PC2232 – Tutorial 8 Solutions

1.
   - Location of foci: $F_1 = \left(b^2 - a^2,\, 0\right)$ $\qquad F_2 = \left(a^2 - b^2,\, 0\right)$
   - Place extra atom at $(4, 0)$ and expect a mirage at $(-4, 0)$
     Or vice versa
   - 2 or more rings of atoms will make the mirage more prominent

3. (a) $\psi(x,y) = \dfrac{2}{L}\sin\left(\dfrac{n_x\pi}{L}x\right)\sin\left(\dfrac{n_y\pi}{L}y\right)$

   (b) $E = \dfrac{h^2}{8mL^2}(n_x^2 + n_y^2)$

   (c) $E_1 = 2\dfrac{h^2}{8mL^2}$ $\Rightarrow$ 1 states: $\psi_{1,1}(x,y)$

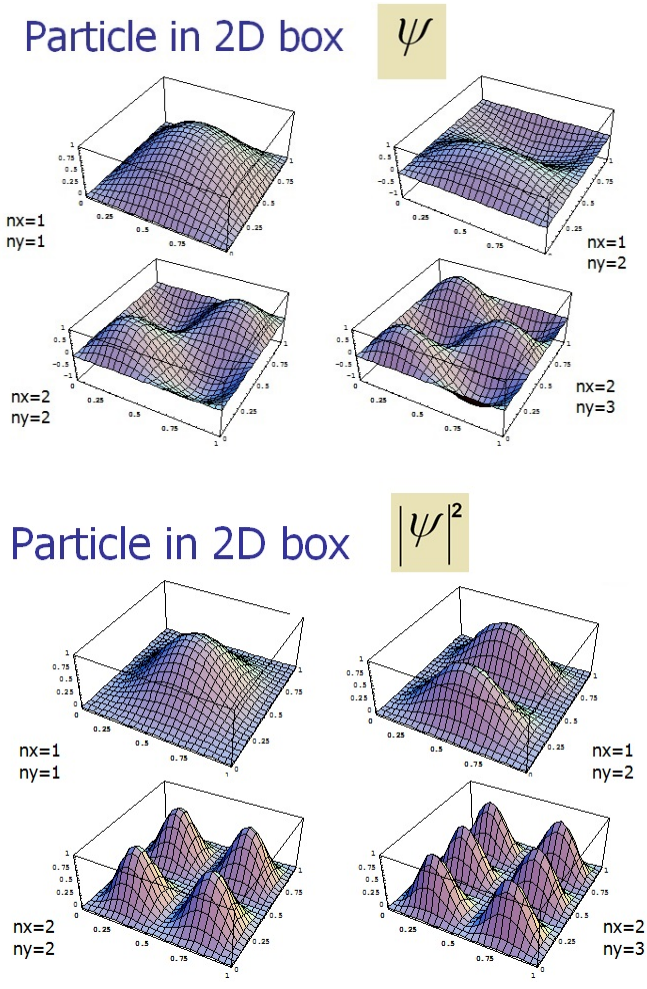
   $E_2 = 5\dfrac{h^2}{8mL^2}$ $\Rightarrow$ 2 states: $\psi_{1,2}(x,y)$; $\psi_{x,y}(2,1)$

   $E_3 = 8\dfrac{h^2}{8mL^2}$ $\Rightarrow$ 1 states: $\psi_{2,2}(x,y)$

   $E_4 = 10\dfrac{h^2}{8mL^2}$ $\Rightarrow$ 2 states: $\psi_{1,3}(x,y)$; $\psi_{x,y}(3,1)$

   $E_5 = 13\dfrac{h^2}{8mL^2}$ $\Rightarrow$ 2 states: $\psi_{2,3}(x,y)$; $\psi_{x,y}(2,3)$

4. Using mathematica:



5. (a) $E_0 = 107\dfrac{h^2}{8mL^2}$

   (b) Positions where highest energy particles will most likely be found

$$\left(\frac{2m+1}{6}L,\ \frac{1}{2}L,\ \frac{1}{2}L\right) \qquad \left(\frac{1}{2}L,\ \frac{2m+1}{6}L,\ \frac{1}{2}L\right) \qquad \left(\frac{1}{2}L,\ \frac{1}{2}L,\ \frac{2m+1}{6}L\right)$$
$$(n_x = 3,\ n_y = 1,\ n_z = 1) \qquad (n_x = 1,\ n_y = 3,\ n_z = 1) \qquad (n_x = 1,\ n_y = 1,\ n_z = 3)$$

   where m is any integer that runs from 1 to 3

6. (a) Quantum number of the first 20 states: $(n_x = m,\ n_y = 1,\ n_z = 1)$
   where $m = 1, 2 \ldots, 20$

   (b) First 5 longest absorption wavelength

$$\lambda_{1\to2} = 0.00275\text{m} \qquad \lambda_{1\to3} = 0.00103\text{m} \qquad \lambda_{1\to4} = 0.00055\text{m}$$
$$\lambda_{1\to5} = 0.00034\text{m} \qquad \lambda_{1\to6} = 0.00024\text{m}$$

7. Refer to excel file.