Ch 29/30 HW: Problem 29.1 - The Photoelectric Effect

Light with wavelength $\lambda$ shines on a metal surface, causing the surface to emit photoelectrons with a maximum kinetic energy of 1.45 eV. A second light source with a wavelength $\lambda/2$ causes the surface to emit photoelectrons with a maximum kinetic energy of 6.25 eV.

a) What is the work function of the metal (in eV)?
b) What is the wavelength of the incident light $\lambda$?
c) What is the cutoff wavelength of the metal?
Photons with a wavelength of 220 nm illuminate a metal surface. There is also a uniform magnetic field of 25 µT in the region. Thus, electrons ejected from the metal are bent into circular arcs with radii ranging from essentially zero up to a maximum radius of 24 cm.

a) What is the maximum kinetic energy of electrons ejected from the metal (in eV)?
b) What is the work function of the metal (in eV)?
c) What wavelength of light would result in a maximum radius for the circular arcs of 48 cm?
Ch 29/30 HW: Problem 29.3 - Momentum of a Photon

Photons could be reflected off a shiny solar sail in order to propel a spacecraft. Suppose such a sail is constructed of a highly reflective material so that a 120 square meter sail spacecraft has a total mass of about 2.3 kg. The sail is to be propelled by a laser with wavelength of 525 nm striking its surface perpendicularly.

a) Determine how many photons per second must strike the sail in order to cause an acceleration of $9.8 \times 10^{-4}$ m/s$^2$, which is one ten-thousandth of the acceleration felt on the surface of the Earth.

b) What must be the intensity (power per unit area) of the beam?

c) Assuming the spacecraft has an initial speed of 85,000 m/s thanks to booster rockets, how much time (in years) would be necessary to triple that speed using just the laser beam for propulsion?
Ch 29/30 HW: Problem 30.1 - Spectral Absorption and Emission

Below are four possible transitions for a Hydrogen atom:

A. \( n_i = 2; n_f = 5 \)
B. \( n_i = 5; n_f = 3 \)
C. \( n_i = 7; n_f = 4 \)
D. \( n_i = 3; n_f = 6 \)

a) Which transition will emit the shortest wavelength photon? What is that wavelength?
b) For which transition will the electron gain the most energy? How much energy?
c) For which transition will the electron lose the most energy? How much energy?
Ch 29/30 HW: Problem 30.2 - Spectral Absorption and Emission

Consider a hydrogen atom with an electron initially in the \( n = 4 \) state.

a) List the 3 different wavelengths that could be observed in the emission spectrum for this atom given the electron begins in level \( n = 4 \).

b) What is the longest wavelength photon that could potentially be absorbed by the electron in the level \( n = 4 \)?

c) How much energy would be required to ionize this atom?

d) What is the maximum wavelength of the photon necessary to produce ionization?