HW KEY 9

12.42)

Most of the prevalent information can be found in Section 12.15 in your textbook

12.49)

Solution 12.49

We want to compute the plate spacing of a parallel-plate capacitor as the dielectric constant is increased form 2.2 to 3.7, while maintaining the capacitance constant. Combining Equations 12.26 and 12.27 yields the following expression:

$$C = \varepsilon \frac{A}{l} = \varepsilon_r \varepsilon_0 \frac{A}{l}$$

Now, let us use the subscripts 1 and 2 to denote the initial and final states, respectively. Since $C_1 = C_2$, then we can write the following:

$$\frac{\varepsilon_{r1}\varepsilon_0 A}{l_1} = \frac{\varepsilon_{r2}\,\varepsilon_0 A}{l_2}$$

And, solving for l_2 leads to the following:

$$l_2 = \frac{\varepsilon_{r2} l_1}{\varepsilon_{r1}} = \frac{(3.7)(2 \text{ mm})}{2.2} = 3.36 \text{ mm}$$

17.17)

Answer 17.17

Metals are typically better thermal conductors than are ceramic materials because, for metals, most of the heat is transported by free electrons (of which there are relatively large numbers). In ceramic materials, the primary mode of thermal conduction is via phonons, and phonons are more easily scattered than are free electrons.

19.22)

Answer 19.22

Amorphous polymers are normally transparent because there is no scattering of a light beam within the material. However, for semicrystalline polymers, visible light will be scattered at boundaries between amorphous and crystalline regions since they have different indices of refraction. This leads to translucency or, for extensive scattering, opacity, except for semicrystalline polymers having very small crystallites.

19.14)

Solution 19.14

This problem asks us to determine the range of visible light wavelengths over which ZnSe (E_g = 2.58 eV) is transparent. Only photons having energies of 2.58 eV or greater are absorbed by valence-band-to-conduction-band electron transitions. Thus, photons having energies less than 2.58 eV are not absorbed; the minimum photon energy for visible light is 1.8 eV (Equation 19.16b), which corresponds to a wavelength of 0.7 μm. From a rearranged form of Equation 19.3, the wavelength of a photon having an energy of 2.58 eV (i.e., the band-gap energy) is just

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

$$= \frac{(4.13 \times 10^{-15}\ \text{eV-s})(3 \times 10^{8}\ \text{m/s})}{2.58\ \text{eV}}$$

$$= 4.80 \times 10^{-7}\ \text{m} = 0.48\ \mu\text{m}$$

Thus, pure ZnSe is transparent to visible light having wavelengths between 0.48 and 0.7 μm.