NAME

PHYS-1200 PHYSICS II QUIZ 3 DECEMBER 6, 2006

SOLUTIONS

PART A.

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

PART B.

1. a) $N_1 = \dfrac{L}{\lambda} = \dfrac{7.50\times10^{-6}\text{ m}}{5.00\times10^{-7}\text{ m}}$ <u>N_1 = 15</u>

   b) $N_2 = \dfrac{L}{\lambda / n} = n\dfrac{L}{\lambda} = (1.30)(15)$ <u>N_2 = 19.5</u>

   c) **THEY ARE COMPLETELY OUT OF PHASE.**
   $N_2 - N_1 = 4.5$, which is an integer plus ½.

2. a) The Fermi energy is the energy of the highest filled state, *measured from the bottom of the conduction band*. In this case, that is 25 eV – 20 eV.
   <u>E_F = 5 eV</u>

   b) The work function is the difference between the energy of the most energetic electrons in the wells and the top of the well, where electron would be free.
   Φ = 33 eV – 25 eV <u>Φ = 8 eV</u>

   c) **CONDUCTOR**. The highest occupied band is only partially filled.

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PART C.

1. a) $d \sin\theta = m\lambda$, so $d = \dfrac{m\lambda}{\sin\theta} = \dfrac{1(4.0\times10^{-8}\text{ m})}{\sin 2.0°}$ $\underline{d = 1.1\times10^{-6}\text{ m} = 1.1\ \mu\text{m}}$

b) $a \sin\theta = m\lambda$, so $a = \dfrac{m\lambda}{\sin\theta} = \dfrac{1(4.0\times10^{-8}\text{ m})}{\sin 5.0°}$ $\underline{a = 4.6\times10^{-7}\text{ m} = 0.46\ \mu\text{m}}$

c) $K_{el} = \dfrac{p^2}{2m} = \dfrac{h^2}{2m\lambda^2} = \dfrac{(6.63\times10^{-34}\text{ J}\cdot\text{s})^2}{2(9.11\times10^{-31}\text{ kg})(4.0\times10^{-8}\text{ m})^2}$

$\underline{K_{el} = 1.5\times10^{-22}\text{ J} = 9.4\times10^{-4}\text{ eV} = 0.94\text{ meV}}$

d) $\Delta y = D\tan\theta = (0.50\text{ m})\tan 2.0°$ $\underline{\Delta y = 1.7\times10^{-2}\text{ m} = 1.7\text{ cm}}$

2. a) $I = \dfrac{E_m^2}{2c\mu_0}$, so $E_m = \sqrt{2c\mu_0 I} = \sqrt{2(3.0\times10^8\text{ m/s})(4\pi\times10^{-7}\text{ H/m})(5.0\times10^{-2}\text{ W/m}^2)}$

$\underline{E_m = 6.1\text{ V/m}}$

b) $I = \dfrac{P_s}{4\pi r^2}$, so $P_s = 4\pi r^2 I = 4\pi(2.0\text{ m})^2(5.0\times10^{-2}\text{ W/m}^2)$

$\underline{P_s = 2.5\text{ W}}$

c) $E_{photon} = hf = (6.63\times10^{-34}\text{ J}\cdot\text{s})(2.0\times10^{12}\text{ Hz})$

$\underline{E_{photon} = 1.3\times10^{-21}\text{ J} = 8.3\times10^{-3}\text{ eV} = 8.3\text{ meV}}$

d) In time t, the energy that strikes the screen is $U = IAt$. Then, the number of photons in one second is, $N = \dfrac{U}{E_{photon}} = \dfrac{IAt}{E_{photon}} = \dfrac{(5.0\times10^{-2}\text{ W/m}^2)(2.0\times10^{-4}\text{ m}^2)(1.0\text{ s})}{1.3\times10^{-21}\text{ J}}$

$\underline{N = 7.5\times10^{15}}$