Australian Government

Cloud chamber experiment

Teachers notes

Adapted from "Science, Society and America's Nuclear Waste – Ionising Radiation" by US Department of Energy, July 1995.
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Purpose:

The Cloud Chamber experiment illustrates that though radiation cannot be detected with the senses, it is possible to observe the result of radioactive decay.

Concepts:

1. Radiation cannot be detected directly by using our senses, but can be indirectly detected.

Duration of Lesson:

One 50-minute class period.

Objectives:

As a result of the participation in the Cloud Chamber experience, the student will be able to:

1. Describe that as charged particles pass through the chamber, they leave an observable track much like the vapour train of a jet plane; and

2. Conclude that what he/she has observed is the result of radioactive decay.

Optional Objectives:

1. Through measurement of tracks in the Cloud Chamber, the student will be able to determine which type of radiation travels furthest from its source.

2. By holding a strong magnet next to the Cloud Chamber, the student will be able to deduce what effect, if any, a magnet has on radiation.

3. By wrapping the source alternatively in paper, aluminium foil, plastic wrap and cloth, the student will be able to conclude what effect, if any, shielding has on radiation.

Skills:

Drawing conclusions, measuring, note-taking, observing, deductive reasoning, working in groups.

Vocabulary:

Alpha particle, beta particle, gamma ray.

Materials:

Activity Sheets

The Cloud Chamber

Background Notes

Safe Use of Dry Ice

Cloud Chamber

Suggested Procedure:

1. It is suggested that students work in small groups to derive maximum benefit from this experiment. Students should take notes of their observations as the experiment progresses.

2. Prepare cloud chamber as directed on activity sheet.

3. Most of the tracks will be about 1.3cm long and quite sharp. Explain or lead students to derive that these are made by alpha radiation.

4. Sometimes you will see longer, thinner tracks. Explain or lead students to derive that these are made by beta radiation.

5. Occasionally, you may see some twisting, circling tracks that are so faint they are difficult to see. Explain or lead the students to derive that these are caused by gamma radiation.

Sample Discussion Questions:

1. You could not actually see the radiation. What kind of observation did you experience? (Indirect observation)

2. What is actually happening to the radioactive source? (The radioactive source is decaying.)

3. What radiation "footprints" did you see? Describe them. (Answers will vary. See descriptions on activity sheet.)

Teacher Evaluation of Student Performance:

Student notes of observations taken as the Cloud Chamber activities progress may be collected and used to determine degree of comprehension.

Student response to questions/participation in discussion as the experiment progresses will indicate comprehension.

Enrichment:

The following are additional experiments that can be done with a Cloud Chamber:

Experiment A: How far can radiation travel?

Carefully mark the top of the jar at the point where the alpha tracks disappear. Measure how far the radiation travelled from the source. Then measure the beta tracks. Which type of radiation travelled furthest from the source?

Experiment B: Does a magnet affect radiation?

Hold the north end of a strong magnet next to the jar. Note any effect on each of the alpha, beta and gamma tracks.

Experiment C: How does the shielding affect radiation?

Wrap the source in a sheet of paper. Which types of radiation are still visible?

Wrap the sample in a sheet of aluminium foil. Is the effect the same?

What happens if you use the plastic wrap or cloth?

What types of radiation are stopped by each material?

(Be sure to allow time to cool the jar after each time it is opened.)

If you have access to a Geiger counter, students can test various items to see if they are radioactive. Materials that can be used include luminous clock dials from old clocks, “lite” salt (potassium chloride), some cloisonné jewellery, orange-glazed Fiestaware dishes, and smoke detectors. Students can also test the background radiation present in the classroom.

SAFE USE OF DRY ICE

Caution: Dry ice must be handled with care.

1. Dry ice must not be tasted, placed near the mouth or allow to touch the skin, as the extremely low temperature could cause a burn.

2. Dry ice must not be placed in glass jars, bottles, or tightly sealed containers. They could explode due to the high pressure.

3. Do not breathe the gas from dry ice in an enclosed space. Store the dry ice in a container such as a Styrofoam cooler until you are ready to use it.

4. When you are finished with the dry ice, open the container and let the dry ice dissipate in a safe place, preferably outside where students or others will not find it and play with it.

THE CLOUD CHAMBER – BACKGROUND NOTES

Materials Required

- Plastic container for the cloud chamber (available through science supply companies).
- Radioactive Sources. You can use a multi decay source such as uranium or individual sources, measuring the effects of each type of decay individually.
- Dry ice.
- Ethyl alcohol
- Flat black spray paint
- Blotter paper (one strip about 5 centimetres wide and long enough to fit around the inside of the jar)
- Cotton or silk cloth
- Tongs or gloves for handling dry ice
- Flashlight

What To Look For

The air layer near the bottom of the jar is supersaturated with alcohol vapour. (There is more vapour in the air than is usual and as a result, the gas will form liquid droplets whenever it is disturbed.) Dust in the jar will cause the alcohol to condense into small droplets, which you can see as a fine mist falling from the bottom of the jar during the first half hour that you are using the chamber. After a while, however, most of the dust will have fallen to the bottom of the dish and the mist will disappear.

The tracks formed by the radiation appear to be white lines in the cloud. As the radiation passes through, it knocks the electrons out of the atoms in the air. The alcohol vapour then condenses on the charged particles, forming little “storms” along the path. These tracks disappear almost immediately.

Students may be able to find three kinds of tracks. (See activity sheet.)
After a while the tracks will become faint because the radiation has affected so many of the atoms in the jar. When this happens, rub the top of the jar briskly with the cotton or silk cloth. The static electricity that is produced will clear the jar and cause the tracks to become visible again.

THE CLOUD CHAMBER – ACTIVITY SHEET

Three important forms of ionising radiation are alpha and beta particles and gamma rays. Alpha particles are identical to the nucleus of a helium atom. They have a double positive charge (two protons) and are relatively large. Beta particles are much smaller. They carry a single negative charge (one electron). Gamma rays have no charge.

Ionising radiation cannot be detected using our senses. However, a cloud chamber allows you to see the tracks created while moving through a dense gas. When charged particles pass through the chamber, they leave a track much like a vapour trail of a jet plane.

PURPOSE:

What is the purpose of this activity?

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HYPOTHESIS:

Directions: Draw a picture of what you expect the radiation tracks to look like. Remember that there three types of radiation: alpha and beta particles and gamma rays.

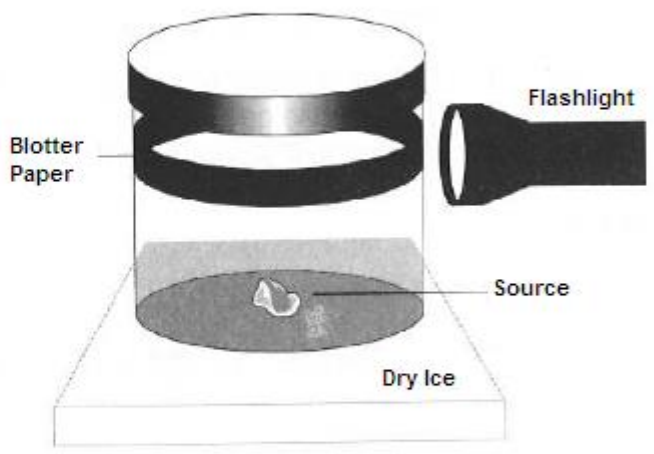
MATERIALS:

- Small transparent container with transparent, tight-fitting lid (such as a refrigerator jar or cloud chamber purchased from scientific supply shop)
- Flat black spray paint
- Blotter paper (one strip about 5 centimetres wide and long enough to fit around the inside of the jar)
- Cotton or silk cloth
- Ethyl alcohol
- Source (uranium ore, numeral from a luminous dial, purchased source, etc.)
- Masking tape
- "Dry ice"
- Tongs or gloves for handling dry ice
- Flashlight

CAUTION: DO NOT HANDLE DRY ICE WITH YOUR BARE HANDS. USE TONGS OR GLOVES.

PROCEDURE:

1. Paint the bottom of the jar with the black paint. Allow the paint to dry.
2. Attach the blotter paper to the inside of the jar near the top. You may need to tape it.
3. Pour a very thin layer of ethyl alcohol on the bottom of the jar.
4. Soak the blotting paper ring with alcohol.
5. Place the radiation source on the bottom of the jar and put the lid on tightly. Tape around the lid.
6. Place the jar on top of the dry ice.
7. Allow the jar to super cool for 5 minutes.
8. Darken the room and shine the flashlight through the side of the jar. Through the top, you should see white lines or "tracks" inside the jar close to the bottom.
9. You may be able to find three kinds of tracks:
    a. Most of the tracks will be about 1.3cm long and quite sharp. These are made of alpha radiation.
    b. Sometimes you will see longer, thinner tracks. These are made by beta radiation.
    c. Occasionally, you may see some twisting, circling tracks that are so faint that they are difficult to see. These are caused by gamma radiation.



OBSERVATIONS:

Directions: Draw and label pictures of what you see in the cloud chamber.

CONCLUSION:

1. Were you able to observe radiation directly or indirectly in the cloud chamber?

2. Write a concluding statement explaining how we know radiation exists.