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# Physics 1 for Nano: written Exercises 8

WS 2019 (sheet 7)

**Exercise 44**

Light of wavelength 200nm shines in an aluminium sheet; 4.2eV is required to eject an electron. What is the kinetic energy of (a) the fastest and () the slowest ejected electron? (c) What is the stopping potential in this situation? (d) What is the cutoff wavelength for aluminium?

**Exercise 45**

In MeV/c, what is the magnitude of the momentum associated with a photon having an energy equal to the electron rest energy? What are the (b) wavelength and (c) frequency of the corresponding radiation? What (a) frequency, (b) photon energy, and (c) photon momentum magnitude (in keV/c) are associated with x-rays having wavelength of 35.0 pm?

**Exercise 46**

Calculate the percentage change in photon energy during a collision with an electron for $\phi=90°$ and for radiation (a) in the microwave range with $\lambda=3.0$cm; (b) in visible range with $\lambda = 500$nm; (c ) in x-ray range with $\lambda =25$pm; and (d) in gamma-ray range with photon energy of 1.0 MeV.(e) what are your conclusions about the feasibility for detecting Compton shift in these various regions of the electromagnetic spectrum, judging solely by the criterion of energy loss in a single photon-electron encounter?

**Exercise 47**

The highest achievable resolving power of a microscope is limited only by the wavelength used; that is the smallest item that can be distinguished has dimensions about equal to the wavelength. Suppose one wishes to “see” a diameter of an object of 100pm, that means that one must be able to resolve a width of 10pm. (a) of an electron microscope is used, what minimum electron energy is required? (b) of a light microscope is used, what minimum photon energy is required? (c) which microscope seems more practicable? Why?

**Exercise 48**

The uncertainty in the position of an electron along the x axis is 50pm, which is about equal to the radius of a hydrogen atom. What is the least uncertainty in any simultaneous measurement of the momentum component $q_x$ of this electron? Consider the position of a particle is measured within a distance of $\lambda/2\pi$ where $\lambda$ is the particle´s deBrogli wavelength. Showtaht theuncertainty in the simultaneously measured momentum component is the equal to $\Delta q_x = p$.

**Exercise 49**

A 3.0 MeV proton is incident on a potential energy barrier of thickness 10fm and height 10 MeV. What are (a) the transmission coefficient T, (b) the kinetic energy $K_t$, the proton will have after tunneling throughout the barrier, (c) the kinetic energy, $K_r$, it will have if it reflects from the barrier ? A 3.0 deuteron is incident on the same barrier. Calculate T, $K_t$ and $K_r$.

**Exercise 50**

In about 1916, R.A Millikan found the following stopping potentials data for Lithium in his photoelectric experiments:

| Wavelength (nm) | 433.9 | 404.7 | 365.0 | 312.5 | 253.5 |
|---|---|---|---|---|---|
| Stopping potential (V) | 0.55 | 0.73 | 1.09 | 1.67 | 2.57 |

Derive the value of the Planck´s constant.