Alexandria University **MODERN PHYSICS**
Faculty of Engineering **1st YEAR EE**
EE-Department **EE-131 SHEET:2**

SUBJECT:DUAL ASPECTS

1- What is the quantum energy of a visible photon of wavelength $6000A^0$?

2- A 1000 A^0 photon strikes a copper target and release a photo electron from the surface, the photoelectron moving in the opposite direction to the incident photon. Assume that essentially all photon energy is given to the electron and that the binding energy of an electron to a copper surface is 4.5 eV.
   a) Calculate the max. velocity of the released electrons.
   b) Using the conservation of momentum law, find the momentum imparted to the target.
   c) If the target has a mass of 100 gm, calculate the fraction of the photon energy given to the target." This justifies our original assumption that in the photoelectric effect practically all the photon energy is transformed to the electron".

3- A 1 A^0 photon is incident upon a hydrogen atom initially at rest. the photon gives essentially all its energy to the bound electron thus releasing it from the atom (binding energy=13.6 eV).The released electron moves in the same direction as that of the incident photon.
   a) Find the kinetic energy and velocity of the photoelectron.
   b) What is the momentum and the energy of the positive recoil proton.

4- When a copper surface is illuminated by the radiation of wavelength 2537 A^0 (from mercury arc) the value of the stopping potential is found to be 0.24 volts. Calculate the threshold wavelength for copper. If E_m=11.2 eV find the work done in taking an electron through the surface of the copper.

5- The kinetic energy of photoelectrons range from zero to $4*10^{-19}$J when light of wavelength 3000 A^0 falls on a surface.
   a)What is the stopping potential for this light ?
   b)What is the threshold wavelength for the material ?

6- Potassium is illuminated with UV-light of wavelength 2500 A^0. If

the work function of potassium is 2.21 eV , what is the maximum kinetic energy of the emitted electrons ?If the UV-light has an intensity of $2w/m^2$,calculate the rate of electron emission per/m^2. Calculate also the photo emission current density in (mA/cm^2) from the surface.

7- A surface is irradiated with a light of wavelength λ_1=5461 A^0 giving rise to photoelectrons with the stopping potential is V_1 =0.19v.When radiation of wavelength λ_2=1849 A^0 is incident on the same surface, the stopping potential V_2=4.63v.Evaluate Plank's constant if $e=1.6*10^{-19}$cb.Calculate the work function and threshold frequency for the surface.

8- The smallest angle of Bragg Scattering in potasium chloride (KCl) is 24.8^o for 0.3nm X-rays. Find the distance between atomic planes in potasium chloride.

9- The distance between adjacent atomic planes in calcite ($CaCO_3$) is 0.3nm. Find the smallest angle of Bragg scattering for 0.03nm X-rays.

10- In a Compton-effect experiment in which the incident X-rays have a wavelength of 10.0 pm, the scattered X-rays at a certain angle have a wavelength of 10.5 pm. Find the momentum (magmitude and direction) of the correspoding recoil electrons.

11- Find the de Broglie wavelength of i – an electron whose speed is $1.0x10^8$ m/s and ii – an electron whose speed is twice as much.

12- The phase velocity of ocean waves is $\sqrt{g\lambda/2\pi}$, where g is the accelerationof gravity. Find the group velocity of ocean waves.

13- A beam of neutrons that emerges from a nuclear reactor contains neutrons with variety of energies. To obtain neutrons with an energy of 0.05 eV, the beam is passed through a crystal whose atomic planes are 0.2 nm apart. At what angle relative to the original beam will the desired neutrons be diffracted?

14- i - Derive a relativistically correct formula that gives the de Broglie wavelength of a charged particle in terms of the potential difference V through which it has been accelerated. ii – What is the nonrelativistic approximation of this formula, valid for $eV << m_oC^2$?

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