4-6. A gold foil of thickness 2.0 μm is used in a Rutherford experiment to scatter α particles with energy 7.0 MeV. (*a*) What fraction of the particles will be scattered at angles greater than 90°? (*b*) What fraction will be scattered at angles between 45° and 75°? (*c*) Use N_A, ρ, and M for gold to compute the approximate radius of a gold atom. (For gold, ρ = 19.3 gm/cm^3 and M = 197 gm/mol.)

Answers: (a) 9.8×10^{-5}; (b) 4.05×10^{-4}; 16.2 nm

4-13. The radius of the $n = 1$ orbit in the hydrogen atom is $a_0 = 0.053$ nm. (*a*) Compute the radius of the $n = 6$ orbit. (*b*) Compute the radius of the $n = 6$ orbit in singly ionized helium (He^+), which is hydrogenlike, that is, it has only a single electron outside the nucleus.

Answers: (a) 1.91 nm; (b) 0.95 nm.

4-30. An electron in the K shell of Fe is ejected by a high-energy electron in the target of an x-ray tube. The resulting hole in the $n = 1$ shell could be filled by an electron from the $n = 2$ shell, the L shell; however, instead of emitting the characteristic Fe K_α x ray, the atom ejects an Auger electron from the $n = 2$ shell. Using Bohr theory, compute the energy of the Auger electron.

Answers: 3.118 keV

4-40. Three isotopes of hydrogen occur in nature; ordinary hydrogen, deuterium, and tritium. Their nuclei consist of, respectively, 1 proton, 1 proton and 1 neutron (deuteron), and 1 proton and 2 neutrons (triton). The masses of the three nuclei are given in Table 11-1. (*a*) Use Equation 4-26 to determine Rydberg constants for deuterium and tritium. (*b*) Determine the wavelength difference between the Balmer α lines of deuterium and tritium. (*c*) Determine the wavelength difference between the Balmer α lines of hydrogen and tritium.

Answers: (a) $R_d = 1.0970743 \times 10^7 m^{-1}$; $R_t = 1.0971736 \times 10^7 m^{-1}$; (b) $\lambda_d - \lambda_t = 5.3978 \times 10^{-2} nm$; (c) $\lambda_H - \lambda_t = 2.4627 \times 10^{-1} nm$

4-50. Figure 3-15*b* shows the K_α and K_β characteristic x rays emitted by a molybdenum (Mo) target in an x-ray tube whose accelerating potential is 35 kV. The wavelengths are $K_\alpha = 0.071$ nm and $K_\beta = 0.063$ nm. (*a*) Compute the corresponding energies of these photons. (*b*) Suppose we wish to prepare a beam consisting primarily of K_α x rays by passing the molybdenum x rays through a material that absorbs K_β x rays more strongly than K_α x rays by photoelectric effect on *K*-shell electrons of the material. Which of the materials listed in the accompanying table with their *K*-shell binding energies would you choose? Explain your answer.

Element	Zr	Nb	Mo	Tc	Ru
Z	40	41	42	43	44
E_K (keV)	18.00	18.99	20.00	21.04	22.12

Answers: (a) $E_\alpha = 17.465\ keV$; $E_\beta = 19.683\ keV$; (b) Nb