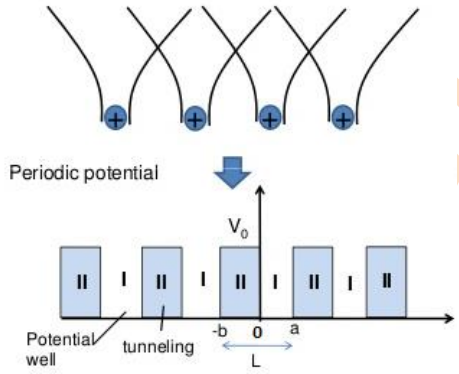
CL31_Q1. Explain the terms (i) Periodic potential (ii) Bloch function and (iii) Effective mass

Answer

(i) Periodic Potential:

If the potential of a solid varies periodically with the periodicity of the space lattice 'a' (inter atomic spacing).



It is assumed that the potential energy of the electron is zero near the nucleus of the positive ion in the lattice and maximum when it is half way between the adjacent nuclei. If V(x) is periodic potential, then V(x+a) = V(x).

(ii) Bloch function:

For the periodically varying potential inside a solid, an acceptable solution of electron wave is of the form $\psi(x) = U_k(x)\, e^{ikx}, where\ U_k(x+a) = U_k(x)$, called Bloch function.

(iii) Effective mass:

The mass of electron in the periodic potential of a crystal is different from the free electron mass and is referred to as effective mass. In terms of energy and propagation constant, effective mass is given by

$$\boldsymbol{m^* = \left(\frac{1}{\hbar^2}\frac{d^2E}{dk^2}\right)^{-1}}$$

CL31_Q2. What is Bloch function and how is it different from the free electron wave function?

Answer

For the periodically varying potential inside a solid, an acceptable solution of electron wave is of the form $\psi(x) = U_k(x)\, e^{ikx}, where\ U_k(x+a) = U_k(x)$, called Bloch function. Any plane wave solution is used to represent the free electron wave function.

CL31_Q3. How does the potential energy of an electron vary in an infinite one-dimensional crystal and how this potential is represented in Kronig-Penny model?

Answer

The Kronig-Penney model assumed the periodic potential in a solid as a long chain of coupled finite square wells, of barrier height Vo, with a period 'a', and barrier thickness 'b'.