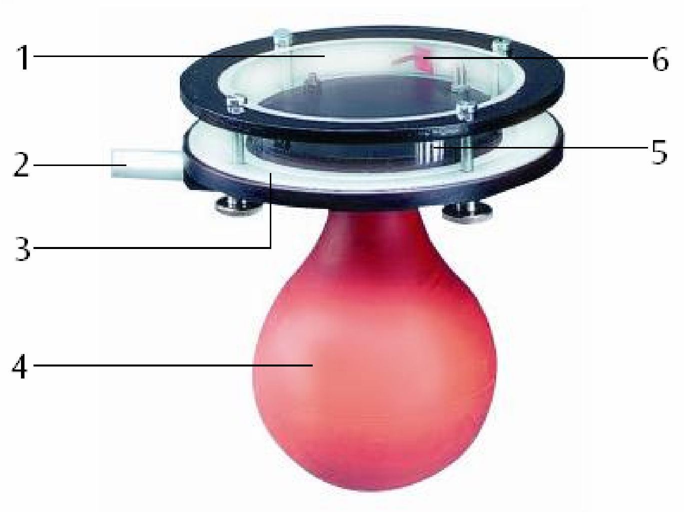
3B SCIENTIFIC® PHYSICS

Cloud chamber U8483220

Instruction sheet

11/07 SP/ALF



1 Cover plate
2 Supporting rod
3 Base-plate
4 Rubber bellows
5 Filling nozzle (with thread for attaching radiation cartridge)
6 Absorption foil on hinged support

1. Safety instructions

- In experiments with radioactive substances, observe the regulations that currently apply for the region (e.g., radiation protection regulations).

2. Description

The cloud chamber is used for making the tracks of ionising radiation visible (especially for α radiation).

The cloud chamber consists of a thick plate of Plexiglas fixed above a base-plate with a gas-tight seal. In the centre of the base-plate there is a nozzle onto which a rubber bellows is pushed. There is also a foam rubber pad recessed into the base-plate, which provides resistance against the air flow during the adiabatic expansion of the gas filling. In the chamber there is an absorption foil (paper) held on a hinged support. One suitable radiation source for use with the cloud chamber is the radium radiation cartridge (U8483110), which can be screwed into an off-centre threaded hole in the base-plate. A supporting rod on the side of the cloud chamber allows it to be clamped to a stand.

The fluid used in the cloud chamber is a mixture of methanol and water in the proportion 50:50.

A cloud chamber such as this does not need to have its design licensed, but this model is in fact licensed as a radiation-proof holder for the radiation cartridge U8483110. The cloud chamber thus qualifies under radiation protection provisions (e.g. II. SVO § 9, 4 in Germany), whereby its design is officially approved (PTB No. VI B/S 3516) and licensed (licensing document BW 8/65/II).

3. Technical data

Chamber dimensions:	15 mm x 90 mm dia.
Supporting rod:	45 mm x 10 mm dia.
Weight:	600 g approx.
Cloud chamber fluid:	methanol/water 30 ml

4. Operating principle

Experiments by R. von Helmholtz in 1887 showed that ions in an atmosphere supersaturated with water vapour act as condensation centres around which cloud droplets form. The charged particles emitted from radioactive elements generate large numbers of ion pairs along their paths in the surrounding atmosphere. If the air is supersaturated with water vapour, the ions act as condensation centres, and with suitable illumination the tracks of the particles become visible as fine vapour trails ("condensation trails").

In the cloud chamber the supersaturation of the surrounding air is produced by sudden expansion and resultant cooling of the gas filling.

5. Operation

5.1 General instructions

1. When the cloud chamber is being closed, the knurled screws must be tightened firmly to ensure an airtight seal. By immersing the chamber under water and squeezing the rubber bellows, any leakage will become apparent.

2. It is essential for the cloud chamber to be kept free of dust particles. When withdrawing the radiation cartridge from the cloud chamber, the filling nozzle must be closed with a rubber bung. The risk of contamination is especially great when the chamber is taken apart. Therefore, do not open the chamber more often than is necessary, and before reassembling it, clean it thoroughly with a damp chamois-leather.

3. The cloud chamber remains usable for a very long time if the radiation cartridge remains attached to the filling nozzle or the nozzle is closed by an air-tight bung.

4. The radiation cartridge is tightly sealed to prevent any emanation. Even when it remains in the cloud chamber for a long time, there is no risk of radioactive contamination.

5. The accurately parallel cover plate allows particle tracks to be photographed with no optical distortion. For this the illumination should be arranged, using apertures, so that the light beam does not fall on the black base-plate.

6. If a deposit of moisture forms on the Plexiglas plate during storage or due to uneven heating by the illuminating lights, it can be eliminated by placing a warm woollen cloth over the plate.

5.2 Experiment procedure

- Using a pipette, introduce the cloud chamber fluid (about 10 to 20 drops) into the chamber through the filling nozzle, and distribute it evenly by shaking.
- Screw the radiation cartridge into the filling nozzle, after first using a screwdriver or flat object to rotate the cartridge shaft so that its flattened end faces towards the middle of the chamber.
- Align the cloud chamber horizontally by clamping it on a stand.
- Set up the illumination so that the light beam enters the chamber from the side at about 90° to the direction of the radiation from the radioactive source.
- Rub the cover plate with a woollen cloth, without applying pressure.
- Squeeze the rubber bellows tightly, hold for 1 to 2 seconds, then release.

On releasing the rubber bellows, the tracks of the α–particles become visible as vapour trails. They slowly disappear after 1 to 2 seconds. The process can be repeated after waiting only a few seconds.

- By tilting the cloud chamber, bring the absorption foil into the path of the radiation and observe the absorption of the α–particles on paper.

5.3 Comments

1. When the cover plate is rubbed, an electric field is generated between it and the base-plate, which purges the chamber of residual ions, which would interfere with the experiment by causing a haze. If the photographs obtained after repeated operation of the rubber bellows are blurred, the cover plate needs to be rubbed again.

2. In the photographs obtained from the cloud chamber, it can clearly be seen that the trails are of different lengths. A large fraction of them are only about half as long as the longest ones. From the different lengths of the trails, it can be concluded that the particles are emitted at differing velocities.

Each α-emitting substance (nuclide) is characterised by a unique emission energy, and a corresponding range of penetration through air. The α-particles from radium 226 have a range of 3.6 cm (at atmospheric pressure). The α–particles with the long trails are emitted by a decay product (Ra A, range 6.3 cm). The radioactive material in the radiation cartridge is surrounded by an extremely thin metal foil. Consequently, the observed ranges are slightly smaller than the values given in the tables.

If an α–particle collides with an atomic nucleus in its flight, its direction is changed and the affected nucleus is set in motion, thus producing a trail of its own. Such collisions are very rare, and therefore you will be very lucky if you are able to observe such an event.

3. If, instead of paper, a very thin film of Hostaphan is placed in front of the source (thickness 5 to 10 μm, or 0.7 to 1.5 mg/cm^2), it can be seen that nearly all the α–particles pass through the film without any significant deviation or shortening of their range. Thus, α–particles can pass through thin films of materials. This experiment is analogous in a qualitative way to Rutherford's scattering experiment, and shows that the structure of matter consists largely of gaps. Instead of Hostaphan, thin foils of other materials can also be used, such as gold leaf. The easiest way to handle such a foil is to tape it over a hole in a strip of adhesive tape (Sellotape or Scotch Tape).

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