PHY420 Tutorial 1

Handed out 16.01.2018, Due 22.01.2018

1. Compare the intensities of the scattered α particles from a gold foil at scattering angles of 10^{-3} rad and 10^{-2} rad in the Rutherford scattering experiment for the Thomson and the Rutherford models of the atom.

2. For what angles will there be an observable deviation from the Rutherford scattering formula for 10 MeV protons incident on gold, if the experiment is sensitive to 1% change in the intensity and has an angular resolution of 10^{-2} rad.

3. Consider a model of the atom consisting of a positively charged sphere surrounded by a negatively charged shell, such that the volumes occupied by the two types of charges are identical. What would be observed in a Rutherford-type scattering experiment with such atoms?

4. Model the emission of α particles as tunnelling of particles from a finite barrier potential in the radial coordinate. Collect the necessary data (size of the nucleus, binding energy of nucleons, etc.) to construct such a potential, and hence obtain the tunnelling probability.

5. Which transition in the H atom would approximately match the frequency of the carrier wave of your mobile phone signal?

6. Obtain the wavelength of the Lyman-α equivalent line in the Na^{10+} ion. What is the 'size' of this ion?

7. Obtain the complete wavefunction for the 2p state of the H atom. Plot the electron cloud density for this state.

8. Calculate the dipole moment of the H atom in the 2p state. How does this compare with the dipole moment in the ground state?