Radiation Physics

Hussein Ali Madlool

Radiology Techniques Department

3rd Class

Al-Mustaqbal University college

Practical 2: Inverse square law

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Inverse square law

Objective

To explore the relationship between the distance from a radioactive source and the intensity of radiation

Apparatus

GM(Geiger-Muller) tube detector, operational source check(Co-60), 12 inch ruler

Theory

Radiation intensity (exposure rate) from a point source decreases with distance, due to divergence of the beam. It is governed by the inverse square law, which states that the exposure rate from a point source of radiation is inversely proportional to the square of the distance. If the exposure rate is I_1 at distance d_1, then the exposure rate $I_x$at another distance d_2 is given by

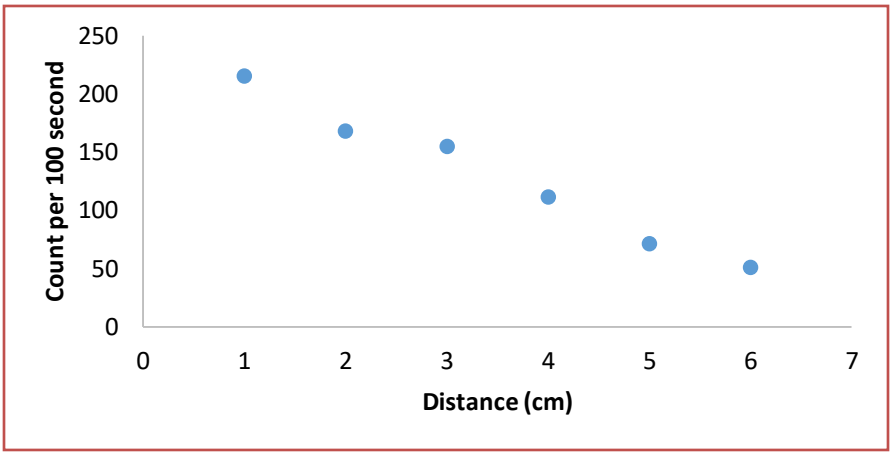
$$I_x = I_1 \left(\frac{d_1}{d_2}\right)^2$$

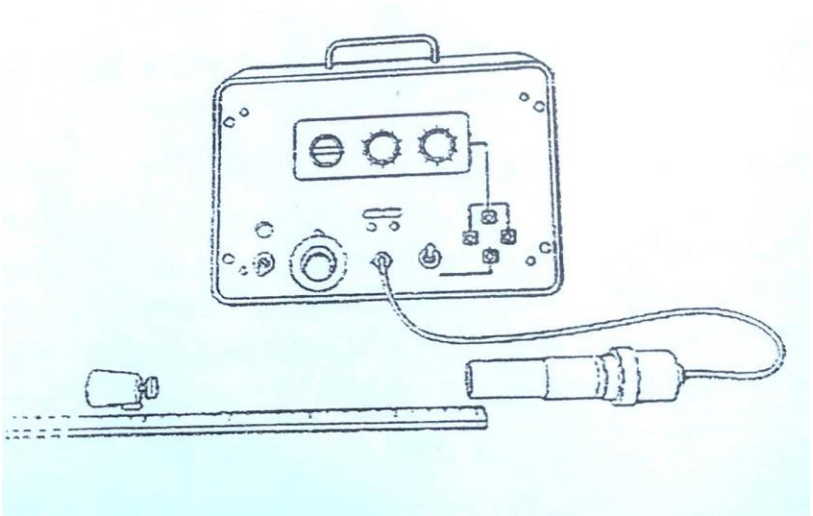
$$\mathrm{N} \propto \frac{1}{d^2}$$

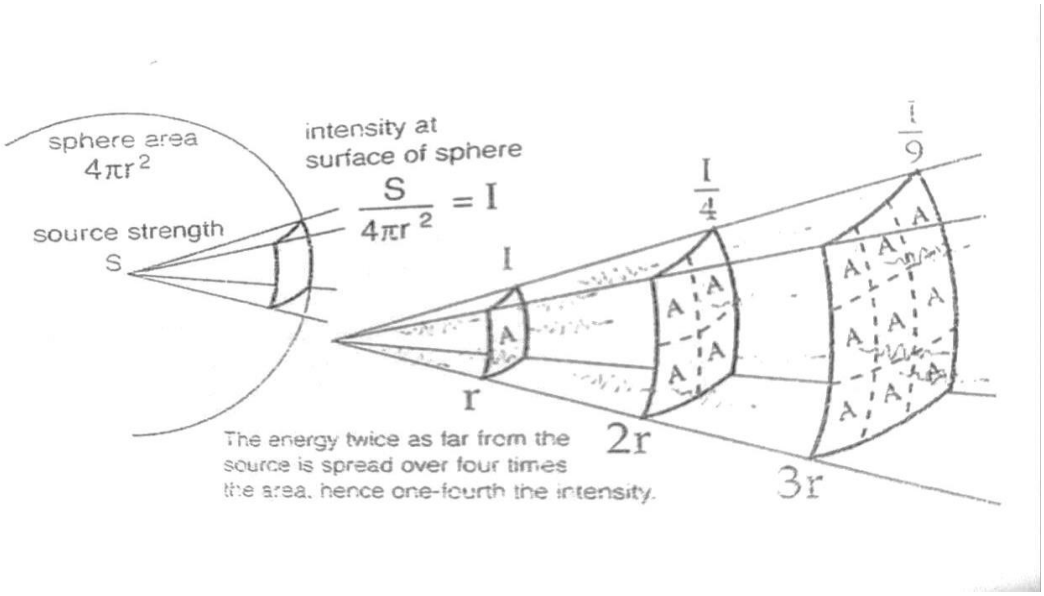
Procedures

1. Put the source at different distances from 1 to 6 between the source and the counter
2. Record the reference rays (background).
3. Two measurements are taken of the distance N1 and N2
4. Measurement the average counts N_{av}
5. calculate the count net $N = N_{av}-N_B$
6. Plot the count N vs. distance d

d	d^2	N1	N2	NB	Nav=N1+N2/2	N=Nav-Nb	1/d^2
1	1	250	255	37	252.5	215.5	1
2	4	210	200	37	205	168	0.25
3	9	193	190	37	191.5	154.5	0.11111
4	16	150	147	37	148.5	111.5	0.0625
5	25	110	106	37	108	71	0.04
6	36	90	86	37	88	51	0.02778







Worked Example

The exposure rate from a fluoroscopic X-ray machine is 5 R/min at 50 cm. What would be the exposure rates at (i) 40 cm, and (ii) 60 cm?

I_1 = 5 R/min, d_1 = 50 cm, d_2= 40 cm, I_x = ?

$$I_x = I_1 \left(\frac{d_1}{d_2}\right)^2$$

= 5 R/min × (50 cm/40 cm)^2

= 7.81 R/min

I_1 = 5 R/min, d_1 = 50 cm, d_2 = 60 cm, I_x = ?

I_x = 5 R/min × (50 cm/60 cm)^2

= 3.47 R/min