Experiment 8

Name:

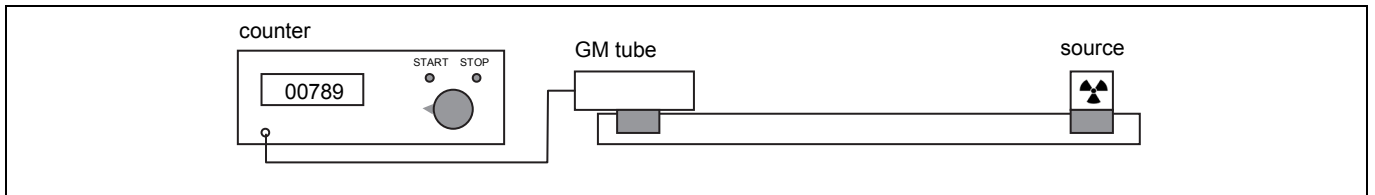# Radiation Intensity and Distance

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Aim

To determine the relation between radiation intensity and distance to a radioactive point source.

Set-up

The set-up consists of a Geiger-Müller tube, a pulse counter, and a source of strontium-90 (^{90}Sr). The distance between the GM tube and the source is adjustable.

Read the introduction on page 10 of the booklet *ISP Experiments* about the relation between radiation intensity and distance.

Measurements

1 Measure the intensity I_b of the background radiation (in pulses per 10 s) three times and record your measurements in the table below. Calculate the average intensity $I_{b,avr}$ of the background radiation. Record the result in the table below.

I_b (pulses/10s)				$I_{b,avr}$ (pulses/10s)	

2 After removing the cover, position the source in the holder of the set-up.

3 Measure the intensity I of the radiation (in pulses per 10 s) three times at a distance r of 70 cm between the GM tube and the source. Record your measurements in the table below. Calculate the average intensity I_{avr} (in pulses per 10 s). Correct for the background radiation: $I_{cor} = I_{avr} - I_{b,avr}$. Record your results in the table below.

4 Repeat these measurements and calculations for the other distances between the GM tube and the source as indicated in the table.

r (m)	I (pulses/10s)			I_{avr}	I_{cor}	$1/r^2$ (m^{-2})
0.70						2.0
0.50						4.0
0.40						6.2
0.30						11.1
0.25						16.0
0.20						25.0

5 Take the source out of the set-up and put the lid back on.

Assignments

1 Plot your measurements (intensity I_{cor} as a function of distance r) in the graph on the other side of this worksheet (left).

2 In the graph of Assignment 1, choose a value of the distance r (for example, 0.30 m) and read the radiation intensity at that distance r and at a distance that is twice as large (so, 2·r). How many times

as low is the radiation intensity when the distance is twice as large? What will then probably be the relation between radiation intensity and distance?

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From Assignment 2 it appears that the relation between radiation intensity *I* and distance *r* is probably inversely squared. In a formula:
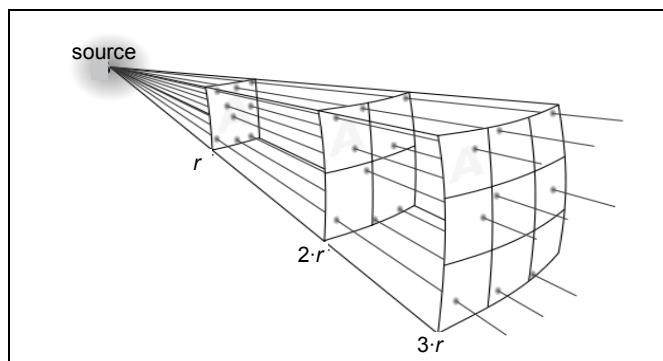
$$I = \frac{c}{r^2} = c \cdot \frac{1}{r^2}$$

In this formula, *c* is a proportionality constant. To check whether this relation is indeed valid, we plot the intensity *I* of the radiation versus $1/r^2$. The graph then has to be a straight line that also goes through the origin, as the above formula indicates that the intensity *I* is proportional to $1/r^2$.

3   Check whether the relation between radiation intensity and distance is indeed inversely squared. Do this by plotting the intensity of the radiation I_{cor} (so, the intensity corrected for the background radiation) versus $1/r^2$ in the graph on the right. In the table with the measurements on the other side of this worksheet, the values for $1/r^2$ are already calculated.

→ intensity I_{cor} (pulses/10s) → distance *r* (m)

→ intensity I_{cor} (pulses/10s) → $1/r^2$ (m^{-2})
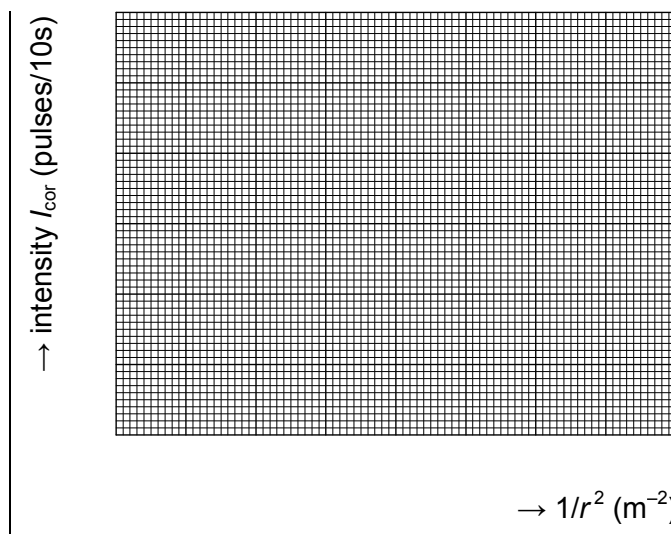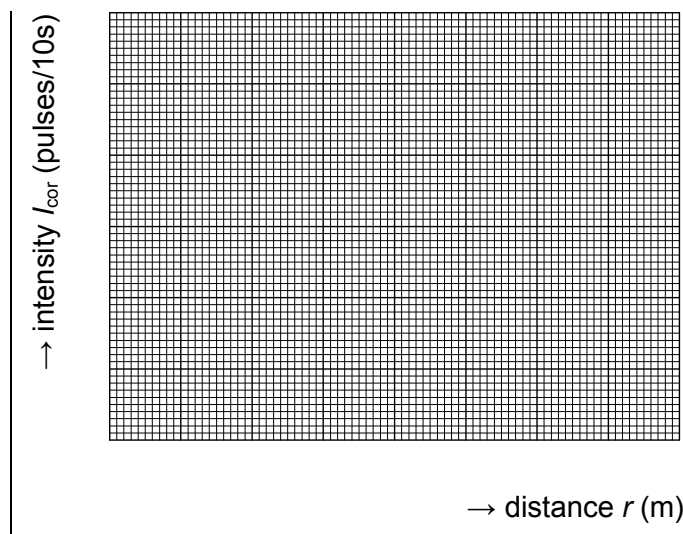
4   The relation between intensity of the radiation and distance to the source is called the *inverse square law*. Explain this law using the drawing below.

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source

r

2·*r*

3·*r*

5   When working with radioactive material, the use of tweezers often helps in reducing the radiation dose received. This is, of course, because of the inverse square law. For example, when you pick up a radioactive source with a pair of tweezers of 12 cm instead of with your bare hands (when the distance between the source and your hands will be about 0.5 mm), the distance is about …….times as large and thus the radiation dose received by your hands will be about …... times as low.