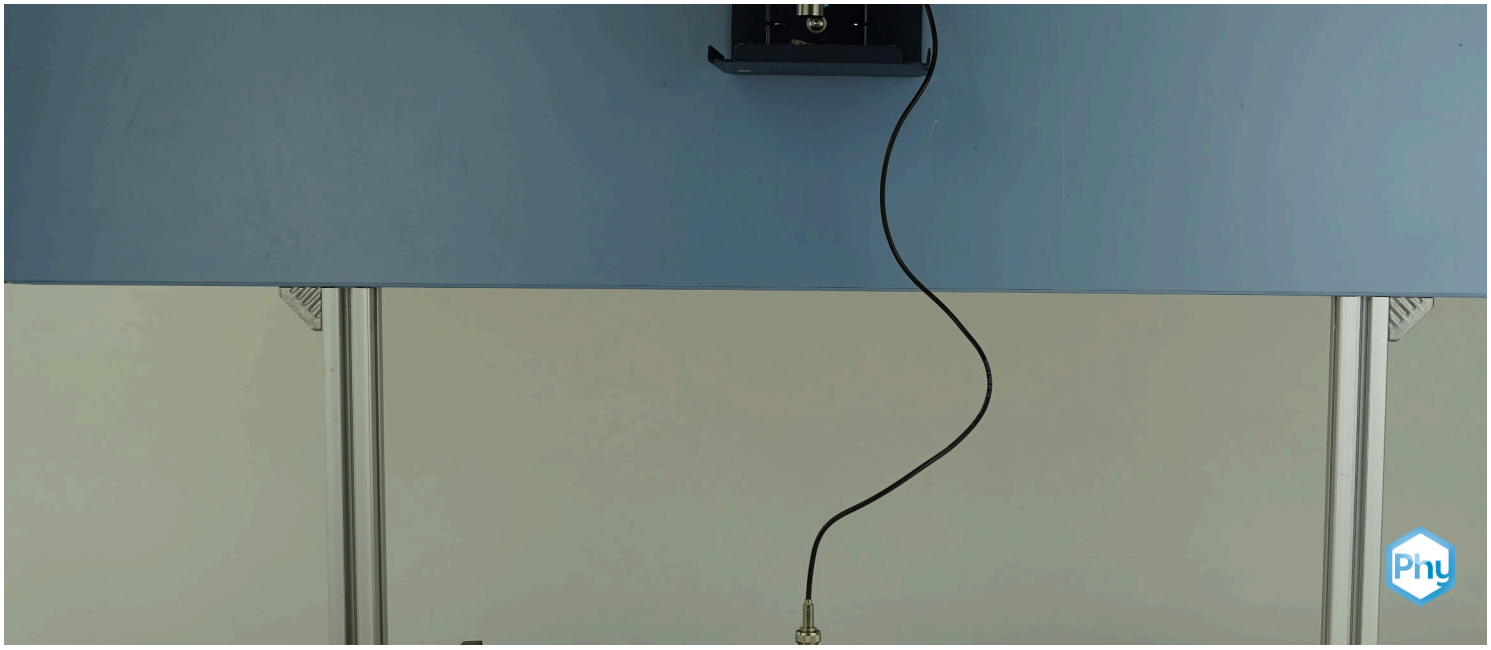
Radioactivity of minerals



Physics > Modern Physics > Radioactivity

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

This content can also be found online at:

http://localhost:1337/c/6593e333cb349a0002a9025c

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Teacher information

Application

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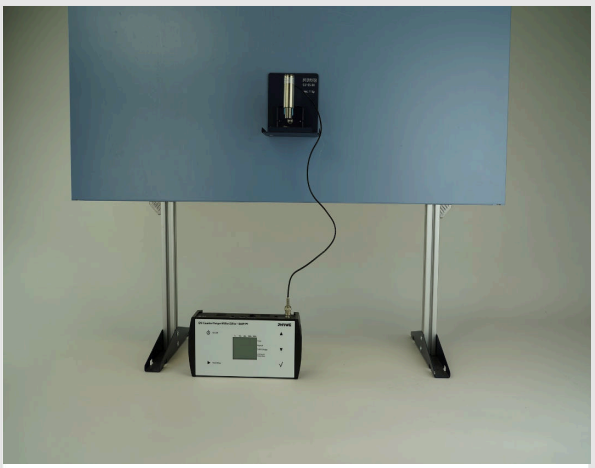

Experimental setup

This experiment involves determining the radiation intensity of various minerals and comparing it with the zero rate.

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Other teacher information (1/2)

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Prior

No prior knowledge is required for the first part of the experiment. The additional experiment requires knowledge of the shielding behaviour of the different types of radiation.

Principle

The radioactive elements uranium, thorium and their derivatives are found in relatively high concentrations in numerous minerals, such as pitchblende, monazite sand or columbite, and the externally detectable radioactivity of these substances is quite low due to self-absorption in the material. The results obtained with a Geiger-Müller counter tube must be interpreted with the necessary caution, as the detection sensitivity of the counter tube for γ-radiation is quite low and the α- and β-radiation from the interior of the samples is absorbed by the overlying layers. This means that essentially only the surface activity is registered.

Other teacher information (2/2)

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Learning

The aim of the experiment is to categorise the different minerals in terms of their radiation intensity.

Tasks

- Measurement of radiation intensity for various minerals

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Student information

Motivation

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Radioactivity is a phenomenon that occurs everywhere in nature. This is demonstrated by the Geiger-Müller counter tube used in this experiment, which is sensitive to the presence of all types of radioactive radiation and is used to measure radiation intensity.

This experiment investigates how different minerals differ in their radiation intensity and whether they stand out from the background radiation.

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Equipment

Position	Material	Item No.	Quantity
1	Support clamp for small case	02043-10	1
2	Clamp on holder	02164-00	1
3	Support rod,stainl.steel, 100mm	02030-00	1
4	Counter tube holder on fixating magnet	09201-00	1
5	Support plate on fixing magnet	02155-00	1
6	Geiger-Mueller counter tube, type B, BNC cable 50 cm	09005-00	1
7	PHYWE Geiger-Müller Counter	13609-99	1
8	PHYWE Demo Physics board with stand	02150-00	1
9	Absorption material f.student exp	09014-03	1
10	Columbite, natural mineral	08464-01	1
11	G-clamp	02014-01	2

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Setup

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- The test setup is as shown in Fig. 1.
- Place the base with the first stone sample on the demo panel.
- Clamp the counting tube vertically in the counting tube holder, remove the protective cap and push it up to a distance of 1-2 cm from the stone sample.

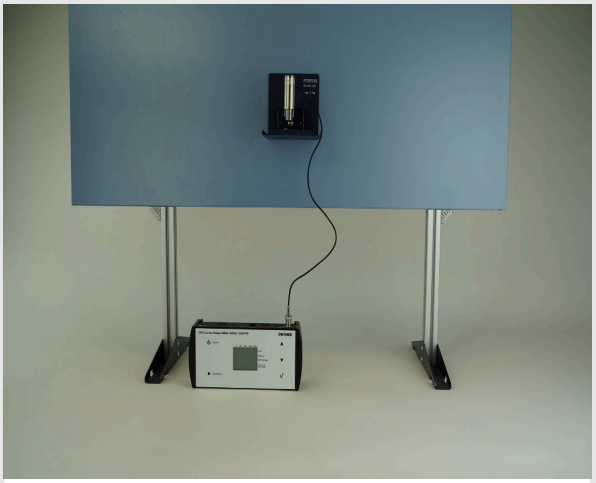

Figure 1

Procedure

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- Select a measuring time of 60 s and carry out at least 3 measurements. Enter the measured values in a table (Table 1).
- Before changing the stone samples, first move the counting tube upwards and only set the same distance again after placing the next stone sample.
- After analysing all stone samples, determine the zero rate at least three times with the same measuring time and record the measured values.
- After completing the measurements, place the protective cap on the counter tube.

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Report

Table 1

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Stone sample	$\frac{Z}{Imp/60\ s}$	$\frac{Z}{Imp/60\ s}$	$\frac{Z}{Imp/60\ s}$	Mean value
1				
2				
3				
4				
Zero rate				

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Task 1

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Is the activity of the rocks within the statistical error range of the zero rate?

No, the activity of Columbit is too high and is probably radioactive.

Yes, so none of the rock samples are radioactive.

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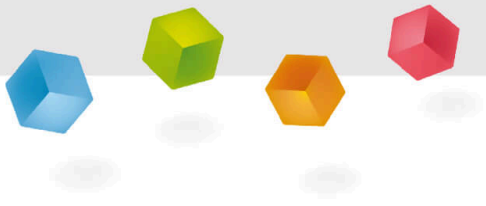

Additional attempt

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Motivation

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Since radioactivity was only registered in columbite sample no. 3, while the pulse rates determined from all other stone samples are within the statistical error of the zero rate, the question now arises as to what type of radiation is emitted. This is to be investigated in the following additional experiment.

Setup

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- The test setup is as shown in Fig. 1.
- Place the columbite sample in the open container on the surface, remove the protective cap from the counting tube and push the counting tube up to a distance of 1 cm from the columbite sample.

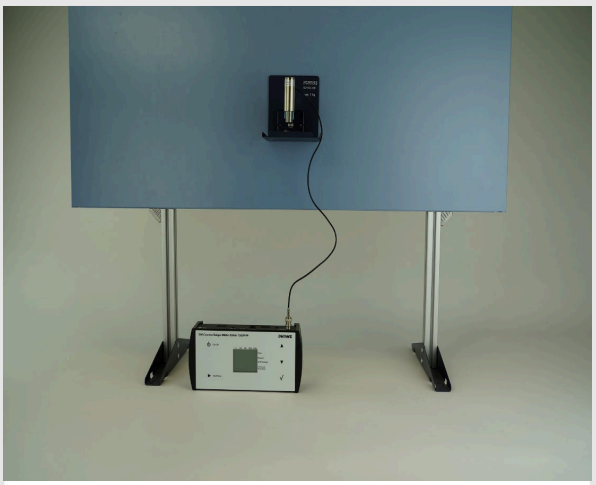

Figure 1

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Procedure

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- Select a measuring time of 100 s and determine the pulse rate three times; enter the measured values in a table (Table 2).
- Insert a sheet of paper and then a sheet of lead 1 mm thick between the columbite sample and the counting tube and determine the counting rates three times each; also enter the measured values in Table 2.

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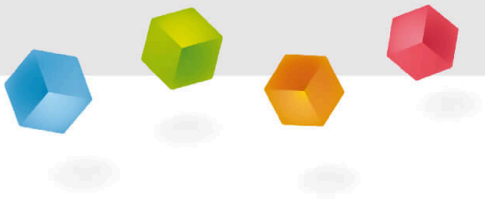

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Table 2

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Columbite sample:	$\frac{Z}{Imp/60\ s}$	$\frac{Z}{Imp/60\ s}$	$\frac{Z}{Imp/60\ s}$	Mean value
Without cover				
with paper cover				
with Pb cover				

Table 2

PHYWE

Columbite sample:	$\frac{Z}{Imp/60\ s}$	$\frac{Z}{Imp/60\ s}$	$\frac{Z}{Imp/60\ s}$	Mean value
Without cover				
with paper cover				
with Pb cover				

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Task 2

Which cover has blocked at least some of the radiation?

- ○ Lead cover
- ○ Paper cover
- ○ neither of them

Check

Which types of radiation are therefore candidates for the emitted radiation.

- ☐ β-Radiation
- ☐ none
- ☐ α-Radiation
- ☐ γ-Radiation

Check

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