WJEC (Wales) Physics A-level

SP3.5b - Investigation of the Variation of Intensity of Gamma Radiation With Distance

Practical Flashcards

What safety precautions must be taken when working with a radioactive source?

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- Limit the time of exposure
- Warning signs should be displayed so people are aware that a radioactive source is in use
- Keep sources an arm's length away at all times, and only ever handle the source using long-handled tongs

How should a radioactive source be handled safely?

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Long-handled tongs should be used to handle a radioactive source, and you should remain at least an arm's length away from it at all times.

How should a radioactive source be stored safely?

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Radioactive sources should be locked away in a sealed lead-lined container. A hazard symbol should be visible on the container as well as at the location where it is stored.

What is the inverse square law of radiation?

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The intensity of radiation is inversely proportional to the square of the distance from the source. As the distance doubles, the intensity quarters.

What device can be used to measure a radioactive count rate?

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A Geiger Counter or Geiger-Muller Tube connected to a scaler.

Why is Cobalt-60 a suitable source for this experiment?

Why is Cobalt-60 a suitable source for this experiment?

Cobalt-60 is safe for use in schools and has a half-life of around 5 years, meaning it can be reused for a number of years. The activity is low enough to be safe, but high enough for measurements to be taken easily.

When measuring the count-rate, what advantage comes with measuring over a longer period of time?

When measuring the count-rate, what advantage comes with measuring over a longer period of time?

The longer the period of time over which it is recorded, the lower the measurement uncertainty will be.

What preliminary recording should be taken before bringing the radioactive source into the lab?

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Before bringing the radioactive source into the lab, the background radiation count should be taken.

How should the background radiation count be accounted for in the experimental data?

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The background count should be subtracted from the counts for each distance, to produce corrected counts (C').

How do you convert from a count to a count rate for a given distance?

How do you convert from a count to a count rate for a given distance?

The count should be divided by the length of time over which it was taken to produce a count rate.

What preliminary experiment could you carry out with the source before commencing this experiment?

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Recordings could be taken to find the maximum distance from the source at which you can still get a reasonable count. You could also take recordings closer to the source to determine a suitable time period over which to take readings.

What equation can be used to represent the inverse square law?

What equation can be used to represent the inverse square law?

$$C' = k/d^2$$

Where C' is the corrected count rate, 'd' is the distance from the source and k is a constant.

How can the constant ‘k’ be determined from a graph of C’ against $1/d^2$?

How can the constant ‘k’ be determined from a graph of C’ against $1/d^2$?

The constant ‘k’ in the relationship $C' = k/d^2$ is given by the gradient of the graph.

What alternative graph can be plotted to confirm that the inverse square law has been obeyed?

What alternative graph can be plotted to confirm that the inverse square law has been obeyed?

A graph of 1/√C' against d can be plotted. If the inverse square law has been obeyed, this should form a straight line graph with a positive gradient.

Why is it advantageous to plot $1/\sqrt{C'}$ against d instead of a graph of C' against $1/d^2$?

Why is it advantageous to plot 1/√C' against d instead of a graph of C' against 1/d²?

A graph of 1/√C' against d prevents any potential systematic error in the distance measurements from being propagated in a manner that could affect the calculation of 'k'.

Why is there likely to be a systematic error in your distance measurements in this experiment?

Why is there likely to be a systematic error in your distance measurements in this experiment?

The precise location of the radioactive source within the sealed capsule, and the precise location of ionisation in the GM tube are both unknown.

How can you obtain the systematic distance error from a graph of $1/\sqrt{C'}$ against d?

How can you obtain the systematic distance error from a graph of $1/\sqrt{C'}$ against d?

The straight line plotted will cross through the negative side of the x-axis rather than through the origin. This difference will be the systematic error.

Why may an old gamma source be unsuitable for this experiment?

Why may an old gamma source be unsuitable for this experiment?

Depending on the source's half-life and its age, the activity of the source may have fallen to a level that is too low to obtain recordable counts over a large enough range of distances.