PHYSICS 4E QUIZ 1 SPRING QUARTER 2020
PROF. HIRSCH APRIL 13

Open book. Show all steps in your calculations. Justify all answers. Write clearly.

Some info: $hc = 12{,}400 eVA,\ \ k_B = 1/11{,}600 eV/K,\ \ m_e c^2 = 511{,}000 eV$

$\sigma = 5.67 \times 10^{-8} W/m^2K^4$; $1eV = 1.6 \times 10^{-19} J$; $1A = 10^{-10} m$; $c = 3 \times 10^8 m/s$

Wien law: $\lambda_m T = 2.898 \times 10^{-3} m \cdot K$; $J = u \cdot c/4$ (J=power/area, u=energy density)

Problem 1 (10 pts)
When light of wavelength 3000A is incident on a metal, the stopping voltage is V_0. When light of wavelength 2000A is incident on that same metal, the stopping voltage is $2V_0$.
(a) What is the maximum wavelength light for which photoelectrons will be ejected from this metal? Give your answer in A.
(b) What is the value of V_0, in Volts?
(c) What is the workfunction for this metal, in eV?
Hint: the easiest way to solve this problem may not be in alphabetical order.

Problem 2 (10 pts)
In a Compton scattering experiment, photons scattered at angle 45^0 have wavelength 0.5A.
(a) What is the wavelength of the incident photons, in A?
(b) What is the kinetic energy of the recoiling electrons in the process where the photon is scattered at a 45^0 angle? Give your answer in eV.
(c) Find the momentum of the recoiling electron in that process, p_e. Give your answer as $p_e c$ in eV.
(d) Using only conservation of momentum in direction perpendicular to the direction of incidence (not in direction parallel to the direction of incidence) find the angle at which that electron is scattered, in degrees.

Problem 3 (10 pts)
A metal sphere emits maximum power per unit wavelength at wavelength 30,000A. The total power it emits at all wavelengths is 100,000W. Assume it emits as a black body.
(a) What is the temperature at the surface of the sphere? What about at the center?
(b) Find the radius of the sphere, in cm.
(c) Estimate the power (in W) that this sphere emits with wavelengths in the range 0.95m to 1.05m. Show all the steps in your calculation, watch the units, and justify any approximations.