

Modern Physics Problem Set 7

Due: Nov 4, 2025

Problem 1

Starting from conservation of energy and momentum for a photon-electron collision (electron initially at rest), derive

$$\Delta\lambda = \lambda' - \lambda = \frac{h}{m_e c}(1 - \cos\theta).$$

Problem 2

An x-ray photon of wavelength $\lambda = 0.0711$ nm scatters from a stationary electron.

- (a) What is the *maximum* possible wavelength shift $\Delta\lambda_{\max}$?
- (b) What is the corresponding photon energy loss in eV?

Problem 3

A photon of energy $E = 200$ keV is scattered through $\theta = 90^\circ$.

- (a) Find the scattered photon energy E' .
- (b) Find the electron recoil kinetic energy T_e .

Problem 4

Using the Bohr model, find the $n = 3$ orbital radius r_3 , electron speed v_3 , and orbital frequency f_3 .

Problem 5

What is the minimum photon wavelength (threshold) required to ionize a hydrogen atom starting from the $n = 2$ level?

Problem 6

For He^+ ($Z = 2$), including reduced mass for the helium nucleus, find: (a) the ground-state energy E_1 , and (b) the Lyman- α ($n = 2 \rightarrow 1$) wavelength and photon energy.