Problems

1-Define the electromagnetic radiation .

2-Explain by diagram the form of the electromagnetic spectrum according to the wave lengths ranging between them and visible region of spectrum in details.

3-Prove that the velocity of electromagnetic radiation equal to ($3*10^8$ m/s).

4-What the meaning of electromagnetic radiation according to perspective of a quantum mechanics?

5-What are the energies of light with wavelengths equal to: a) 400 nm, and b) 800 nm? What are their colors?

6- Compare R* , the reflectance in silica glass ($\eta s = 1.46$) to that in pure PbO ($\eta s = 2.60$). Explain briefly why ornamental glassware has a small percentage of PbO present.

7- Visible light having a wavelength of 5×10^{-7} m appears green. Compute the frequency and energy of a photon of this light.

8- Distinguish between materials that are opaque, translucent, and transparent in terms of their appearance and light transmittance .

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

10- Zinc selenide (ZnSe) has a band gap of (2.58 eV). Over what range of wavelengths of visible light is it transparent?

11- The transmissivity T of a transparent material 15 mm thick to normally incident light is 0.80. If the index of refraction of this material is 1.5, compute the thickness of material that will yield a transmissivity of 0.70.

12- Briefly explain why some transparent materials appear colored while others are colorless.

13- Define the electronic polarization

14- What caused when electromagnetic radiation interact with material?

15- What the consequences generated by electronic polarization?

16-Define the photoconductivity of semiconductors.

17-Explaine temperature dependence of the heat capacity.

18-What the meaning of thermal expansion and how you can recognize between an harmonic and harmonic potential?

19-How you can recognize between the materials according to its heat conduction?

20-Explaine the mechanisms of heat conduction.

Solutions

5-Solve: *The photon energy is:*

$E_{photon} = hc/\lambda_L = (6.63 \times 10^{-34}\ J.s \times 3 \times 10^{8}\ m/s)/(1.6 \times 10^{-19}\ C \times \lambda_L) = 1.24\ eV/\lambda_L$.

a) When $\lambda_L = 400\ nm$ *or* $0.4\ \mu m$, $E_{photon} = 3.1\ eV$ *(blue).*

b) When $\lambda L = 800\ nm$ *or* $0.8\ \mu m$, $E_{photon} = 1.55\ eV$ *(red).*

6-Solve:

the reflectance formula: $R^* (glass) = (1.46 - 1)^2 /(1.46 + 1)^2 = 0.035$.

Similarly, $R^* (PbO) = (2.60 - 1)^2 /(2.60 + 1)^2 = 0.198$. *PbO*

is therefore more reflective, which gives the ornamental value.

7-solve-

We must compute the frequency of a photon of green light,

$v = c\lambda = 3x10^{8} m/s \; . \; 5x10^{-7} m = 6 \; x \; 10^{14} \; s^{-1}$ *(Hz)*

The energy a photon of green light $E = hc / \lambda = (6.63x10^{-34} J.s)(3x10^{8} m/s) / 5x10^{-7} m = 3.98 \; x \; 10^{-19} \; J = (2.48 \; eV)$

8-solve:

Opaque materials are impervious to light transmission; it is not possible to see through them. Light is transmitted diffusely through translucent materials (there is some internal light scattering). Objects are not clearly distinguishable when viewed through a translucent material. Virtually all of the incident light is transmitted through transparent materials, and one can see clearly through them.

9-solve:

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. The light energy is totally absorbed or reflected, and, since none is transmitted, the material is opaque.

10-solve:

Only photons having energies of 2.58 eV or greater are absorbed by valence-band-to-conduction band electron transitions. The minimum photon energy for visible light is 1.8 eV, which corresponds to a wavelength of 0.7 μm.

$\lambda = hc / E = (4.13x10^{-15} eV.s)(3x10^{8} m/s) / 2.58 \; eV = 4.80 \; x \; 10^{-7} \; m = 0.48 \; \mu m$ *Thus, pure ZnSe is transparent to visible light having wavelengths between 0.48 and 0.7 μm*

11-Solve:

All reflection losses should be considered. $R = (ns-1)^2 / (ns+1)^2 = (1.5-1)^2 / (1.5+1)^2 = 4.0 \; x \; 10^{-2}$ *since:* $I_T = I_0 \; (1 - \;)^2 e^{-\beta l}$ *and* $I_T / I_0 (1-R)^2 = e^{-\beta l}$ *And taking the natural logarithms of both sides of this expression gives*

$\ln[I_T / I_0(1-R)^2] = -\beta l$ and $\beta = -1/l \ln [I_T / I_0(1-R)^2]$ Since the transmissivity is T is equal to I_T/I_0, then the above equation takes the form

$\beta = -(1/l) \ln [T / (1-R)^2]$ and $\beta = -(1/15mm) \ln [0.80 / (1-4.0x10^{-2})^2] = 9.43 \times 10^{-3}$ mm -1

12-Solve

For a transparent material that appears colorless, any absorption within its interior is the same for all visible wavelengths. On the other hand, if there is any selective absorption of visible light (usually by electron excitations), the material will appear colored, its color being dependent on the frequency distribution of the transmitted light beam.