NAME

PHYS-1200 PHYSICS II QUIZ 3 APRIL 29, 2005

SOLUTIONS

PART A.

1. D
2. E
3. E
4. B
5. B
6. D
7. E
8. A

PART B.

1. **IT WILL FALL WITH A CONSTANT ACCELERATION OF 4.9 m/s²**
When the radiation supports the disk, the radiation force is equal in magnitude to the weight of the disk. When the reflecting disk is replaced by an absorbing disk, the radiation force is reduced to one half of its original value. Therefore, there is a net downward force equal to one half the weight of the disk. $F = ma$, $\frac{mg}{2} = ma$, so $a = \frac{g}{2}$.

2. **DECREASE THE ILLUMINATION**
$\sin\theta = 1.22\frac{\lambda}{d}$**.** Decreasing the illumination causes d to increase, so θ will get smaller.

3. a) **The potential energy well is *not* infinitely deep.**

   b) **For the n = 1 state of an infinite well, $\lambda = 2L$.**
   In this case, the wavelength is longer than $2L$, so the well is of finite depth.

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PART C.

1. a) $I = \dfrac{P}{A} = \dfrac{P}{\pi r^2} = \dfrac{7.0\text{ W}}{\pi(5.0\times10^{-2}\text{ m})^2}$ $\underline{I = 8.9\times10^{2}\text{ W/m}^2 = 890\text{ W/m}^2}$

   b) The energy of N photons of frequency f is $E = Nhf$, so $P = \dfrac{dE}{dt} = \dfrac{d(Nhf)}{dt} = hf\dfrac{dN}{dt}$

   Then, $\dfrac{dN}{dt} = \dfrac{P}{hf} = \dfrac{P\lambda}{hc} = \dfrac{(7.0\text{ W})(5.5\times10^{-7}\text{ m})}{(6.63\times10^{-34}\text{ J}\cdot\text{s})(3.0\times10^{8}\text{ m/s})}$

   $\underline{N = 1.9\times10^{19}\text{ photons/s}}$

   c) **INCREASES**
   THE SIZE OF THE CENTRAL MAXIMUM DECREASES, AND THE POWER REMAINS THE SAME

2. a) $E_F = \frac{1}{2}mv_F^2$, so $v_F = \sqrt{\dfrac{2E_F}{m}} = \sqrt{\dfrac{2(5.5\text{ eV})(1.6\times10^{-19}\text{ J/eV})}{9.11\times10^{-31}\text{ kg}}}$ $\underline{v_F = 1.4\times10^{6}\text{ m/s}}$

   b) **NO** To eject an electron, the energy of the photon must be greater than the work function. For 450 nm, $E = hf = \dfrac{hc}{\lambda} = \dfrac{(4.14\times10^{-15}\text{ eV}\cdot\text{s})(3.0\times10^{8}\text{ m/s})}{4.5\times10^{-7}\text{ m}} = 2.76\text{ eV}$
   This is less than 4.6 eV.

   c) The cutoff wavelength is the wavelength of a photon whose energy equals the work function. $\Phi = \dfrac{hc}{\lambda_{cutoff}}$, so $\lambda_{cutoff} = \dfrac{hc}{\Phi} = \dfrac{(4.14\times10^{-15}\text{ eV}\cdot\text{s})(3.0\times10^{8}\text{ m/s})}{4.6\text{ eV}} = 2.7\times10^{-7}\text{ m}$

   $\underline{\lambda_{cutoff} = 2.7\times10^{-7}\text{ m} = 270\text{ nm}}$