

# Homework Assignment #12

## Chapter 6 The Rutherford-Bohr Model of the Atom

### Modern Physics (3rd Edition) by Kenneth Krane

**Due Date: Tuesday, April 18, 2017**

In these problems, when the problem asks for mass, energy, and momentum, please write your answers in units of:

**Mass**  $\rightarrow MeV/c^2$  not kilograms !!

**Momentum**  $\rightarrow MeV/c$  not kilograms·meters/sec !!

**Energy**  $\rightarrow MeV$  not joules !!

unless otherwise specified.

When you are asked for velocities, always quote your answers in units of “c,” the speed of light.

$$\text{velocity} = \beta c$$

1. How much kinetic energy must an alpha particle have in order to reach a distance of 6.0 fm from the center of a silver nucleus? Assume a “head-on” collision where the impact parameter is zero.

$$K = \text{_____} MeV$$

2. Alpha particles having a kinetic energy of 8.00 MeV and a flux  $2 \times 10^7$  particles/sec are incident on a gold foil 7.00  $\mu\text{m}$  thick.

- a. What fraction of the alpha particles are scattered in the backward hemisphere (i.e.,  $f_{>90^\circ}$ )?

- b. What is the distance of closest approach for alpha particles scattered at  $90^\circ$ ?

$$r_{min} = \text{_____} fm$$

- c. If a 10cm  $\times$  10cm detector were positioned at  $30^\circ$  above the beam direction 2.00 meters away from the target, calculate the flux of particles passing through the detector.

$$flux = \text{_____} particles/sec$$

3. Using equations from the Bohr model, calculate the following quantities for singly ionized helium atoms in the  $n = 3$  state:

a. The velocity of an electron:

$$v_3 = \text{_____ } c$$

b. The radius of the electron's orbit:

$$r_3 = \text{_____ } nm$$

c. The total energy of the electron:

$$E_3 = \text{_____ } eV$$

4. How much energy is required to liberate the last electron from doubly-ionized lithium ( $Li^{2+}$ )? In other words, what is the binding energy for this hydrogen-like atom?

$$E = \text{_____ } eV$$

5. Problem 27 from chapter 6

6. Problem 28 from chapter 6 (O o o h h , I love this one !!)