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ENGINEERING PHYSICS

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Department of Science & Humanities

ENGINEERING PHYSICS

Unit III : Application of Quantum Mechanics to Electrical transport in Solids

➢ *Suggested Reading*

1. *Solid state Physics, S.O Pillai, Chapter 6*

2. *Learning material prepared by the department-Unit III*

➢ *Reference Videos*

1. *https://nptel.ac.in/courses/115/104/115104109/*

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Unit III : Application of Quantum Mechanics to Electrical transport in Solids

Class #32

- *Effective mass of charge carriers in a periodic potential*

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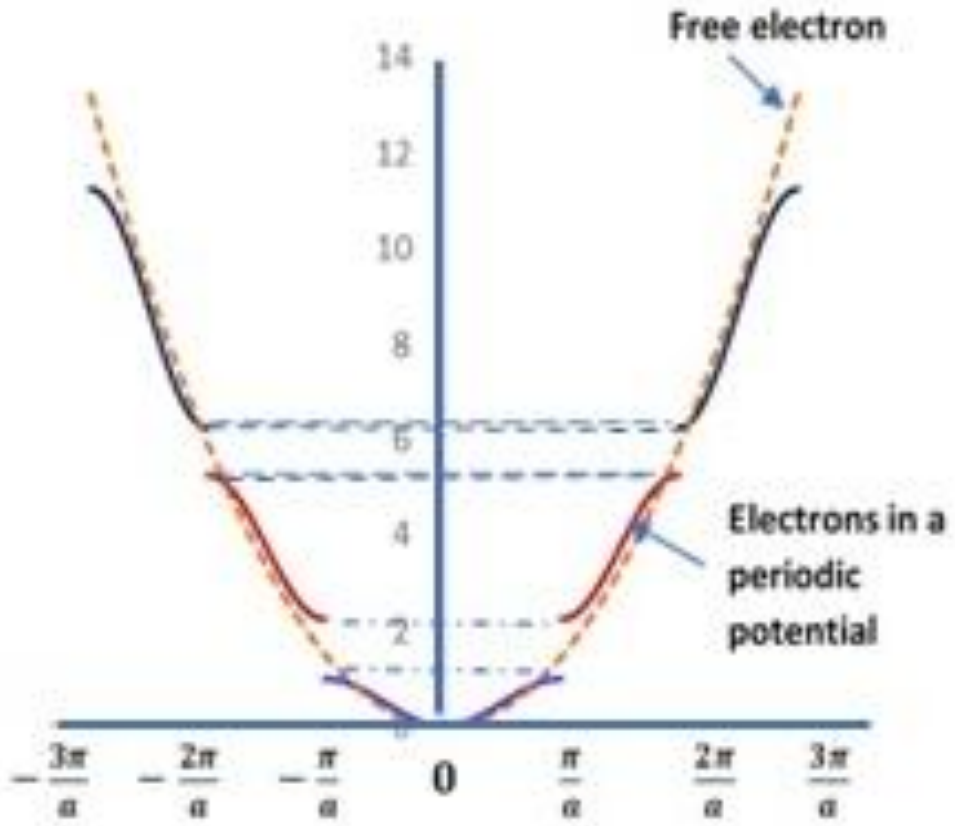
Effective mass of charge carriers in a periodic potential

E-K graph



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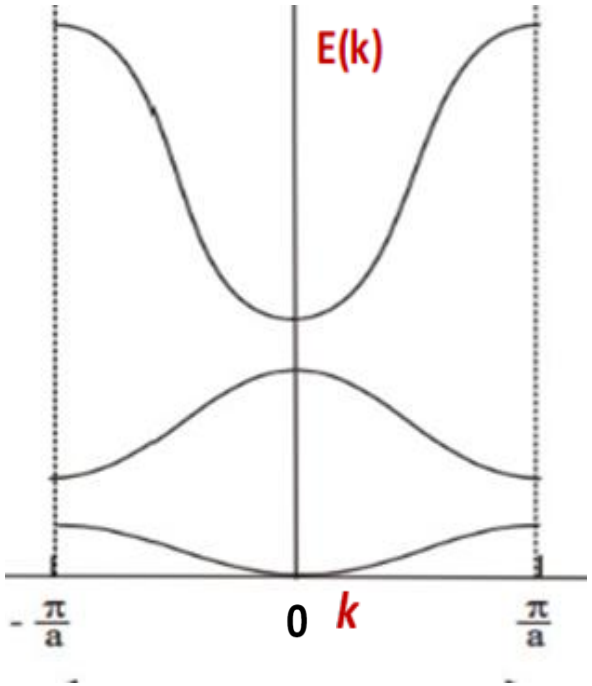
Effective mass of charge carriers in a periodic potential



The expression for energy in terms of momentum is given by

$$E = \frac{\hbar^2 k^2}{2m}$$

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Effective mass of charge carriers in a periodic potential

Differentiating the expression twice with respect to k

$$\frac{dE}{dk} = \frac{\hbar^2 k}{m}$$

$$\frac{d^2E}{dk^2} = \frac{\hbar^2}{m}$$

$$\text{or} \quad m^* = \frac{\hbar^2}{\left(\frac{d^2E}{dk^2}\right)}$$

*Curvature of E-K graph gives effective mass m**

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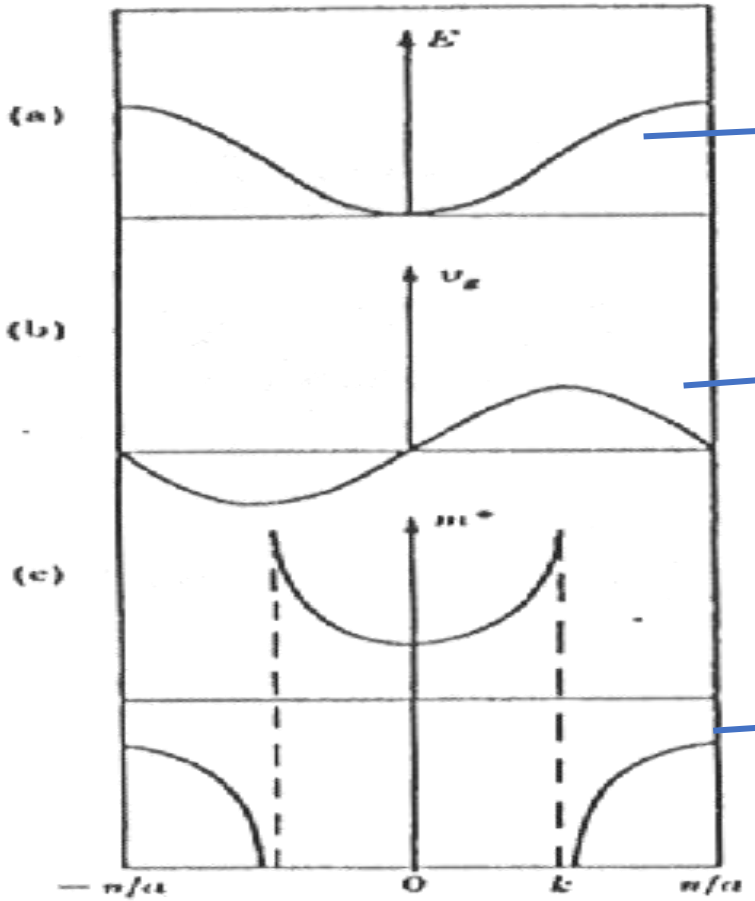
Effective mass of charge carriers in a periodic potential



$$E = \frac{\hbar^2 k^2}{2m}$$

$$\frac{dE}{dk} = \frac{\hbar^2 k}{m}$$

$$\frac{d^2E}{dk^2} = \frac{\hbar^2}{m}$$

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Effective mass of charge carriers in a periodic potential

- *Curvature in the conduction band is positive-effective mass +ve*
- *Curvature in the valence band is negative - effective mass -ve*
- *Effective mass helps in understand-mobility of charge carriers*
- *In most compound semiconductors-effective mass of electrons and holes are much smaller than the rest mass of electrons(m_e).*

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Class 32 . Quiz …

The concepts which are correct are….

1. ***Higher is the curvature of E-K graph, larger will be the effective mass of the charge carriers*.**
2. ***If the curvature of the E-k curve is positive in the conduction band, then the effective mass of the charge carrier is positive.***
3. ***The effective mass of electrons can only be higher than the rest mass of the electrons and does not depends on the position of the electron in the particular band.***
4. ***The concept of the effective mass helps in understanding the mobility of charge carriers.***

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THANK YOU

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