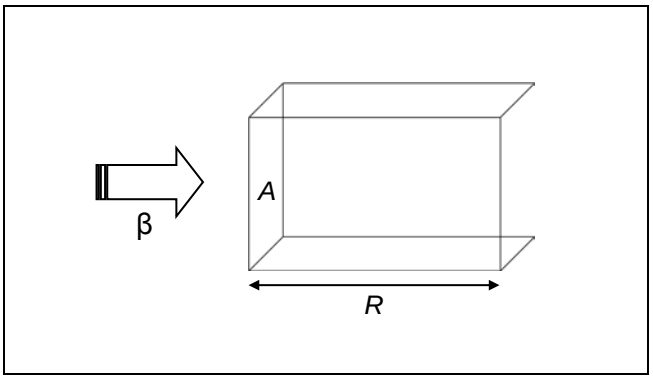
Experiment 5
Information sheet

Absorption of Beta Particles in Aluminium and Perspex
Universal Range

A material absorbs incident β particles. Depending on their energy, β particles cover a certain distance over which they transfer all their energy to the absorbing material. This distance is called the *range R*. This range is different for each material. But if we consider the mass per unit area *m*/*A* (and not the thickness *d*) of the absorbing material, it appears that each material has fully absorbed the β particles at roughly the same value of *m*/*A*. This value of *m*/*A* is called the *universal range* R_u.

Mass per Unit Area
In the drawing on the right a beam of β radiation enters an absorbing material. The thickness *d* of this material is chosen equal to the range *R* of these β particles in this material. Therefore, the β radiation is just fully absorbed by the material. The mass per unit area *m*/*A* for which this is the case is given by:

$$\frac{m}{A} = \frac{\rho \cdot V}{A} = \frac{\rho \cdot A \cdot R}{A} = \rho \cdot R$$



In deriving this formula, ρ represents the density of the material ($\rho = m/V \rightarrow m = \rho \cdot V$), *V* the volume of the material ($V = A \cdot R$) and *A* the area of the material exposed to the β radiation.
In the case of absorption of β radiation, the mass per unit area *m*/*A* is in practice given in g/cm^2 or mg/cm^2 (instead of in kg/m^2). The corresponding units for the density ρ and the range *R* then are g/cm^3 or mg/cm^3 and cm.

Universal Range
The universal range R_u is defined as the value of *m*/*A* for which the material has fully absorbed the β particles. According to the formula given above, the universal range can then be expressed as:

$$R_u = \rho \cdot R$$

In this formula R_u represents the universal range (in g/cm^2 or mg/cm^2), ρ the density of the absorbing material (in g/cm^3 or mg/cm^3) and *R* the range of β particles in this material (in cm).

The universal range R_u of β particles has roughly the same value for all materials. From the formula for this universal range then follows that the range *R* of β particles depends on the density ρ of the absorbing material: the larger the density of the absorbing material is, the smaller is the range of β particles in that material. Or, in terms of a quantitative relation: the range *R* of β particles in a material is inverse proportional to the density ρ of the absorbing material.
However, this relation only holds when it concerns β particles with the same energy. The universal range R_u of β particles does not depend on the absorbing material, but does depend on the energy of the β particles: the larger the energy of the β particles is, the larger is the universal range R_u.

Leave this information sheet at the equipment set-up