Cloud Chamber

Radioactive elements continually undergo a process of radioactive decay during which their nuclei emit high speed particles and rays. These are much too small to be seen under a microscope. The Cloud Chamber is an instrument designed for the study of the trails of these radioactive emissions. The investigation is accomplished in the following way. First, the air must be saturated with water or alcohol vapor. When the high energy particles plow through the air, electrons are knocked loose from some of the atoms and form ions. Ions act as excellent centers for condensation. This condensation, however, must be stimulated by cooling the air. The water vapor or alcohol condenses on the ions, leaving a vapor trail which clearly reveals the path of the ray.

INVESTIGATIONS—Time: 30 Minutes

Part 1 Observing radioactive decay

Pre-lab activity

Several days before the investigation, place a tightly-bound, unexposed roll of photographic film in a drawer next to the uranium ore sample (uraninite) from the kit. It should be left there for at least 24 hours. Then, have the film developed and begin the discussion on the day of the investigation with an examination of the film.

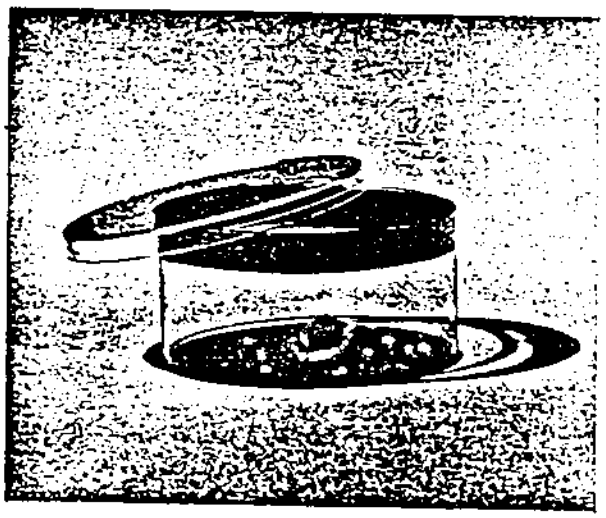
Procedure

Discuss the partial exposure which resulted on the roll of photographic film. The students should speculate on how this phenomenon occurred. From the basis of the results of this experiment, begin the investigation with the Cloud Chamber.

Provide the students with the *Cloud Chamber Kit* and the background information provided in the *Introduction*. Three types of rays are given off by a radioactive element. They are *alpha particles* (positive nuclei of helium atoms traveling at high speed), *beta particles* (high speed negative electrons), and *gamma rays* (electromagnetic waves similar to X-rays).

Saturate the felt band on the inside of the Cloud Chamber with alcohol. Quickly place the radioactive source (uranium ore) on the bottom of the chamber and cover the entire chamber. Place a slab of dry ice in a tinfoil or paper dish and then set the Cloud Chamber on its surface. Wait until the air becomes saturated. Viewing will be much better if the lights are turned off and each student is provided with a lamp similar to the one provided in the Hubbard *Radiation Kit*. The lamp should be directed from above down onto the black surface of the Cloud Chamber. Observe the tracks of the particles and answer the following questions.

SPECIFICATIONS OF MATERIALS



plastic cloud chamber (3¼" diameter)
uranium ore (or other radioactive source)
lantern mantle; Fiestaware
Additional materials needed:
photographic film, unexposed roll
alcohol, 95% ethyl
dry ice
lamp (provided in Hubbard *Radiation Kit*) → flashlight
magnet → optional

What you will see:

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

You may be able to find three kinds of tracks:

a. Most of the tracks will be about one-half inch long and quite sharp. These are made by alpha radiation.

b. Sometimes you will see longer, thinner tracks. These are made by beta radiation.

c. Occasionally you will see some twisting, circling tracks that are so faint that they are difficult to see. These are caused by gamma radiation.

After awhile the tracks will become faint because the radiation has affected so many of the atoms in the chamber. When this happens, rub the top of the chamber briskly with a cotton or silk cloth. The static electricity that is produced will clear the chamber and cause the tracks to become visible again.

Things to do with your Cloud Chamber

Experiment A: How far can radiation travel?

Carefully mark the top of the chamber at the point where the alpha tracks disappear. Measure how far the radiation traveled from the radioactive source. Then measure the beta tracks. Which type of radiation travels the farthest from the source?

Experiment B: Does a magnet affect radiation?

Hold the north end of a strong magnet next to the chamber. Do you see any effect on the alpha tracks? On the beta?

Experiment C: Radiation Detection

Count the number of tracks that you can see in ten seconds. If your school has a Geiger counter, use it to count radiation from the source for ten seconds. Which type of count is more accurate?

Experiment D: Shielding

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

Wrap the sample in a sheet of aluminum foil. Is the effect the same? Use as many different materials as you can find, including plastic, cloth, etc. Which types of radiation are stopped by each type of material?

Experiment E: Different Source

Remove the source from the cloud chamber. Replace the cover. Allow the chamber to cool off again before continuing.

Hold a wrist watch or clock with a luminous dial (containing radium) close to the side of the chamber. Do you see any radiation tracks? What type?

Experiment F: Natural Radiation

Are any tracks visible when no source of radiation is near the chamber?

What type of radiation is found in our environment?

CLOUD CHAMBER

Look Down Through Lid