrating abilities
- Secondary Ideas
  - principles related to other areas of nuclear science such as uses of radiation (power, medicine, industrial applications, etc.)
  - historical perspectives: Curie, Roentgen, Becquerel and others
  - principles of laboratory safety
  - usage of radiation in our world

Teacher Activities:

- Assemble/organize all materials needed for activity
- Present background materials to students
- Distribute Activity Sheets to students
- Discuss construction of Cloud Chambers and how to make observations using them (use a previously constructed chamber as an example)
- Stress Safety Precautions
- Divide students into work groups/lab partners (2-3 students)
- Help distribute materials
- Monitor student activities/ render assistance as needed
- Inventory radiation sources prior to distribution and at end of exercises to make certain that all are accounted for
- Complete lesson by stressing main points

Student Activities:

- Listen carefully to background information issued by teacher
- Obtain handouts
- Pay close attention to directions given by teacher regarding the lab activity
- Take notes during discussion as needed
- Observe safety precautions
- Complete Activity Sheets
- Ask teacher for help as needed
- Construct cloud chambers as directed
- Return lab materials to their proper locations after lab activities have been completed
- Observe and draw particle tracks/trails
- Participate in post-activity discussion

Evaluation:

- Direct observation
- Post-activity discussion
- Student drawings

Extension/Enrichment:

- Have students use/compare different radiation sources to determine which produces the best results
- Have students work on a project to build a larger, more sophisticated chamber
- Use a Polaroid camera to photograph tracks/trails
- Test the effects of magnets or current upon the trials/tracks
- Take your class on a field trip to tour a nuclear power plant
- Research cloud chambers on the Internet
- Have students research various areas of nuclear science
- Research/discuss topics such as:
  - Transmutation
  - Chart of the Nuclides
  - Use of Radiation to Preserve Food
- Describe differences between Fission and Fusion
- Life Forms that are Resistant to Radiation
- Nuclear Structure

Safety Considerations:

- Have students use gloves when handling all radioactive sources. Caution students against handling sources and placing their fingers in their mouths, noses, or eyes. Do not distribute loose uranyl nitrate or other radioactive chemicals.
- Do not use any radioactive liquids as sources.
- Alcohols are quite flammable and should be handled with caution. You may wish to remind students that the alcohols used for this activity are denatured and quite poisonous.
- Have students wear gloves and use dry towels (such as pot holders) when handling dry ice. Dry ice should never be touched with wet skin.
- Do not allow students to attempt to take the mylar coverings off of sealed sources.
- Some of the materials used for this project are glass and may be easily broken.
- Insist that all students wash their hands after completion of the lab.
- Make certain that you take up all radiation sources and that you store them properly in a secure location.
- Goggles (Z87 compliant) must be worn during this exercise.

HOW TO SEE

ACTIVITY SHEET ONE

RADIATION

(READ THIS ENTIRE SHEET BEFORE BEGINNING THE EXERCISE)

Introduction

One of the characteristics of radioactive particles is that they are not visible to us. Even though we can't see the particles themselves, there is a way that we can see where they have been. The concept is sort of like that of a jet high in the earth's atmosphere. You have probably seen contrails way up in the sky. Sometimes the jet is so high it can't be seen. What we see is only the condensation trail it leaves behind as super-hot gases that cause a trail of condensed water vapor. You will be constructing a device called a Cloud Chamber that may be used to view trails caused by alcohol condensation.

A cloud chamber is a sealed, transparent chamber that contains a supersaturated atmosphere and a radioactive source. In the chamber you construct, alcohol will be used to create the supersaturated environment within the chamber. This means there is a high concentration of alcohol vapor within the cloud chamber. The radioactive source you place within the cloud chamber emits subatomic alpha and/or beta particles that ionize some of the atoms that make up the vapor. Vapor in the chamber then condenses around the free ions created by the alpha/beta particles. This condensation forms tiny droplets that form trails or tracks along the path taken by the alpha/beta particles. Although we can't really see the particles themselves, we can see the paths they traveled.

Before you start building your cloud chamber, you need to take a minute to think about safety. You will be using a weak radioactive source in this activity. Make certain that you wear gloves and handle it with caution. You will also be using dry ice with this exercise. The extreme cold temperature of dry ice can damage tissues so wear gloves and use a dry towel when handling it. One further item you will be using may present a hazard, as alcohol is highly flammable. Use caution when working with the alcohol. Keep it away from sparks, flame or heat. Recap the bottle from which it came immediately after use. The alcohol used in this experiment is denatured. This means that it is poisonous if ingested. You must wear goggles and lab aprons during the exercise.

If you have questions during any point during the activity, ask your instructor for help.

Procedure

- Put on safety attire (goggles, gloves, aprons, etc.).
- Observe all safety precautions.
- Obtain all materials from the supply table as directed by your teacher.
- Place the block of dry ice in a pan.
- Cut the black velvet (or blotter paper) in a circle just right to fit in the bottom of the glass jar; glue it to the inside bottom of the jar using the epoxy or glue provided.
- Cut a circular piece of black felt to fit snugly inside the jar lid.
- After the glue holding the velvet (or blotter paper) is dry, pour several mL of alcohol in the jar; swirl it around so that the velvet (or blotter paper) is completely saturated; if you need to add more to saturate it do so; if you have excess alcohol, pour it out.
- Place the radioactive source in the middle of the jar lid; screw the jar (upside down) tightly onto the lid; allow the apparatus to sit undisturbed 10 minutes.
- Place the jar (upside down) onto the block of dry ice; see Fig. 1 on the following page.

Procedure (continued):

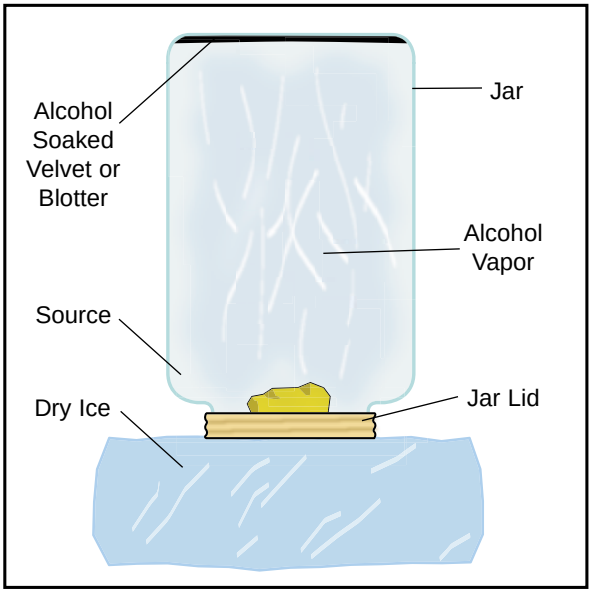

Figure 1.

- Allow the apparatus to sit 5-6 minutes; then place your hand on the top of the jar to warm it (this is the side opposite the dry ice side); be careful not to touch the dry ice.
- Turn off the room lights and use the flashlight to shine a beam of light through the side of the jar; look closely for ionization trails in the beam.
- Note characteristics of the trails and sketch several of the ones you observe in your chamber.

PROBLEMS????????

- If you can only see mist or "smoke" wait another ten minutes or so for the apparatus to get really cold.
- If, after waiting, no tracks appear, check to make sure that you have an airtight seal; if not, tighten the lid and try again (you may have to add more alcohol).
- If only one or two tracks are visible, change the position of the light; it may also help to place a sheet of black construction paper against one side of the jar to visualize the tracks.
- If you still are not successful, try using a larger jar and a different radiation source; a source that emits alpha and beta particles is best; avoid pure gamma sources.

ANSWER THE FOLLOWING QUESTIONS

1. How many different shapes of tracks did you see?

2. Why do you think that tracks have different appearances?

3. Do you think that the types of tracks observed might be different if you used a different radiation source? Why or why not?

4. After drawing several of the tracks you observed, compare the drawings with those of other groups. Are they all the same? How are they different? How are they similar?

5. Which group observed the most tracks? Which observed the least tracks? Why do you think this is so?

6. Do you think that tracks might still be observed if you removed the radioactive source? Why or why not?

7. Predict what would happen if a strong magnet were placed near the jar. Would this alter any of the tracks and, if so, how?