Chapter 22 Living in a nuclear age

Short investigation 22.1: Penetration of radioactive particles

Name: .....

Aim

To compare the penetrating power of alpha, beta and gamma radiation and their absorption by different absorbing materials

Materials

Geiger counter (G-M probe and radiation counter with power supply), radioactive sources (alpha, beta and gamma), absorbing materials (sheets of lead foil, aluminium foil, plastic squares, paper)

Note: Squares of plastic cut from 2 litre ice cream containers or the plastic containers used for Chinese takeaways are suitable and give good results with beta radiation.

Handling radioactive sources

The radioactive sources are almost always sealed sources, in which the radioactive material is sealed inside a protective casing that prevents the material from leaving the source. These sources are quite safe, but the following rules should be observed while working with them:

- Remove a source from storage only when you are ready to use it, and replace it as soon as you have finished with it.
- Do not eat, or drink in areas where sources are being used.

Theory

The relative penetrating power of alpha, beta and gamma radiation will be determined for a variety of materials.

A radioactive source will be placed close to the G-M probe and different materials inserted between the source and probe. The distance between the source and probe should be kept constant throughout the investigation. As alpha particles are absorbed by air, the separation of the source and the probe should be kept as small as possible. The probe will detect background radiation as well as radiation coming from the source, so it will be necessary to make measurements of that background count.

Method

1. (a) Set up the G-M probe so that it is mounted vertically above the alpha particle source and just far enough above it to let you insert the absorbing materials between the source and the probe.

   (b) Remove the source and make sure that the box of radioactive sources is well away from the G-M counter.

(c) Start the counter and record the background radiation for at least one minute, possibly longer.

(d) Record this reading and the time interval used.

This background measurement could be repeated at the end of the investigation and average values used.

2. Replace the alpha particle source and measure the activity over an interval of 15 seconds. (The time may have to be varied depending on the apparatus you are using but 15 seconds will probably give a reasonable count.) Each count should be repeated several times and an average value used.
3. Make similar measurements of the activity when from one to four thicknesses of paper are used as absorber between the source and the probe. (You may find that the reading drops quickly to the background reading, and it may not be necessary to complete readings for all the layers of paper.) Draw up tables similar to those below and record your measurements.
4. Repeat step 3 with the other materials you have available.
5. Repeat steps 2–4 with the beta particle source.
6. Repeat steps 2–4 with the gamma ray source.

Analysing the results

Average background count = counts per 15 seconds

Radiation recorded (counts per 15 second interval)
(*Note:* The average background count should be subtracted from each reading.)

Table 22.1A: Radiation recorded for alpha particles

	Layers of absorbing material				
Absorber	**0**	**1**	**2**	**3**	**4**
Paper					
Plastic					
Aluminium					
Lead					

Table 22.1B: Radiation recorded for beta particles

Absorber	**Layers of absorbing material**				
	0	**1**	**2**	**3**	**4**
Paper					
Plastic					
Aluminium					
Lead					

Table 22.1C: Radiation recorded for gamma rays

Absorber	**Layers of absorbing material**				
	0	**1**	**2**	**3**	**4**
Paper					
Plastic					
Aluminium					
Lead					

Questions

1. Which type of radiation is the most penetrating?

2. Which type of radiation is the least penetrating?

3. Which of the materials that you used was the best absorber and hence would give the best protection against all three types of radiation?

4. Suggest a reason for the relative penetrating powers of the alpha, beta and gamma radiation.

5. You may have found that your results for gamma radiation did not show a significant decrease. In fact, it is possible that some readings were greater when the thickness was increased. Suggest a reason why the results may not have shown a decrease when the thickness was increased.

Notes: