P 6.4.4

Attenuation of α, β and γ radiation

P 6.4.4.1 Measuring the range of α radiation in air

P 6.4.4.2 Attenuation of β radiation when passing through matter

P 6.4.4.3 Confirming the law of distance for β radiation

P 6.4.4.4 Absorption of γ radiation when passing through matter

Absorption of γ radiation when passing through matter (P 6.4.4.4)

High-energy α and β particles release only a part of their energy when they collide with an absorber atom. For this reason, many collisions are required to brake a particle completely. Its range R

$$R \propto \frac{E_0^2}{n \cdot Z}$$

depends on the initial energy E_0, the number density n and the atomic number Z of the absorber atoms.

Low-energy α and β particles or γ radiation are braked to a certain fraction when passing through a specific absorber density dx, or are absorbed or scattered and thus disappear from the beam. As a result, the radiation intensity I decreases exponentially with the absorption distance x.

$$I = I_0 \cdot e^{-\mu \cdot x}$$

μ: attenuation coefficient

The first experiment determines the range R of monoenergetic α particles in air. Here, the ionization current I is measured in an ionization chamber of variable height as a function of the distance d between the cover and the Am-241 preparation. The ionization current initially increases with the distance d before remaining constant at distances which are greater than the range.

The second experiment examines the attenuation of β radiation from Sr-90 in aluminum as a function of the absorber thickness d. This experiment shows an exponential decrease in the intensity. As a comparison, the absorber is removed in the third experiment and the distance between the β preparation and the counter tube is varied. As one might expect for a point-shaped radiation source, the following is a good approximation for the intensity:

$$I(d) \propto \frac{1}{d^2}$$

The fourth experiment examines the attenuation of γ radiation in matter. Here too, the decrease in intensity is a close approximation of an exponential function. The attenuation coefficient μ depends on the absorber material and the γ energy.

Cat. No.	Description	P 6.4.4.1	P 6.4.4.2	P 6.4.4.3	P 6.4.4.4
559 82	Am 241 preparation	1			
546 25	Ionization chamber	1			
546 27	Telescopic cylinder	1			
546 35	Adapter for ionization chamber	1			
521 70	High voltage power supply 10 kV	1			
532 00	I-measuring amplifier D	1			
575 24	Screened BNC/4 mm	1			
531 100	Multimeter METRAmax 2	1			
311 52	Vernier calipers, plastic	1			
300 02	Stand base, V-shape, 20 cm	1			1
300 41	Stand rod, 25 cm	1			
301 01	Leybold multiclamp	1			1
666 555	Universal clamp, 0...80 mm dia.	1			
500 610	Safety connecting lead, 25 cm, yellow/green	1			
501 40	Connecting lead, Ø 2.5 mm^2, 25 cm, yellow/green	1			
501 45	Pair of cables, 50 cm, red and blue	2			
559 83	Set of 5 radioactive preparations		1	1	1
559 18	Holder with absorber foils		1		
559 01	End-window counter for α, β, γ and x-rays		1	1	
575 471	Counter S		1	1	
590 02	Small clip plug		1	1	
591 21	Large clip plug		1	1	
532 16	Connection rod		2	2	
300 11	Saddle base		2	2	
460 97	Scaled metal rail, 0.5 m			1	
667 9182	Geiger counter				1
559 94	Set of absorbers and targets				1
300 51	Stand rod, right angled				1
501 644	Set of 6 two-way plug adapters, black				1