

a) Particle in a box energies are (width  $a$ )

$$E = \frac{n^2 h^2}{8m^* a^2}$$

$$m^* = 0.07 m_e$$

effective mass

Energy of photon is energy difference between two levels

$$\hbar \omega_{\text{photon}} = E_{n+1} - E_n$$

$$= \frac{h^2}{8m^* a^2} ((n+1)^2 - n^2)$$

$$\hbar \omega_{\text{photon}} = \frac{h^2}{8m^* a^2} (2n+1)$$

$n$  refers to lower level quantum number

b)  $\lambda = 10 \mu\text{m}$  has energy of

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

$$\Rightarrow \frac{hc}{\lambda} = \frac{h^2}{8m^* a^2} (3)$$

$$a^2 = \frac{3h\lambda}{8m^* c}$$

$$a = \sqrt{\frac{3h\lambda}{8m^* c}} = \sqrt{\frac{3 \cdot 6.626 \times 10^{-34} \text{ J}\cdot\text{s} \cdot 10^{-5} \text{ m}}{8 \cdot 0.07 \cdot 9.109 \times 10^{-31} \text{ kg} \cdot 3 \times 10^8 \text{ m/s}}}$$

$$a = 11.4 \text{ nm}$$