Answer on Question # 72838 - Chemistry - General Chemistry

What fraction of the α particles in Rutherford's gold foil experiment are scattered at large angles? Assume the gold foil is two layers thick, as shown in the figure, and that the approximate diameters of a gold atom and its nucleus are 2.8 Å and 1.5×10−4Å, respectively. Hint: Calculate the cross-sectional area occupied by the nucleus as a fraction of that occupied by the atom. Assume that the gold nuclei in each layer are offset from each other.

Solution

The fraction of incident particles scattered through an angle greater than θ is given by

$f = \sigma nt,$

where σ is the cross-sectional area, n is the number of atoms per volume and t is the thickness of the foil.

Taking that the large angles are angles more than 90 degrees, θ = 90°.

The differential cross-section in Rutherford scattering model is given by

$$\frac{d\sigma}{d\ \cos\theta} = \frac{\pi}{2} z^2 Z^2 \alpha^2 \left[\frac{\hbar c}{KE}\right]^2 \frac{1}{(1-\cos\theta)^2}$$

where KE is the kinetic energy (one can be derived from the energy of alpha-particles).

Therefore, in order to calculate the fraction of the α particles in Rutherford's gold foil experiment that are scattered at large angles, the energy of beam required.