(10.4) In Rutherford scattering on a silver foil using α-particles from a thin-walled radon tube, the following data were observed: dσ/dΩ = 22(θ 150º), 47(105º), 320(60º), 5260(30º), 105400(15º) barns per steradian. Calculate the energy of the incident α-particles.

Use eqn (10.18) $d\sigma/d\Omega = (k*Z_1*Z_2*e^2/(2*m_{red}*(v_1^0)^2))^2/\sin^4(\theta/2)$ and then $E_{kin}=m*v^2/2$:

$$\varepsilon_0 := 8.8541878 \cdot 10^{-12} \cdot \frac{coul}{volt \cdot m} \qquad q_e := 1.6021773 \cdot 10^{-19} \cdot coul \qquad u_n := 1.660540 \cdot 10^{-27} \cdot kg$$

$$k := \frac{1}{4 \cdot \pi \cdot \varepsilon_0} \qquad k \text{ in eqn. (10.13)} \qquad barn := 10^{-28} \cdot m^2$$

$$M_{Ag} := 107.87 \cdot u_n \qquad M_\alpha := \left(4.002603 - 2 \cdot 5.4857990 \cdot 10^{-4}\right) \cdot u_n \qquad (\alpha = He^{2+})$$

$$m_{red} := \frac{1}{\left(\frac{1}{M_{Ag}} + \frac{1}{M_\alpha}\right)} \qquad Z_1 := 2 \qquad Z_2 := 47 \qquad m_{red} = 6.407 \cdot 10^{-27} \cdot kg$$

$$k = 8.988 \cdot 10^9 \cdot kg \cdot m^3 \cdot sec^{-2} \cdot coul^{-2}$$
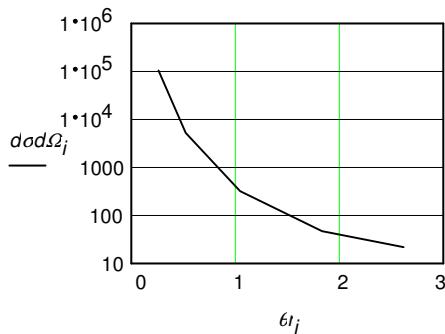
$i := 1..5$

$$a\sigma a\Omega_i := \qquad \theta_i := \qquad 6r_i := \theta_i \cdot \frac{\pi}{180} \qquad v_{1_i} := \sqrt{\frac{k \cdot Z_1 \cdot Z_2 \cdot q_e^2}{2 \cdot m_{red} \sqrt{\left(barn \cdot a\sigma a\Omega_i\right)} \cdot \sin\left(\frac{6r_i}{2}\right) \cdot \sin\left(\frac{6r_i}{2}\right)}}$$

$a\sigma a\Omega_i$	θ_i
22	150
47	105
320	60
5260	30
105400	15

v_{1_i}

v_{1_i}
$6.219 \cdot 10^6 \cdot m \cdot sec^{-1}$
$6.263 \cdot 10^6 \cdot m \cdot sec^{-1}$
$6.152 \cdot 10^6 \cdot m \cdot sec^{-1}$
$5.902 \cdot 10^6 \cdot m \cdot sec^{-1}$
$5.532 \cdot 10^6 \cdot m \cdot sec^{-1}$

$$v_{avg} := \frac{\sum\limits_{i=1}^{5} v_{1_i}}{5}$$

$$v_{avg} = 6.013 \cdot 10^6 \cdot m \cdot sec^{-1}$$

$$E_{avg} := \frac{1}{2} \cdot M_\alpha \cdot v_{avg}^2$$

$$E_{avg} = 1.201 \cdot 10^{-13} \cdot joule$$

$$= \frac{1.201 \cdot 10^{-13} \cdot coul}{q_e} = 7.496 \cdot 10^5 \qquad eV$$

$$= 0.75 \text{ MeV}$$