ENGG 2120 Fall 2011 Chapter 21 Assignment with answers

1. Define refractive index of material.

Ans:

Refractive index of material is defined as ratio of velocity of light in vacuum or air to velocity of light in medium.

$$n = \frac{c}{v}$$

Where

n- Refractive index of medium

c- Velocity of light in vacuum

v- Velocity of light in medium

2. Visible light having a wavelength of 5×10^{-7} m appears green. Compute the frequency and energy of a photon of this light. ($h = 6.63 \times 10^{-34}$ J-s)

Ans:

Frequency of photon is given by

$$\nu = \frac{c}{\lambda}$$

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^{8}\, m/s}{5 \times 10^{-7}\, m} = 6 \times 10^{14}\ s^{-1}$$

Energy of a photon is given by

$$E = \frac{hc}{\lambda}$$

$$E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34}\, J\text{-}s)(3 \times 10^{8}\, m/s)}{5 \times 10^{-7}\, m}$$

$$= 3.98 \times 10^{-19} \text{ J} \quad (2.44 \text{ eV})$$

3. The index of refraction of corundum (Al_2O_3) is anisotropic. Suppose that visible light is passing from one grain to another of different crystallographic orientation and at normal incidence to the grain boundary. Calculate the reflectivity at the boundary if the indices of refraction for the two grains are 1.757 and 1.779 in the direction of light propagation.

Ans:

This problem calls for a calculation of the reflectivity between two corundum grains having different orientations and indices of refraction (1.757 and 1.779) in the direction of light propagation, when the light is at normal incidence to the grain boundary.

Reflectivity (R) at interface between two media for normal incidence is given by

$$R = \left(\frac{n_2 - n_1}{n_2 + n_1} \right)^2$$

$$= \left(\frac{1.779 - 1.757}{1.779 + 1.757} \right)^2 = 3.87 \times 10^{-5}$$

4. In your own words, briefly describe the phenomenon of photoconductivity.

Ans:

The conductivity of semiconductors depends on the number of free electrons in conduction band also number of holes in valence band. Thermal energy associated with lattice vibrations can promote the electron excitations in which free electrons and holes are created. Additional charges generated as a consequence of photon induced electron transition in which light is absorbed. This attendant increase in conductivity is called photoconductivity.

5. Match the folloings for Al_2O_3.

1. Single crystal	A. Translucent
2. Polycrystalline dense	B. Opaque
3. Polycrystalline porous	C. Transparent

Ans:

1-C, 2-A, 3-B

6. Briefly explain what determines the characteristic color of (a) a metal and (b) a transparent nonmetal.

Ans:

(a) The characteristic color of a metal is determined by the distribution of wavelengths of the non absorbed light radiation that is reflected.

(b) The characteristic color of a transparent nonmetal is determined by the distribution of wavelengths of the non absorbed light radiation that is transmitted through the material.

7. Intensity of light at interface of a material is given by

A) $I_o=I_R-I_A+I_T$
B) $I_o=I_R+I_A-I_T$
C) $I_o=I_R+I_A+I_T$
D) $I_o=I_R+I_A$

Ans: C

8. Write acronym of LASER

Ans:

LASER: Light amplification by Stimulated Emission of Radiation

9. Briefly explain why metals are opaque to electromagnetic radiation having photon energies within the visible region of the spectrum.

Ans:

The electron band structures of metals are such that empty and available electron states are adjacent to filled states. Electron excitations from filled to empty states are possible with the absorption of electromagnetic radiation having frequencies within the visible spectrum, according to equation $E = h\upsilon$. The light energy is totally absorbed or reflected, and, since none is transmitted, the material is opaque.