# CH#39
## H.W. Solution

#2

$$E = \left(\frac{h^2}{8mL^2}\right) n^2$$

$$E_{ground} = \left(\frac{h^2}{8mL^2}\right)$$

a. $L = 2 \times 10^{-10}\ m$

$m_e = 9.1 \times 10^{-31}\ kg$

b. $m_p = 1.67 \times 10^{-27}\ kg.$

#9. $$E_n = \left(\frac{h^2}{8mL^2}\right) n^2$$

$$E_n = hf = \frac{hc}{\lambda_n}$$

$$\lambda_n = \frac{hc}{E_n}$$

a. $\lambda_1 = \dfrac{hc}{E_1}$

b. $\lambda_2 = \dfrac{hc}{E_2}$

c. $\lambda_3 = \dfrac{hc}{E_3}$.

#13.

Probability of findinging the electron between $x_1$ and $x_2$

$$= \int_{x_1}^{x_2} A^2 \sin^2\left(\frac{n\pi}{L}x\right) dx$$

$$= A^2 \int_{x_1}^{x_2} \sin^2(ax)\, dx \quad , \quad a = \frac{n\pi}{L}$$

$$A = \sqrt{\frac{2}{L}}$$

$$\cancel{= A^2 \left[ \int \left( \right.\right.}$$

$$\cos 2ax = 1 - 2\sin^2 ax$$

$$\sin^2 ax = \frac{(1 - \cos 2ax)}{2}$$

$$\therefore A^2 \int_{x_1}^{x_2} \sin^2 ax\, dx = \frac{A^2}{2} \int (1 - \cos 2ax)\, dx$$

$$= \frac{A^2}{2} \left[ x - \frac{1}{2a} \sin 2ax \right]_{x_1}^{x_2}$$

$$P = \frac{A^2}{2} \left[ (x_2 - x_1) - \frac{1}{2a} \left[ \sin 2a x_2 - \sin 2a x_1 \right] \right]$$

a. $x_1 = 25 - 5 = 20\ pm$ , $x_1 = 25 + 5 = 30\ PM$

b. $x_1 = 50 - 5 = 45\ PM$ , $x_2 = 50 + 5 = 55\ PM$

c. $x_1 = 90 - 5 = 85\ PM$ , $x_2 = 90 + 5 = 95\ PM.$

#16.

$E_3 =$ From Fig 39-4

$E_3 = 280$ eV

$U_0 = 450$ eV

$$KE = \cancel{E} U_0 - E_0$$
$$= 450 - 280$$
$$= 270 \text{ eV}.$$

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#20 $$E_{n_x, n_y} = \frac{h^2}{8m}\left[\frac{n_x^2}{L_x^2} + \frac{n_y^2}{L_y^2}\right]$$

$$E_{n_x, n_y} = \frac{h^2}{8mL^2}\left[n_x^2 + \frac{n_y^2}{4}\right]$$

a. ground state $n_x = n_y = 1$

$$E_{1,1} = \frac{h^2}{8mL^2}\left[1 + \frac{1}{4}\right] = \frac{5h^2}{32mL^2}$$

b. 1st excited state is $n_x = 1$, $n_y = 2$

$$E_{1,2} = \frac{h^2}{4mL^2}.$$

c. $$E_{2,2} = \frac{h^2}{8mL^2}[4 + 1] = \frac{5h^2}{8mL^2}.$$

# 2c- continue

d. second Excited state
is when,
$n_x = 2, \quad n_y = 1$

$$E_{21} = \frac{h^2}{8mL^2}\left[4 + \frac{1}{4}\right]$$

$$= \frac{17 h^2}{32 mL^2}.$$

Third Excited-state

$$E_{22} = \frac{5h^2}{8mL^2}$$

$$\Delta E = E_{22} - E_{21}$$

$$= \frac{h^2}{8mL^2}\left[5 - \frac{17}{4}\right]$$

$$= \frac{h^2}{8mL^2}\left(\frac{20-17}{4}\right)$$

$$\Delta E = \frac{3h^2}{32 mL^2}$$

#30.

$$P(r) = \frac{4}{a^3} r^2 e^{-2r/a}.$$

a. $r = 0$

$$P(0) = 0$$

b. $r = a$

$$P(a) = \frac{4}{a^3} a^2 e^{-2}$$

$$= \frac{4}{a} e^{-2}$$

c. $r = 2a$.

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#35

$\cancel{E = U + KE}$ $KE = 13.6\ eV$

at $r = a$

$$U = \frac{e^2}{4\pi\epsilon_0 a} = \frac{(1.6\times10^{-19})^2}{4\pi(8.85\times10^{-12})(5.3\times10^{-11})}$$

$$= \frac{2.56\times10^{-38}}{5.89\times10^{-21}}$$

$$= 4.34\times10^{-18}\ J$$

$$= -27.2\ eV$$

# #44

$$\frac{1}{\lambda} = R\left[\frac{1}{n^2_{Low}} - \frac{1}{n^2_{high}}\right]$$

$$\frac{1}{n^2_{Low}} - \frac{1}{n^2_{high}} = \frac{1}{\lambda R}$$

$$= \frac{1}{102.6\times10^{-9} \times 1.097 \times 10^7}$$

$$\frac{1}{1} - \frac{1}{9} = 0.888$$

$n_{Low} = 1$

$n_{high} = 3$

Lyman series.