Physics Experiment
Inverse square law of radiation

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A. Objective: To investigate the inverse square law for γ-radiation.

B. Safety
Never touch a radioactive source with bare hands. Whenever you need to transfer a radioactive material, always hold it with a lifting tools, like forceps. After the experiment, place the radioactive material back in a properly designed shielding case. Wash your hands thoroughly.

C. Theory
Vary the distance between a γ-ray source and a GM tube (Fig. 1). If the distance is denoted as x, the net count rate, n, should be proportional to the total emission rate of γ-particles, N, divided by the area of a shell, A , i.e.

$$n \propto \frac{1}{A} = \frac{1}{4\pi x^2} \quad \text{or} \tag{1}$$

$$\frac{1}{\sqrt{n}} = k\,x, \text{ where } k \text{ is a constant.} \tag{2}$$

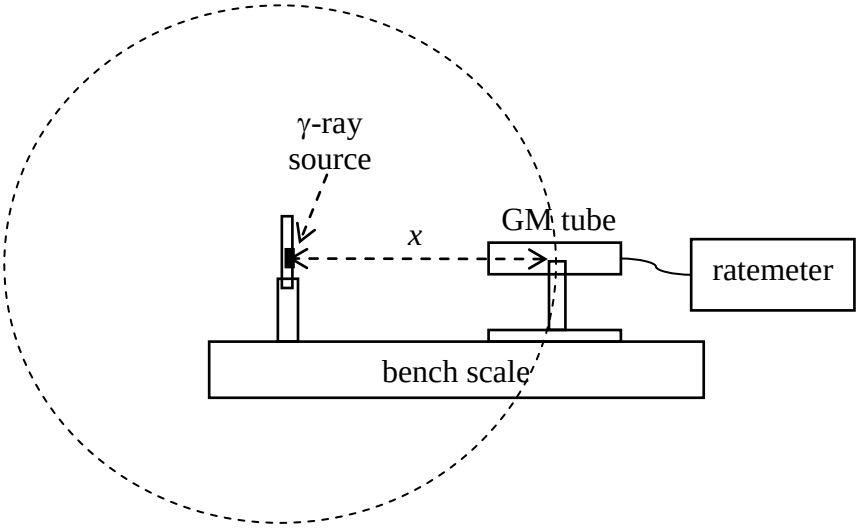

Fig. 1 Experimental setup.

The plot of $\frac{1}{\sqrt{n}}$ against x is a straight line, whereas k is the slope.

D. Experiment

D.1. Safety consideration

The radiation exposure shown by a survey meter placed 30 cm away from the source is _____ (mR hr^{-1}) or _____ (mSv hr^{-1}). Assess the risk of the experiment.

D.2 Radiation-distance dependence

- Set up the experiment as shown in Fig. 1. Connect the GM tube to a ratemeter, and apply 400 V to the tube.
- Record the number of counts of the background for 300 s = _____.
- Place a γ-ray source (sealed Ra-226) at a distance of 50 cm from the GM tube. Move the source towards the GM tube with 5 cm per step. Record the number of counts for 300 s for each step. Subtract the background count from the data. Calculate the net count rate, *n*, and complete Table 1.

Table 1 Each measurement lasts for 300 s.

Background counts (in 300 s)									
Background count rate (/s)									
Distance, *d* (cm)	50	45	40	35	30	25	20	15	10
Number of counts, *N*									
Count rate (counts s^{-1})									
Corrected count rate, *n* (counts s^{-1})									
$1/\sqrt{n}$									

E. Analysis and conclusion

- Plot $\frac{1}{\sqrt{n}}$ versus *x*.
- Hence, derive the value of *k*.

- END -