PRACTICE PROBLEMS

1. A small source emits monochromatic light of wavelength 1 micron. Find the density of photon flux (number of quanta per 1 cm^2 per second) at a distance 1 m form the source if the power of the source is 1 wt.

   $/4 \cdot 10^{13}$ quant/$\mathrm{cm}^2 \cdot s./$

2. A photon with the wavelength 0.17 $\mathring{A}$ knocks out an electron from the deep level (binding energy 69.3 keV) in a tungsten atom initially at rest. The electron flies away under an angle of 90° with respect to the direction of the incident photon. Find (in eV/c) the recoil momentum of the atom.

   $/p = (1/c)[(\hbar\omega)^2 + 2m_e c^2(\hbar\omega - \epsilon)]^{1/2} = 95.5$ keV/$c./$

3. In the process of irradiation of a substance by hard monochromatic X-rays it was found that the maximum kinetic energy of Compton electrons is $E_{\max} = 0.44$ MeV. Find the wavelength of X-rays.

   $/\lambda = (4\pi\hbar c/E_{\max})\{[1 + (2mc^2/E_{\max})]^{1/2} - 1\}^{-1} = 0.02\,\mathring{A}./$

4. Find the radius of the first Bohr orbit, ionization potential for the ground state, first excitation potential and corresponding wavelength of radiation for the ions He^+ and Li^{++}.

   $/r = a_0 n^2/Z = 0.265$ Åand 0.176 Å; $V_i = E_0 Z^2/(en^2) = 54.5$ and 122.5 V; $V_1 = (3/4)\mathrm{Ry}\, Z^2 =$ 40.8 and 91.5 eV, 304 Åand 135 Å./

5. At what value of kinetic energy the de Broglie wavelength of the electron is equal to its Compton wavelength?

   $/K = (\sqrt{2} - 1)mc^2 = 0.211$ MeV./

6. A neutron with kinetic energy 100 eV collides with the helium atom at rest. Find wavelengths of both particles in the center-of-mass frame.

   $/\lambda = 2\pi\hbar(1 + m_n/m_{He})/\sqrt{2m_n K_n} = 0.036$ Å./

7. A particle is localized within a spot of size 1 micron. Estimate the minimum error in the determination of the velocity of the particle for an electron and for a ball of mass 10^{-3} g.

   $/10^4$ cm/s and 10^{-20} cm/s./

8. Alpha-particles are emitted by a point source in a certain direction. They reach a target after 10 μs. Estimate the spread of points of arrival on the target.

   $/\Delta x \sim \sqrt{\hbar t/m} \approx 0.4\,\mu$m./