3.18 (*a*) The forbidden bandgap energy in GaAs is 1.42 eV. (*i*) Determine the minimum frequency of an incident photon that can interact with a valence electron and elevate the electron to the conduction band. (*ii*) What is the corresponding wavelength? (*b*) Repeat part (*a*) for silicon with a bandgap energy of 1.12 eV.

a) GaAs

(i) Per section 2.1.1, $E = h\nu$

$$\nu = \frac{E}{h} = \frac{1.42\,eV(1.6021766\times10^{-19}\,J/eV)}{6.626\,07015\times10^{-34}\,J/Hz}$$

$$\nu = 3.4335\times10^{14}\,Hz = 343.35\,THz$$

(ii) $\lambda = c/f = c/\nu = \frac{2.9979\times10^{8}}{3.4335\times10^{14}}$

$$\lambda = 8.7313\times10^{-7}\,m = 873.13\,nm$$

b) Silicon

$$\nu = \frac{1.12(1.60218\times10^{-19})}{6.62607\times10^{-34}}$$

$$\nu = 2.7081\times10^{14}\,Hz = 270.815\,THz$$

$$\lambda = \frac{2.9979\times10^{8}}{2.708\times10^{14}}$$

$$\lambda = 1.107\times10^{-6}\,m = 1107\,nm$$