# Shri Shankaracharya Institute of Professional Management & Technology, Raipur

**April-May 2021**
**Class Test-II (August 2021)**

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**Roll No.:**

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**Enrollment No.:**

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**Course:** B.Tech **Semester:** 2nd

**Branch:** COMPUTER SCIENCE AND ENGINEERING

**Subject Name:** Physics-1

**Subject Code:**

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# Unit - I

## Q1>

**Ans =>** Wave Packet: A wave packet refers to the case where two (or more) waves exist simultaneously. A wave packet is often referred to as a wave group.

Heisenberg Uncertainity Principal:
It states that for particles exhibiting both particle and wave nature, it will not be possible to accurately determine both the position and velocity at the same time.

Heisenberg Eq$^n$:

$$\boxed{\Delta x \cdot \Delta p \geq \frac{h}{4\pi}}$$

## Q4>

**Sol→(i)** velocity = 600m/s , accuracy = 0.005 %

The momentum of electron = mv

$= 9.1 \times 10^{-31} \times 600$ (kgm/s)

($\because$ mass of electron $= 9.1 \times 10^{-31}$ kg)

$\Rightarrow$ ~~$\Delta x \cdot \Delta p = \frac{h}{4\pi}$~~

$\Rightarrow$ ~~$\Delta x = \frac{h}{4\pi \cdot (\Delta p)} = \frac{6.62 \times 10^{-34}}{}$~~

$$\Rightarrow \quad \Delta p.x = \frac{0.005}{100} \times mv$$

$$= 5\times10^{-5} \times 9.1\times10^{-31} \times 600 \text{ kg m/s}$$

$$\Rightarrow \quad \Delta x = \frac{h}{\Delta p.x \cdot 4\pi}$$

$$= \frac{6.62\times10^{-34}}{5\times10^{-5}\times 9.1\times10^{-31}\times 600 \times 4 \times 3.14}$$

$$= \underline{\underline{1.9248\times10^{-3} \text{ m.}}} \quad \text{Ans}$$

(ii)

Sol → We know that the energy of a particle moving in a one-dimensional box (width $a = 1\,\text{Å} = 10^{-10}$ m) is given as

$$E = \frac{n^2h^2}{8ma^2} \qquad \text{where } n = 1, 2, 3, ---$$

For the minimum energy $n=1$, $\therefore E = \frac{h^2}{8ma^2}$

$$\text{or} \quad E_{min} = \frac{(6.6\times10^{-34})^2}{8\times(9.1\times10^{-31})\times(10^{-10})^2}$$

$$= 5.98\times10^{-18} \text{ J}$$

To convert From J to e-V

$$= \frac{5.98\times10^{-18}}{1.6\times10^{-19}} \text{ eV}$$

$$= \underline{37.375 \text{ eV}}. \quad \text{Ans}$$

Q3>

Ans => De Broglie's hypothesis of matter waves postutates that any particle of matter that has linear momentum is also a wave. The wavelength of a matter wave associated with a particle is inversely proportional to the magnitude of the particle's linear momentum.

Suppose an electron accelerates through a potential difference of V volt. The workdone by electric field on the electron appears as the gain in its kinetic energy. So, we have

$$K.E. = eV = \frac{1}{2}mv^2$$

where e is the charge on the electron, m is the mass of electron and v is the velocity of electron, then

$$m^2v^2 = 2meV$$

or $$mv = \sqrt{2meV}$$

∴ The de-Broglie wavelength of electron is given by.

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2meV}} = \frac{6.63\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times1.6\times10^{-19}\,V}}$$

$$\boxed{\lambda = \frac{12.27}{\sqrt{V}}}$$

This is the de-Broglie wavelength for electron moving in a potential diff. V volt

The intensity of the scattered beam is measured for different values of scattering angle $\phi$, the angle between the incident and the scattered electron beam.

The experiment was performed by varying the ~~accle~~ accelerating voltage from 44 V to 65 V. It was noticed that at accelerating voltage 54 V, the variation of intensity (I) and scattering angle ($\phi$) is ~~the~~ of the type shown.


From the graph, it is noted that at accelerating voltage 54 V, there is a sharp peak in the intensity of the scattered electrons for scattering angle ~~$\theta$~~ $\phi = 50°$.

The appearance of peak is due to constructive interference from different layers of regularly spaced atoms of crystal.

The electrons beam will be given by

$$\theta + \phi + \theta = 180°$$

$$\Rightarrow \quad \theta = \frac{1}{2}(180 - \theta) = \frac{1}{2}(180° - 50°) = 65°$$

Now for the nickel crystal, the interatomic seperation is,

~~d = 0.0~~

$$\boxed{d = 0.91\ \text{Å}}$$

According to Bragg's Law for the first order diffraction maxima (n = 1), we have.

$$2d \sin\theta = 1 \times \lambda$$

$$\therefore \lambda = 2 \times 0.91 \times \sin 45$$

$$\boxed{\lambda = 1.65\ \text{Å}}$$

According to de-Broglie hypothesis, the wavelength of the wave associated with electron is given by

$$\lambda = \frac{12.27}{\sqrt{V}} = \frac{12.27}{\sqrt{54}} = 1.66\ \text{Å}$$

This shows there is a close agreement with the estimated value of de-Broglie wavelength and the experimental value determined by Davisson & Germer.

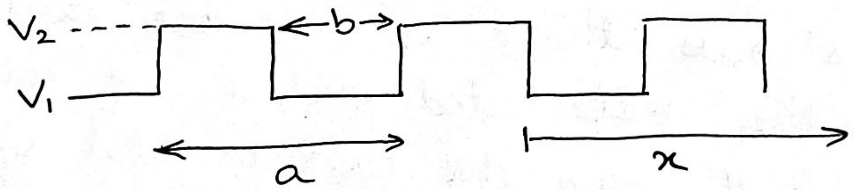
# Unit - 2

Q1>

Ans=> The Kronig - Penney model is a simplified model for an electron in a one - dimensional periodic potential. The possible states that the electron can occupy are determined by the shrodinger equation.

$$\boxed{-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} + V(x)\psi = E\psi}$$

In the case of the Kronig - Penney model, the potential $v(x)$ is a periodic square wave.




A virtue of this model is that it is possible to analytically determine the energy eigen values and eigen functions. It is also possible to find analytic expressions for the dispersion relation (E Vs K) and the electron density of states.

Q4>

Sol→(i) we have the formula,

$$E_F = \frac{1}{2} m v_F^2$$

Therefore, $V_F = \left(\frac{2E_F}{m}\right)^{1/2}$

$$= \left[\frac{2 \times 2.1\,\text{eV} \times 1.602 \times 10^{-19}\,\text{J/eV}}{9.11 \times 10^{-31}\,\text{kg}}\right]^{1/2}$$

$$V_F = \underline{8.6 \times (10)^5}\ \text{m/s. Ans}$$

(ii) Energy Difference $E_F - E = 0.01\,\text{eV}$

Thermal energy at room temperature,

$$KT = 0.026\,\text{eV}.$$

$$f(E) = \frac{1}{1 + e^{-(E_F - E)/KT}}$$

$$f(E) = \frac{1}{1 + e^{-0.01\text{eV}/0.026\text{eV}}}$$

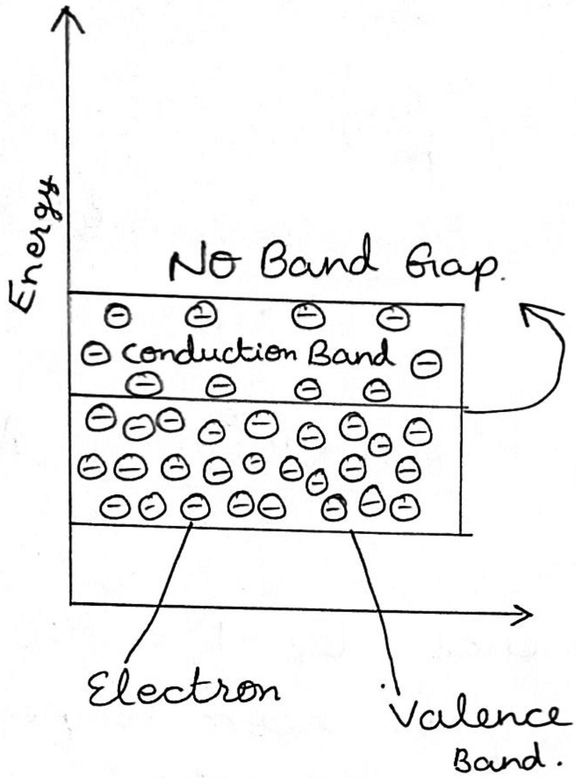
$$= \frac{1}{1 + e^{-0.3846}}$$

$$= 0.595$$

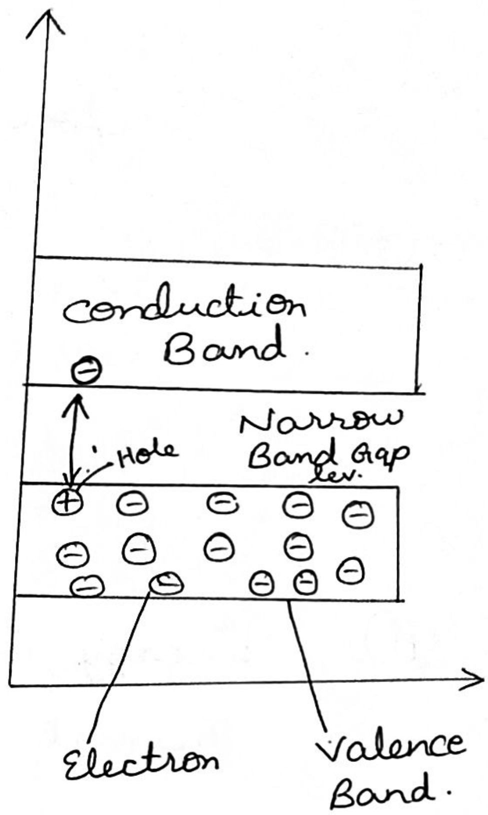
Therefore, $P = 1 - f(E) = 1 - 0.595 = \underline{\underline{0.405}}$ Ans

Q3>

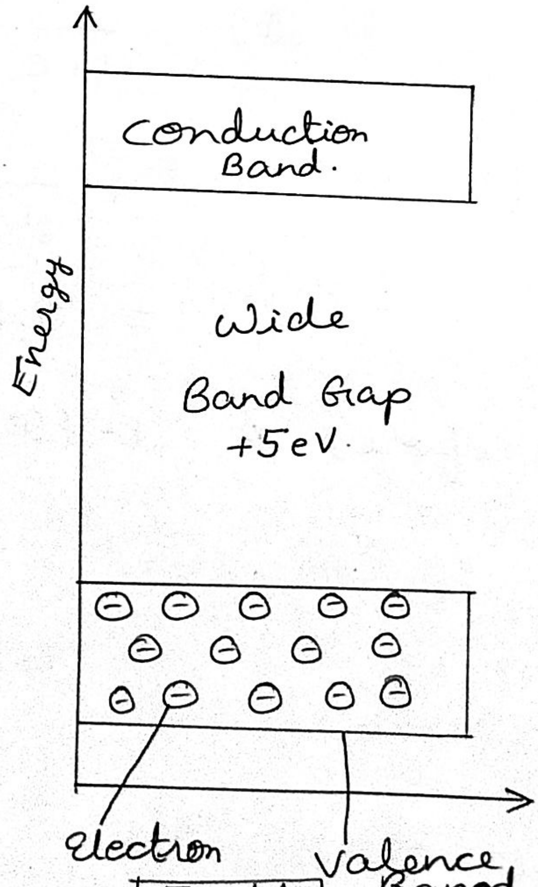
Ans =>




Conductor.




Semiconductor.




Insulator

| Parameter | Conductor | Semiconductor | Insulator |
|---|---|---|---|
| Forbidden Energy Gap | Not exist | Small (1 ev) | large (5 eV) |
| Conductivity | High ($10^{-7}$ mho/m) | Medium ($10^{-7}$ to $10^{-13}$ mhO/m) | very low ($10^{-3}$ mho/m) Almost negligible. |
| Resistivity | Low | Moderate | High |
| Charge carriers in conduction band | completely filled. | Partially filled | completely vaccant. |
| charge carriers in ~~valenge~~ valence band | Almost vaccant | partially filled | completely filled |
| Example | copper, graphite aluminium, etc. | Silicon, arsenic Germanium, etc. | Paper, rubber glass, plastic etc. |
| Applications | conducting wire, Transformer, in electrical cords etc. | Diodes, transistor opto couplers etc. | Sports equipments, home appliances etc. |