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BATCH: B10

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Physics-2 (15B11PH211)

Tutorial-10

Q.1. $a = 3.61\text{Å}$

$$\frac{1}{\rho} = \sigma = \frac{ne^2\tau}{m} \rightarrow \tau = 2.37\times10^{-8}\ \text{sec}$$

$m \rightarrow$ in gram

$$a^3 = 4$$

$$n\ /m^3 = \frac{4}{a^3} \rightarrow n = \frac{4}{(3.61)^3} = 8.5\times10^{28}$$

$$V_d = \frac{eE\tau}{m} = 0.416\ \text{m/s}$$

Q.2. $$f(\epsilon) = \frac{1}{e^{\frac{(\epsilon-\epsilon_F)}{KT}}+1}$$

probability of occupancy of ϵ $\quad \epsilon - \epsilon_F = K_BT$

$$= \frac{1}{e^{KT/KT}+1} = \frac{1}{e+1} \approx 0.268$$

Q.3. $$\frac{1}{20} = \frac{1}{e^{\frac{0.1eV}{KT}}+1}$$

$$20 = e^{\frac{0.1eV}{KT}}+1$$

$$2.94 = \frac{0.1\times1.6\times10^{-19}}{KT} = \frac{1.6\times10^{-20}}{T\times1.38\times10^{-23}}$$

$$T = 394\ K$$

Q.4. $$K_BT_F = E_F = \frac{\hbar^2}{2m}\times\left(\frac{3}{8\pi}\frac{N}{V}\right)^{2/3}$$

$\rho =$

$1\text{Kg} = \frac{N_A\times[illegible]3}{27}$

$n = 1kg = \frac{N_A \times 10^3}{27} \times 9 \quad \left(\frac{atom}{kg} \times \frac{kg}{m^3}\right)$

$n = \frac{N}{V} = 18.07 \times 10^{28} / m^3 \rightarrow E_f = \frac{h^2}{2m} \times \left(\frac{3}{8\pi} \times 18.07 \times 10^{28}\right)^{2/3}$

$T_f = \frac{E_f}{K_B} = \frac{18.88 \times 10^{-19}}{1.38 \times 10^{-23}} = 13.68 \times 10^4 K \Big] = 18.88 \times 10^{-19} J$

Q.5. $E_n = \frac{n^2 \pi^2 \hbar^2}{2ml^2}$

$E_n = (n_x^2 + n_y^2 + n_z^2) \frac{\pi^2 \hbar^2}{8ml^2}$ (in 3D)

Given: $E_n = \frac{38}{8} \frac{\pi^2 \hbar^2}{ml^2}$

n_x	n_y	n_z	(for 38)
6	1	1	
1	6	1	9 fold degeneracy.
1	1	6	
5	3	2	
5	2	3	
3	5	2	
2	5	3	
2	3	5	
3	2	5	

Q.6. (a) Assumption :-

* Valence e^- are treated as though they constitute an ideal Gas
* Valence e^- are move freely in the volume of the solid.
* the Attraction force b/w e^- & core ions & Repulsion b/w e^-s are insignificant

Merits :-

* It explain the specific heat of free e^-.
* It explain the temp. dependence of resistivity or Conductivity in metal.
* It explain the dependence of 'σ' on e^- Concentration.
* ferromagnetism is also explain by him.

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Demerit :-

* It does not explain why are some metals & other non-metal.
* It does not explain the conductivity of conductor, but in semiconductor & insulator
* It does not explain the e^- does not move under constant potential.

(b) $$\vec{J} = ne\vec{V_d} = \frac{\tau e e n \vec{E}}{m}$$

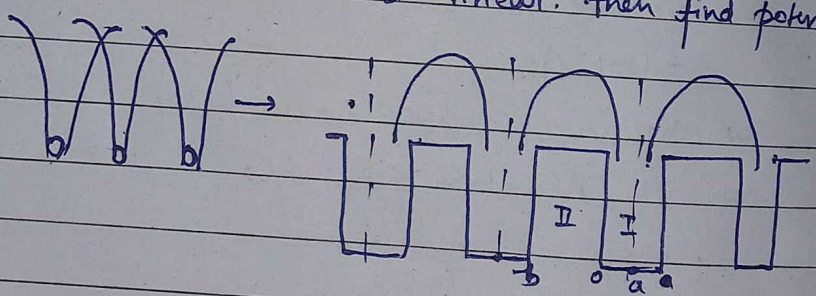
we've know ; $\vec{J} = \sigma \vec{E}$

$$\therefore \sigma = \frac{\tau e e n}{m}$$

$$\sigma = \frac{ne^2\tau}{m^*} = \frac{ne^2}{m^*}\frac{\lambda}{v_f}$$

(c) Bloch Theorem : free e^- move in periodic field provided by the lattice.

KP model : It is difficult to find potential because potential is variable. So we assume it linear. then find potential



Q7. $$\frac{P\sin\alpha a}{\alpha a} + \cos\alpha a = \cos ka = 1 \qquad \frac{P}{\alpha a} = \frac{1-\cos\alpha a}{\sin\alpha a}$$

$$\frac{P}{\alpha a} = \frac{1-\left(1-\frac{\alpha^2a^2}{2!}+\dots\right)}{\left(\alpha a-\frac{(\alpha a)^3}{3!}+\dots\right)} = \frac{\alpha^2a^2}{2\alpha a}$$

$$P = \frac{\alpha^2a^2}{2} = \frac{2mE}{\hbar^2}\times\frac{a^2}{2} \rightarrow E = \frac{\hbar^2 P}{ma^2}$$