Ionising Radiation

To know what alpha, beta and gamma are and be able to list their uses and dangers
To know the inverse-square law of radiation and be able to calculate intensity at given distances
To know what background radiation is and what contributes to it

Ionisation

The process of ionisation involves the removal of one or more electron from an atom. When radiation enters a GM tube it may ionise the atoms inside, the electrons are attracted to a positive wire and a small current flows. There are three types of radiation, each with its own properties, uses and dangers.

Alpha: *A Helium nucleus – two protons and two neutrons*

Relative mass: 4 **Relative charge:** +2 **Deflection by E/M field:** Yes
Ionising power: High **Penetrating power:** Low **Range in air:** 5cm **Stopped by:** Skin, paper
Uses: Smoke detectors, radiotherapy to treat cancer
Danger out of body: Low **Danger in body:** Cell death, mutation and cancer

Beta: *A fast moving electron*

Relative mass: 1/2000 **Relative charge:** -1 **Deflection by E/M field:** Yes
Ionising power: Medium **Penetrating power:** Medium **Range in air:** 2-3m **Stopped by:** Aluminium
Uses: Thickness control in paper production
Danger out of body: Damage to skin **Danger in body:** Similar to alpha but less damage

Gamma: *A high frequency electromagnetic wave*

Relative mass: 0 **Relative charge:** 0 **Deflection by E/M field:** No
Ionising power: Low **Penetrating power:** High **Range in air:** 15m **Slowed by:** Lead, concrete
Uses: Tracers: medical and industrial, sterilising surgical equipment
Danger out of body: Cell death, mutation and cancer **Danger in body:** Low

The Inverse-Square Law

Gamma radiation from a source will spread out. The radiation from a small source can be considered the same in all directions (isotropic), imagine a sphere around the source. As we move further away from the source the bigger the sphere gets. The same amount of energy is shared over a greater surface area. The further we move from the source the less intensity of the gamma radiation.

Intensity is measured in Watts, W

The intensity, I, of the radiation at a distance x from the source is given as
Where I_0 is the intensity at the source and k is a constant.

$$\boxed{I = \frac{kI_0}{x^2}}$$

We do not always need to know the intensity at the source to find it at a given distance.
Consider two points, A and B, a certain distance away from a gamma source.

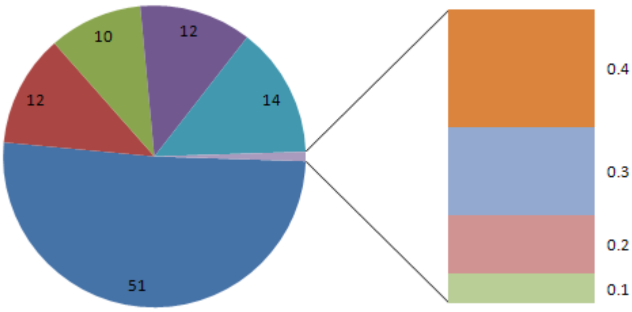
$$I_A = \frac{kI_0}{(x_A)^2} \rightarrow I_A(x_A)^2 = kI_0 \quad \text{and} \quad I_B = \frac{kI_0}{(x_B)^2} \rightarrow I_B(x_B)^2 = kI_0$$

We can combine these to give $I_A(x_A)^2 = kI_0 = I_B(x_B)^2$ →

$$\boxed{I_A(x_A)^2 = I_B(x_B)^2}$$

Background Radiation

We are continuously exposed to a certain level of background radiation. In the lessons to come **you must remember to subtract the background radiation from the recorded radiation** level to get the true (or corrected) reading. The main contributors to background radiation are:



Radon and Thoron gas: 51%
Ground, rocks and buildings: 14%
Food and drink: 12%
Medical: 12%
Cosmic rays: 10%
Air travel: 0.4%
Nuclear weapons testing: 0.3%
Occupational: 0.2%
Nuclear power: 0.1%