

OPERATING INSTRUCTIONS

The Tracker Diffusion Cloud Chamber No. 32308

1. Introduction

The Tracker Diffusion Cloud Chamber enables students to see the tracks left by subatomic particles. You use a volatile alcohol and a cooling environment in The Tracker Diffusion Cloud Chamber to produce a supersaturated vapor. The vapor rapidly condenses due to a temperature gradient caused after you add dry ice to the bottom tank of the cloud chamber. When you insert a radioactive source into the chamber, the source emits alpha and beta particles that ionize this supersaturated vapor. As the ionized vapor continuously condenses, it leaves a trail of alcohol droplets; these tracks are left by the path of the alpha and beta particles. You can photograph both the commercial source tracks and the tracks left by naturally occurring cosmic radiation through the large window of The Tracker. You can also see “secondary” electrons produced by gamma rays.

2. Description

The diffusion-type cloud chamber includes a 100VAC 50/60Hz power source that provides 1,000V at 350 μ A to clear ionization tracks immediately after their occurrence. This action allows for immediate new track formation; you can take distinct photographs during the continuous condensation process.

The dry ice tank is a 20 x 30 x 12.5cm metal box that sits within a styrofoam-lined 24 x 24 x 15cm metal larger box. This tank arrangement forms an insulating seal to keep the dry ice cold for many hours. The inner metal box has four springs inside that support a dry-ice slab.

Two electric lamp lighting sources mount neatly alongside the ionization tank with its 20 x 20cm top observation window. Side observation windows are also built into the ionization tank.

A 14cm-long rod with a 1cm needle point at one end is provided to handle the radioactive source.

In addition to about 1 kilogram of dry ice you will need to obtain a radioactive source and some methyl alcohol. We suggest the following:

<u>Description</u>	<u>Catalog No.</u>
Alpha-Beta Needle Source Set	00035-96
Methyl Alcohol, CH ₃ OH	37230-1

You should also have on hand a saw for cutting the dry ice, and proper gloves for your safety in handling the dry ice.

3. Setup

Caution! At no time should you handle the apparatus with the power switch turned on. Although the power supply has a high resistance built in, the voltage of the output terminal is 1,000 volts.

(The ionization tank is the topmost 5cm deep metal tank with the viewing windows.) Detach the ionization tank by pushing the side levers of the two attaching hooks into the hooks. While holding the side levers in, snap the bottom of the hook up.

Place a 4cm-thick slab of dry ice on the springs in the interior tank. Do not place the ice within the springs.

Fasten the ionization tank back onto the dry ice tank. You will again have to push the side levers in on the hooks while you are fastening them. Level the apparatus, using the three leveling screws at the bottom of the tank. One of these leveling screws (the single one on the radioactive source side) is known as the horizontal adjustment screw.

Apply a generous amount of alcohol to saturate the felt-covered bottom plate inside the ionization tank and the felt-wrapped wires. The felt side should be facing down. Be sure the top lid to the chamber is securely shut and there are no air gaps between the lid and the chamber.

Position the lamps on the sides of the observation windows. The metal overhang will hold them securely in place. Plug the power cord in and turn the power switch on. (If at any time the power fails to go on, the fuse may need to be replaced. It is located at the left-hand exterior of the power supply box. A flat blade screwdriver can be used to exchange the fuse; a spare is included.)

It should not take more than about 15 minutes for favorable observation conditions to develop. You should be able to see cosmic ray tracks at this time. The tracks will appear every few seconds.

Use the needle point of the provided rod to pierce the cork of a radioactive source. Insert the plain end of the rod into the rubber plug and fit it in place in the ionization tank. You can then slide the needle to position the source where you want it placed. Be careful not to rub any radioactive source material off its needle. Store the source according to its instructions.

After about 15 minutes, move the horizontal adjustment screw (the single leveling screw on the source side of the tank) so that the radiation side is slightly higher than its opposite side. The alpha and beta tracks can now be observed.

Caution! Make sure the power switch is "off" when cleaning the observation windows!

Should the observation window become cloudy, apply a thin film of distilled water to the interior of the windows. In fact, if the air is particularly humid, you may wish to apply the film to the window interior before the demonstration is undertaken.

To improve the visibility of the beta particles, view the demonstration in a darkened room.

4. Interpretation of the Tracks

The following are characteristic track patterns.

Short straight paths indicate movement by alpha particles.

Weak tracks that may "wobble" signify beta tracks. Some beta tracks left by very fast electrons are straight, or rectilinear; but this is not the norm.

Weak tracks that are also crooked are displayed by gamma radiation. This secondary electrons'

radiation is released from air molecules by Compton scattering, pair production or the photoelectric effect of the gamma rays.

The track activity in the chamber may be noticeable even before you insert the radioactive source into the chamber. You may see fast beta particles and secondary electrons of gamma particles that penetrate through the chamber wall, as well as alpha particles caused by radium emanation from the atmospheric air that is enclosed in the chamber.

When you bring the radioactive source near the chamber, you will see a high increase of the secondary electrons due to gamma particles, and a low increase of beta radiation, part of which is absorbed by the glass of the observation window.

You will see a high increase of all types of radiation when you insert the radioactive source into the chamber.

5. Troubleshooting

If you are having trouble getting the cloud chamber to show tracks, here are a few things to consider:

- A) While other alcohols (such as ethyl alcohol) will work, methyl alcohol gives the best results.
- B) The felt should be soaked until soggy, but there should not be so much alcohol as to leave a puddle. Too much alcohol will create a thermal insulation. Too little will prevent a vapor from forming. The felt side should be down.
- C) Do not have the clearing field on during the first 15 minutes of use in order to allow the cloud chamber environment to establish itself first. Leaving the clearing field on at this point will erase the initial tracks as they are formed.
- D) Be sure the light is on to view the tracks. If you are using disk sources, you may need a brighter source of light shining into the side windows in order to see the tracks.
- E) Your dry ice should be big enough to cover the dimensions of the bottom of the cloud chamber. If it is not, you may get convection currents. **Always be careful when handling dry ice.**
- F) Check to be sure no air leaks are causing convection currents.
- G) Alpha particles are very weak and may not penetrate the glass of the chamber. Be sure the source is fitted into the proper opening to the chamber.
- H) You might want to pour a light coating of methyl alcohol onto the top of the dry ice. This will ensure a good thermal contact between the floor of the chamber and the dry ice.
- I) If the cloud chamber is working properly you should start to see a few cosmic ray tracks. When initially testing the chamber it may be a good idea to leave the clearing field off. If you see the cosmic ray tracks and you are still not seeing the particle tracks, check the radioactive source.

6. Maintenance

The Tracker Diffusion Cloud Chamber requires no special maintenance. If you should experience any difficulty with a Tracker, please contact Central Scientific Company, giving details of the problem. To ensure better service, please do not return any apparatus to Central Scientific Company until we have sent you authorization.

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