(a) \[ E = hf = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34} \text{ J s})(3.00 \times 10^8 \text{ m/s})}{(650 \times 10^{-9} \text{ m})} = 3.06 \times 10^{-20} \text{ J} \]

(b) \[ \theta_c = \sin^{-1} \left( \frac{n_{\text{air}}}{n_{\text{glass}}} \right) = \sin^{-1} \left( \frac{1}{1.65} \right) = 37.3^\circ \]

(c) \[ \Delta m = \frac{d \sin \theta}{\lambda^2} \quad \sin \theta = \frac{1.25 \text{ cm}}{400 \text{ cm}} \quad \lambda = \frac{(2.00 \times 10^{-6} \text{ m})(1.25 \text{ cm})}{1 (400 \text{ cm})} = 6.25 \times 10^{-9} \text{ m} \]

(d) A soap (\( n = 1.33 \)) film is observed to reflect light of perpendicular incidence in the (1100 nm) and the (900 nm), and no color in between. What is the minimum thickness of the soap film?

\[ 2nd = (n+1/2)\lambda_1 = (n+1/2)\lambda_2 \quad \text{by inspection} \]

\[ d = \frac{(n+1/2)\lambda_1}{2n} = \frac{(4.5)(600 \text{ nm})}{2(1.33)} = 1.02 \times 10^{-6} \text{ m} \]

(e) Calculate the focal length of the lens shown in air. The lens is made of glass with \( n = 1.55 \).

\[ \frac{1}{f} = (n-1) \left( \frac{1}{R_1} - \frac{1}{R_2} \right) = (1.55) \left( \frac{1}{170 \text{ cm}} - \frac{1}{450 \text{ cm}} \right) \Rightarrow f = 49.7 \text{ cm} \]

(f) An electron is accelerated through a potential difference of 10,000 volts. Calculate its DeBroglie wavelength.

\[ \lambda = \frac{h}{p} = \frac{h}{mV} \quad V = \sqrt{\frac{2E}{m}} \quad \lambda = \frac{h}{2mE} = \frac{(6.63 \times 10^{-34} \text{ J s})}{2(9.11 \times 10^{-31} \text{ kg})(10000 \text{ eV})(1.6 \times 10^{-19} \text{ eV})} = 1.23 \times 10^{-11} \text{ m} \]