LECTURES 26-27

1) SELF STUDY

2) a) For an infinite QW

$$E_n = \frac{\hbar^2 \pi^2 n^2}{2 m_e L^2}$$

$\hbar = 1.055 \times 10^{-34}$ J.s
$n = 1$
$m_0 = 9.1 \times 10^{-31}$ kg
$L = 10 \times 10^{-9}$ m

$m_e = m_e^* m_0$
$m_e^* = 0.04$

$$= \frac{\left(1.055 \times 10^{-34}\right)^2 \cdot 3.142^2 \cdot (1)^2}{2 \times 0.04 \times 9.1 \times 10^{-31} \times \left(1 \times 10^{-8}\right)^2} \quad J$$

$$= \frac{10.42}{0.728} \times \frac{\times 10^{-68}}{\times 10^{-68}} \quad J$$

$$= 14.31 \times 10^{-21} \quad J$$

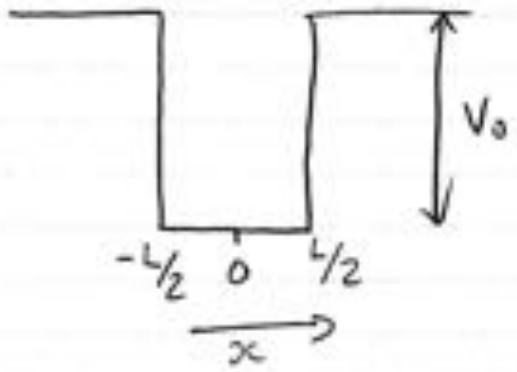
$$= 1.431 \times 10^{-20} \quad J$$

$$= 0.894 \times 10^{-1} \quad eV$$

$$= 8.94 \times 10^{-2} \quad eV$$

$$= 89.4 \quad meV.$$

2] a) FINITE QW (SOME REVISION, DERIVATION INCLUDED)



$$\frac{\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2} + k_1\psi(x) = 0 \qquad |x| < \frac{L}{2}, \quad k_1 = \sqrt{\frac{2mE}{\hbar^2}}$$

$$\frac{\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2} - k_2\psi(x) = 0 \qquad |x| > \frac{L}{2}, \quad k_2 = \sqrt{\frac{2m(V_0 - E)}{\hbar^2}}$$

For even ψ soln is

$$\psi(x) = C_1 \exp(-k_2 x) \qquad |x| > L/2$$

$$\psi(x) = C_2 \cos k_1 x \qquad |x| < L/2$$

@ $x = \pm L/2$ ψ is continuous so

$$C_2 \cos\frac{k_1 L}{2} = C_1 \exp\left(-k_2\frac{L}{2}\right). \qquad -(A)$$

as is $\frac{d\psi}{dx}$ so $-k_2 C_1 \exp\left(-k_2\frac{L}{2}\right) = -k_1 C_2 \sin\left(\frac{k_1 L}{2}\right)$ (B)

2) a) FINITE QW CONTD.

DIVIDE B BY A TO ELIMINATE C_2, C_1.

$$\frac{-k_1 C_2 \sin\left(\frac{k_1 L}{2}\right)}{C_2 \cos\left(\frac{k_1 L}{2}\right)} = \frac{-k_2 C_1 \exp\left(-\frac{k_2 L}{2}\right)}{C_1 \exp\left(-\frac{k_2 L}{2}\right)}$$

$$\Rightarrow \tan\left(\frac{k_1 L}{2}\right) = \frac{k_2}{k_1}$$

⇒ see finite QW Soln.XLS .....

Solns for both exist at ~ 47 meV.

So for finite well E_n = 47 meV.

c.f. 89.4 meV for infinite QW soln.

(Finite QW soln)

2) b). $E_n = \dfrac{h^2 \pi^2 n^2}{2m L^2}$

$\hbar = 1.055 \times 10^{-34}$ J.s
$n = 1$
$m_0 = 9.1 \times 10^{-31}$ kg
$L = 1 \times 10^{-9}$ m

$m_h = m_n^* m_0$
$m_n^* = 0.45$

$$= \frac{(1.055 \times 10^{-34})^2 \cdot 3.142^2 \cdot (1)^2}{2 \times 0.45 \times 9.1 \times 10^{-31} \times (1 \times 10^{-9})^2} \text{ J}$$

$$= \frac{10.42}{8.19} \times \frac{10^{-68}}{10^{-47}} \text{ J}$$

$$= 1.272 \times 10^{-21} \text{ J}$$

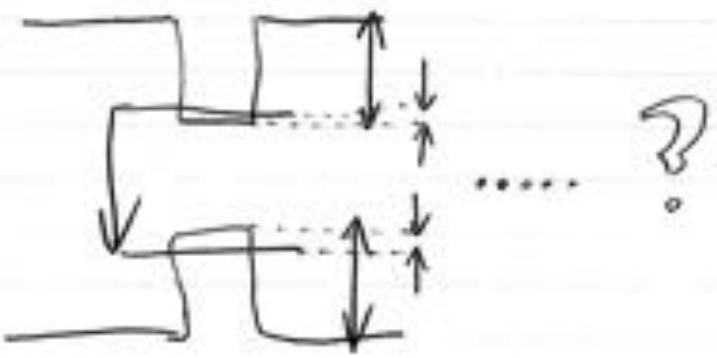
$$= 7.95 \text{ meV}.$$

2) c). $V_{CB} = 0.24$
$V_{VB} = 0.36$

$V_{CB} : V_{VB} = 0.24 : 0.36.$

2) d) ⇨ SELF STUDY.

e) ⇨



3) SELF STUDY.

4) " .