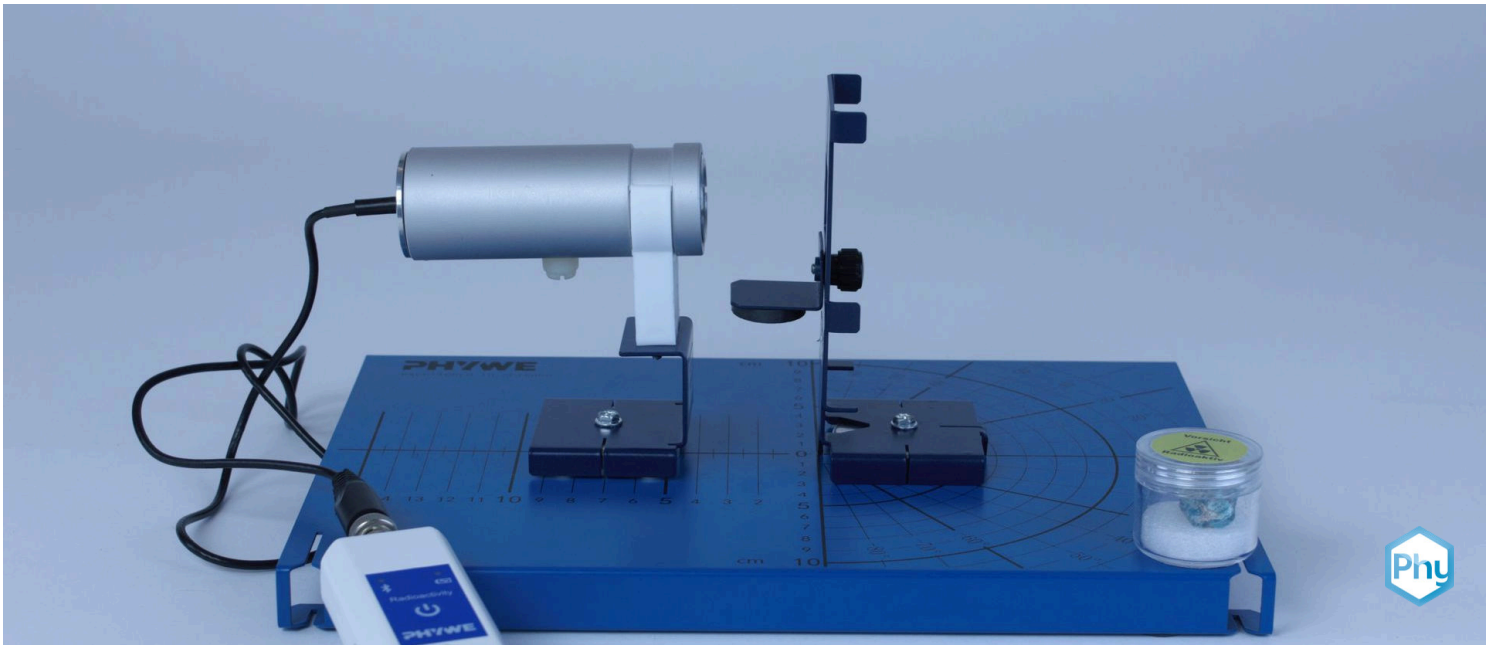
The influence of distance on the intensity of radiation with Cobra SMARTsense



Physics > Modern Physics > Radioactivity

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5f4bf95f7b2768000356b7cc

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Teacher information

Application

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Determining the influence of distance on intensity

One of the most effective methods of reducing exposure to ionising radiation is to maintain a maximum distance from the radiation source. The quadratic dependence of dose line and distance resulting from geometrical considerations requires a point source and a uniform and absorption-free propagation of the radiation in all directions in space. The columbit is a mixed radiation source. Due to the short range of the α radiation, it should be shielded with paper. The share of the ɣ radiation is very small. The investigation is therefore carried out on the β radiation.

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Other teacher information (1/2)

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Prior knowledge

As previous knowledge, the students should have mastered terms such as counting rate, zero rate and the use of the Geiger-Müller counter. Furthermore, the students should be aware that radioactivity is a natural process and that it is a statistically fluctuating process. Furthermore, the different types of radiation should be known.

Scientific principle

The relationship between the distance and the radiation intensity is determined using the columbit sample by increasing the distance between the Geiger-Müller counter tube and the sample.

Other teacher information (2/2)

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Learning objective

The students use the experiment to derive the relationship between the distance and the radiation intensity of the radioactive source.

Tasks

The students investigate how the intensity of radiation from a radioactive source changes with increasing distance.

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Safety instructions

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- The distance between the marks from the preparation and the counting tube is not identical with the distance from the radioactive substance and counting tube, which is essential for the evaluation. Therefore a distance correction is necessary.
- When checking the proportionality of Z and, due to the statistical nature of the decay processes, larger fluctuations of the measured values are to be expected.
- In this experiment, the students should gain the insight that the radiation intensity decreases with distance from the radioactive source and that the law of distance should be confirmed experimentally. If there is not enough time to carry out the entire experiment, the experimental confirmation of the law of distance can be dispensed with.
- The general instructions for safe experimentation in science lessons apply to this experiment.

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Student Information

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Motivation

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The Tihange nuclear power plant near the Belgian city of Huy

To protect your own health, handle radioactive material only briefly and with adequate clearance or shielding. But even nuclear power plants can be found in the immediate vicinity of cities. But what distance is necessary depending on the type of radioactive radiation?

Investigate how the radiation intensity of a radioactive source changes with increasing distance.

Tasks

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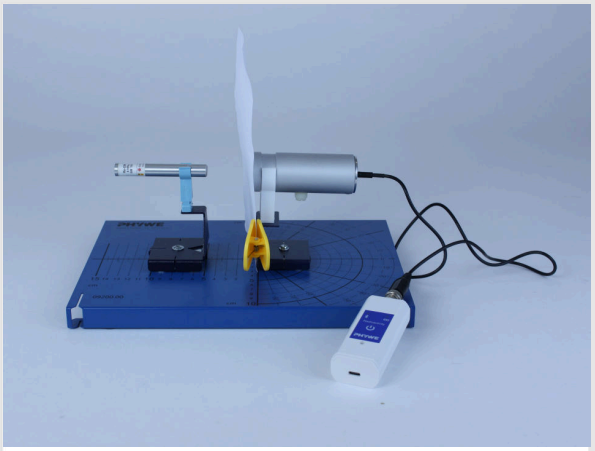

Experimental set-up with a sheet of paper in the beam path

- Record the pulse rate of a α emitter for different ranges first in the air and then with a sheet of paper in the beam path
- Compare the measurement series and conclude on the range of α particles.
- Explain what determines the range in the air.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense- Radioactivity (Bluetooth + USB)	12937-01	1
2	Base plate for radioactivity	09200-00	1
3	Holder for SMARTsense counter tube on holding magnet	09207-00	1
4	Plate holder on fixing magnet	09203-00	1
5	Columbite, natural mineral	08464-01	1
6	Defl.magnets f. plate holder,2pcs	09203-02	1
7	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up (1/3)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

Set-up (2/3)

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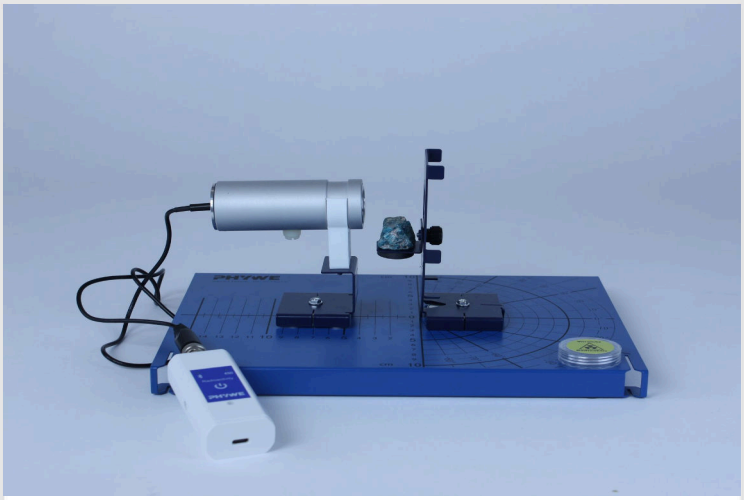

Complete test setup with radioactive sample

- Clamp the Geiger-Müller counter tube into the counter tube holder, place it on the mounting plate so that the edge of the counter tube holder points to the 1.5 cm mark of the length graduation.
- Attach a deflecting magnet to the plate holder using the knurled screws so that a support surface is created. Place the plate holder on the mounting plate and move it so that the bearing surface is above the zero mark of the length graduation.

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Set-up (3/3)

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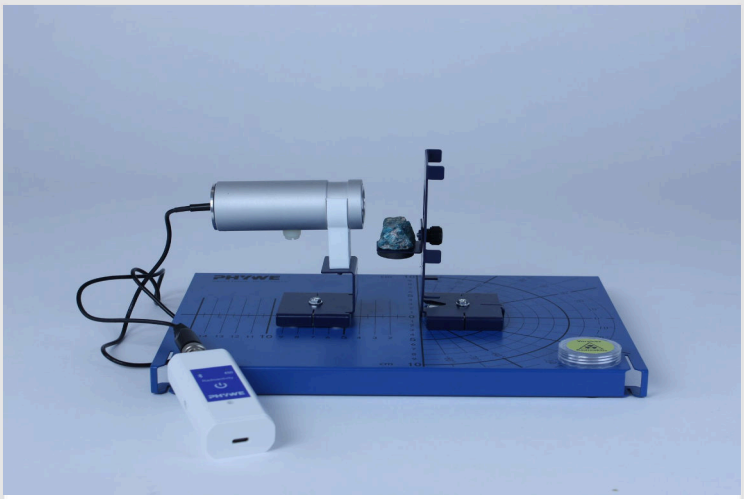

Complete test setup with radioactive sample

- Connect the Geiger-Müller counter tube to the sensor unit.
- Connect the sensor to the PHYWE Measure app on the tablet by pressing the Bluetooth button for 3 seconds. Then the radioactivity sensor can be selected in the app.

Procedure (1/2)

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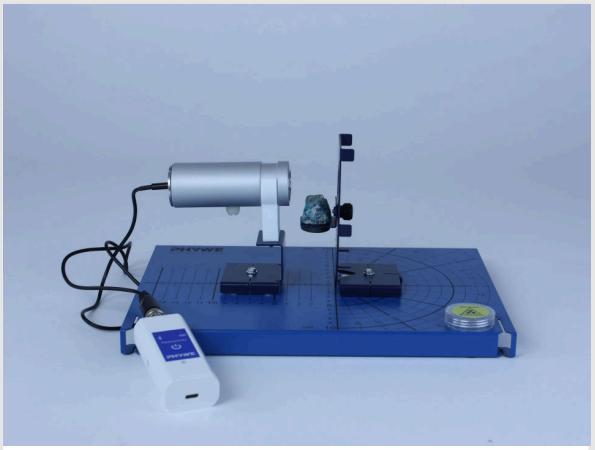

Test setup without absorber material in the beam path

- First determine the zero rate. To do this, read three measured values without the sample and enter them in the table in the protocol.
- Place the columbit sample on the support surface so that it is exactly above the zero mark of the length graduation of the mounting plate. Attach a sheet of paper between the columbitprobe and the counter tube.

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Procedure (2/2)

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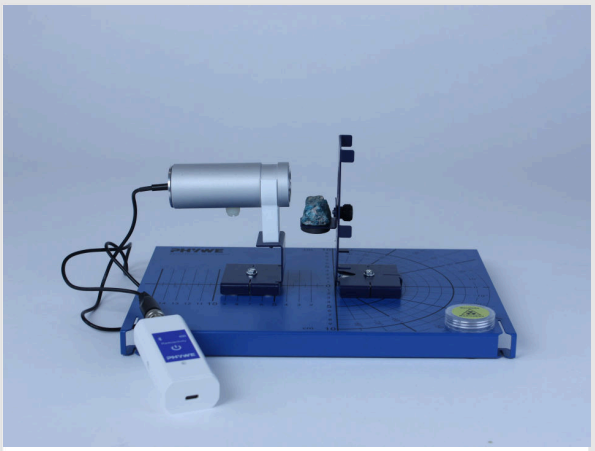

Test setup without absorber material in the beam path

- Record three measured values again and note them in the table in the protocol.
- Move the counter tube to the length graduation 2 cm and repeat the measurement. Also take measurements at a distance of 2.5 cm, 3 cm, 3.5 cm, 4 cm, 5 cm, 6 cm, 7 cm, 8 cm, 9 cm, 10 cm steps.

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Report

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Observation (1/2)

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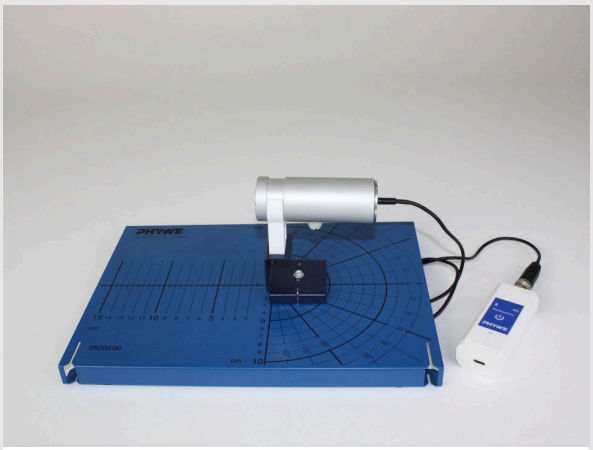

Determining the zero rate without radioactive sample

Note three measured values of the zero rate and calculate its average value.

Measure	Z_0 Imp/min
1	
2	
3	
Average	

Observation (2/2)

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Note the measured values, calculate the average and the difference of the average to zero rate, and the corrected distance (the detector is 1.7 cm behind the protective grid).

Distance in cm	1.5	2	2.5	3	3.5	4	5	6	7	8	9	10
Z_1												
Z_2												
Z_3												
Average												
Difference												
corr. distance												

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Task 1

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1. calculate the ratio of the differences to the distance

Distance	corr. distance	Difference Imp/min	ratio
2			
4			
6			
8			
10			

2. what law can be read from the ratio of the distance and the difference Z? (C=constant.)

$Z = C/R^2$

$Z = C/R$

$Z = C \cdot R^2$

Slide	Score / Total
Slide 18: Regularity: distance and pulse rate	0/1

Total amount 0 / 1

Solutions | Repeat | Exporting text

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