PHYS 232   Take-Home Exam   due before 10:00 am   April 6, 2019

$1 pm = 10^{-12} m$

1. In Compton scattering the incident photon has a wavelength of 3.1 pm and is scattered through an angle $\theta = 60.0°$. Assume it is scattered by a free electron that is initially at rest. Find:
   a. The energy of the incident photon.   (5%)
   b. The energy of the scattered photon.   (5%)
   c. The kinetic energy of the scattered electron.   (5%)
   d. The angle φ through which the electron is scattered.   (15%)

2.   Explain why for $\theta > 0$ the wavelength of some scattered photons does not change (i.e. stays as λ_0) as in Figure 3.23 page 91.
                                                            (10%)

3.   What assumptions did Rutherford make in estimating the radius of the Al nucleus?   (10%)

4.   Calculate the de Broglie wavelength of:
   a) an electron having a kinetic energy of 1.0 GeV.   (5%)
   b) a proton having a kinetic energy of 1.0 GeV.   (5%)

5.   A proton has a kinetic energy of 2.0 MeV. If its momentum is measured with an uncertainty of 3.0 %, what is the uncertainty in its position?   (10%)

6.   A H atom (mass = 940 MeV/c²) moving in the positive x-direction with kinetic energy K_1=100 eV collides with another H atom at rest. Both atoms are initially in the ground state. After the collision one atom gets excited to the first excited state and moves at an angle θ with the x-axis with kinetic energy K_3=20 eV. The second H atom stays in its ground state and moves at an angle φ with the x-axis. Find the kinetic energy K_2 of the second H atom and the values of θ and φ.
Note: No photons are involved in this collision.   (20%)
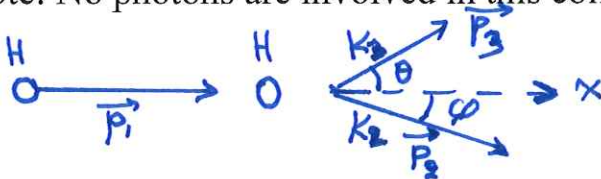
+10% for good hand-writing and clear and well-organized solutions.

You are expected to work alone. Copying = zero