LECTURE 15

1) → REVIEW NOTES, SELF STUDY.

2) a). $R_x = -\frac{\mu}{m_0 \varepsilon_r^2} \cdot R_H$

$$\frac{1}{\mu} = \frac{1}{m_e} + \frac{1}{m_h} \Rightarrow \mu = \left(\frac{1}{0.08} + \frac{1}{0.6}\right)^{-1}$$
$$= 0.071\ m_0$$

$$R_x = \frac{0.071}{(12.5)^2} \cdot 13.6 \text{ eV}$$

$$= 6.14 \text{ meV}$$

b). $a_x = \frac{m_0}{\mu} \varepsilon_r a_H$

$$= \frac{1}{0.071} \cdot 12.5 \cdot 5.29 \times 10^{-9} \text{ m}$$

$$= 931 \times 10^{-11} \text{ m}$$

$$= 9.31 \times 10^{-9} \text{ m} = 9.31 \text{ nm}$$

c) $E_n = -\frac{R_x}{n^2}$ so Energy difference between $n=1$, $n=2$ is

$$\Delta E_n = \frac{R_x}{1^2} - \frac{R_x}{2^2}$$

$$= \frac{3}{4} R_x = 4.6 \text{ meV}$$

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2)d) volume of orbit of n=1 exciton → assume sphere

$$V_{exc} = \frac{4}{3}\pi r_x^3$$

as $n=1$ $r_x = a_x$ so

$$V_{exc} = \frac{4}{3}\pi a_x^3$$

$$= \frac{4\times\pi}{3} \times \left(9.31\times10^{-9}\right)^3 \quad m^3$$

$$= 3.381 \times 10^{-24} \quad m^3.$$

volume of 1 unit cell $= \left(0.587\times10^{-9}\right)^3$

$$V_{uc} = 2.022 \times 10^{-28} \cdot m^3$$

$$\#\text{ unit cells} = \frac{V_{exc}}{V_{uc}} = \frac{3.381\times10^{-24}}{2.022\times10^{-28}} = 16,714$$

e) Need to compare $E_n = 6.14$ meV for $n=1$ with kT.

$$kT = 6.14\times10^{-3} = 8.617\times10^{-5} \cdot T$$

$$T = \frac{6.14\times10^{-3}}{8.617\times10^{-5}} = 0.708\times10^{2} \quad K.$$

$$= 70\ K$$

SO EXPECT THE EXCITON TO BE STABLE TO ~ 70K.

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2)f). M.H density $= \frac{1}{\frac{4}{3}\pi r_n^3}$

$= \frac{1}{V_{occ}} \simeq \frac{1}{2.022} \times 10^{28} \ m^{-3}$

$\sim 0.5 \times 10^{28} \ m^{-3}$

$\sim 5 \times 10^{27} \ m^{-3}$

$\sim 5 \times 10^{21} \ cm^{-3}$

3) - 5) → NOTES, SELF STUDY.