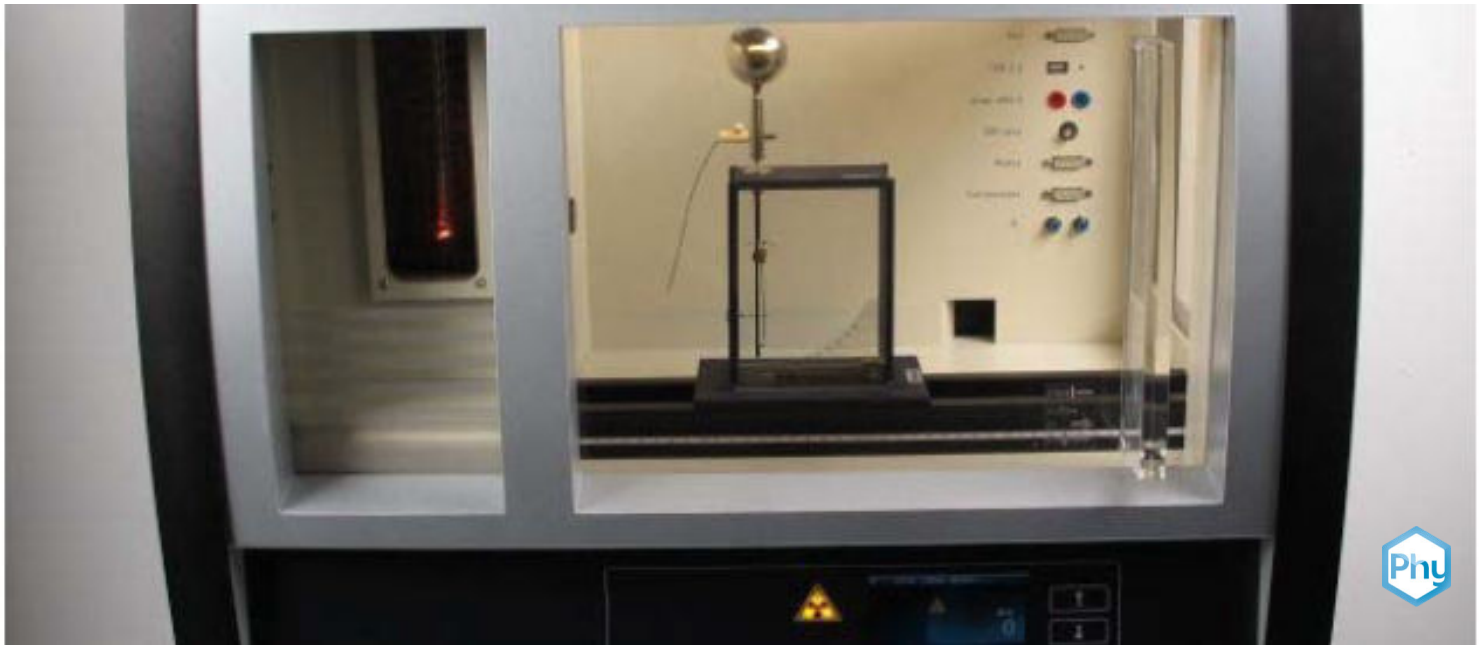
Ionizing effect of X-radiation



Physics > Modern Physics > Production & use of X-rays

Difficulty level	Group size	Preparation time	Execution time
hard	2	45+ minutes	45+ minutes

This content can also be found online at:

http://localhost:1337/c/5f607cff7e9d5b0003e1e641

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General information

Application

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Setup

Most applications of X rays are based on their ability to pass through matter. Since this ability is dependent on the density of the matter, imaging of the interior of objects and even peaple becomes possible. This has wide usage in fields such as medicine or security.

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Other information (1/2)

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Prior knowledge

The prior knowledge required for this experiment is found in the Theory section.

Main principle

As well as the outgoing radiation from a radioactive emitter is able to ionize air, so also X-radiation shows an ionizing effect. When air is penetrated by X-radiation, it is electrically conductive. This is tested on a charged electroscope.

Other information (2/2)

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Learning objective

The goal of this experiment is to get to investigate the ionizing effect of X-radiation.

Tasks

- Illustrate the ionizing effect of X-radiation with the aid of an electroscope.
- Examine the influence of the anode voltage and amperage on the duration until the electroscope is discharged.

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Theory

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X-rays are not charged since they are not deflected by electric or magnetic fields even so they are able to discharge the electroscope.

Roentgen discovered this effect in one of his first experiment 1895 and suspect that the discharge occurred because the X-ray made the air around conductive. The X-radiation produces within the air and the migration of this ions induces the conductivity of the gas.

The importance of X-rays to medical therapy is based on this ionizing effect. By improper handling of X-radiation there is the danger of cell damages. Therefore, the legislature requires strict safety precautions when handling with X-radiation.

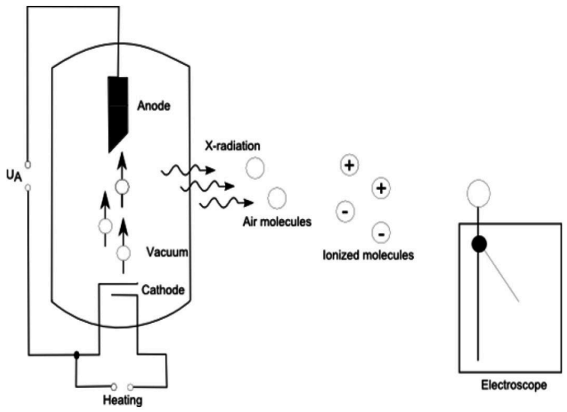

Fig. 1: Schematic diagram of the experiment.

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Equipment

Position	Material	Item No.	Quantity
1	XR 4.0 expert unit, 35 kV	09057-99	1
2	XR4 X-ray Plug-in Cu tube	09057-51	1
3	XR 4.0 X-ray dosimetry upgrade set	09175-88	1

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Setup and procedure

Setup

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Fix a diaphragm tube in the X-ray outlet tube (5 mm tube diameter).

The electroscope with the plugged conductor ball is placed in the experimenting area. An approximately 20 cm long piece of copper wire is bent so that the two wire ends can be plugged together in a banana plug. The banana plug with the wire loop is plugged into the free transversal bore of the electroscope. The wire loop is bent so that it is hit by the X-ray beam.

Note

Details concerning the operation of the X-ray unit can be found in the respective operating instruction.

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Procedure

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Set the anode voltage and current in the “X-ray parameters” menu. Select a voltage of 35 kV and a current intensity of 1 mA.

Charge up the amber rod by firm rubbing with the felt. Using the rod, charge the electroscope. Maybe there is a need to repeat this procedure until the electroscope is fully charged. After the pointer of the electroscope has come to rest, you wait some time and then close the door of the experimental area. Switch on the X-radiation and start the stopwatch.

The experiment should be repeated several times with different voltages (steps of 5 kV, current constant) and current intensities (steps of 0.1 mA, voltage constant).

Alternative Procedure

Alternative you can use the high voltage power supply to charge the electroscope. Choose a voltage of 0.9 kV for charging.

Evaluation

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When the X-radiation is switched off, the charged electroscope is not discharged. When the X-radiation is switched on, the charged electroscope discharges within a short time. The air in the vicinity of the wire loop is traversed by the X-rays and ionized. Thus it is conductive to a certain grade, so that the charge flows from the electroscope. The time needed for discharging the electroscope depends on the used current and voltage. The lower current and voltage are, the longer it takes to discharge the electroscope. Once the voltage falls below a certain value (approx. 6 kV with I_A = 1.0 mA)there is no discharge. This means that below this value no X-radiation is generated.

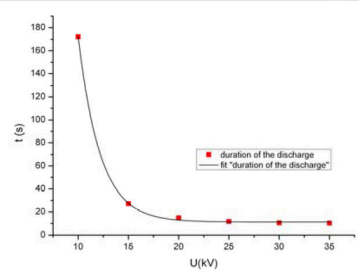

Fig. 2: Speed of discharge as a function of U_A.

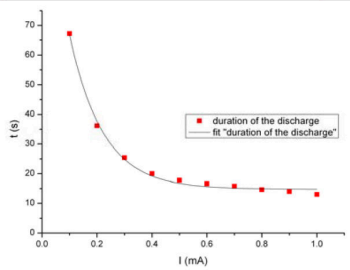

Fig. 3: Speed of discharge as a function of I_A.

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