VE320 Homework 1

Due Sept. 23, 11:40am

1. The work function of a material refers to the minimum energy required to remove an electron from the material. Assume that the work function of gold is 4.90 eV and that of cesium is 1.90 eV. Calculate the maximum wavelength of light for the photoelectric emission of electrons for gold and cesium.

2. (a) The wavelength of green light is λ = 550 nm. If an electron has the same wavelength, determine the electron velocity and momentum. (b) Repeat part (a) for red light with a wavelength of λ = 440 nm. (c) For parts (a) and (b), is the momentum of the photon equal to the momentum of the electron?

3. The lattice constant of a single crystal is 4.50 Å. Calculate the surface density of atoms (# per cm^2) on the following planes: (i) (100), (ii) (110). (iii) (111) for each of the following lattice structures: (a) simple cubic, (h) body-centered cubic,and(c) face-centered cubic lattice.

4. According to classical physics, the average energy of an electron in an electron gas at thermal equilibrium is $3kT/2$. Determine, for $T = 300\ K$, the average electron energy (in eV), average electron momentum, and the de Broglie wavelength.

5. An electron is bound in a one-dimensional infinite potential well with a width of 10 Å. (a) Calculate the first three energy levels that the electron may occupy. (b) If the electron drops from the third to the second energy level, what is the wavelength of a photon that might be emitted?

6. (a) The de Broglie wavelength of an electron is 85 Å. Determine the electron energy (eV), momentum, and velocity. (b) An electron is moving with a velocity of $8{\times}10^5$cm/s. Determine the electron energy (eV), momentum, and de Broglie wavelength (in Å).

7. Consider the wave function $\Psi(x, t) = A\left(\cos\left(\frac{\pi x}{2}\right)\right) e^{-j\omega t}$ for $-1 \le x \le +3$. Determine A so that $\int_{-1}^{+3} |\Psi(x, t)|^2 dx = 1$.

8. Consider the one-dimensional potential function shown in Figure P2.40. Assume the total energy of an electron is $E<V_0$. (a) Write the wave solutions that apply in each region. (b) Write the set of equations that result from applying the boundary conditions. (c) Show explicitly why, or why not, the energy levels of the electron are quantized.

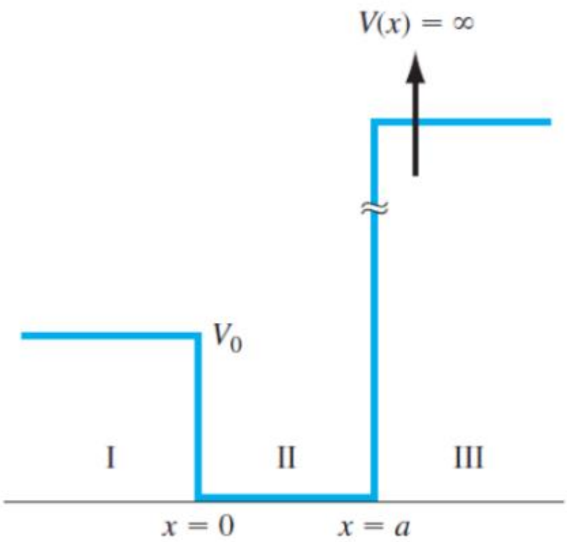

Figure P2.40 | Potential function for Problem 2.40.