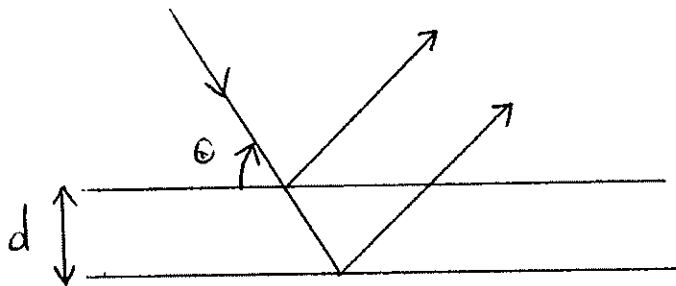


### Assignment 10

1. Radioactive iodine ( $^{131}\text{I}$ ) has a half-life of 8 days. Iodine is absorbed especially strongly by the thyroid gland. Hence, radioactive iodine can cause thyroid cancer. How long does it take for the amount of  $^{131}\text{I}$  to be reduced by a factor of 100?
2. A metal has a work function of 3.5 eV.
  - a) What is the longest wavelength photon that can generate photoelectrons?
  - b) Is this photon in the visible, infrared or ultraviolet portion of the spectrum?
3. The maximum shift in the wavelength of scattered X rays in the Compton effect is 0.0486 Angstrom and occurs when the X ray is scattered in the backwards direction.
  - a) What is the difference in momentum of the incident and scattered X rays?
  - b) What is the final kinetic energy of the electron that was initially at rest?
4. Compute the de Broglie wavelength of the following.
  - a) A human walking briskly
  - b) A proton traveling at  $3 \times 10^5$  m/sec
  - c) An alpha particle traveling at  $3 \times 10^5$  m/sec
  - d) A beta particle having an energy of 50 KeV
5. Consider an electron incident at angle  $\theta$  as shown below on a crystal consisting of planes of atoms separated by a distance  $d$ . Derive the Bragg scattering criteria for constructive interference  $n\lambda = 2 d \sin \theta$  where  $n$  is an integer and  $\lambda$  is the de Broglie wavelength of the electron.



6. What is the value of the principal quantum number for a hydrogen atom to have a size of one micron?
7. Determine an expression for the speed of an electron in the ground (lowest energy) state of hydrogen.

8. Determine the longest wavelength for each of the Balmer and Paschen series. Are these wavelengths in the visible, infrared or ultraviolet parts of the spectrum?
9. A  $\text{He}^+$  ion consists of a nucleus which is an alpha particle plus one orbiting electron. Hence it has a net positive charge.
  - a) Derive an expression for the electron state energies.
  - b) What is the wavelength associated with a transition between the lowest two energy states?
10. A muon is a particle that has a negative charge equal to an electron but is 207 times heavier than an electron. Atoms have been created where the electron in a hydrogen atom has been replaced by a muon. Find the following.
  - a) The allowed radii of the muon atom.
  - b) The energies of the allowed states.
  - c) What is the wavelength corresponding to a transition between the ground and first excited state?