1.15.E-K DIAGRAM (OR) E-K CURVE

Introduction: The E-K diagram/curve is a graph that illustrates the relationship between the energy of an electron and its wave vector (k) of a crystal lattice . We get a dashed line parabola.

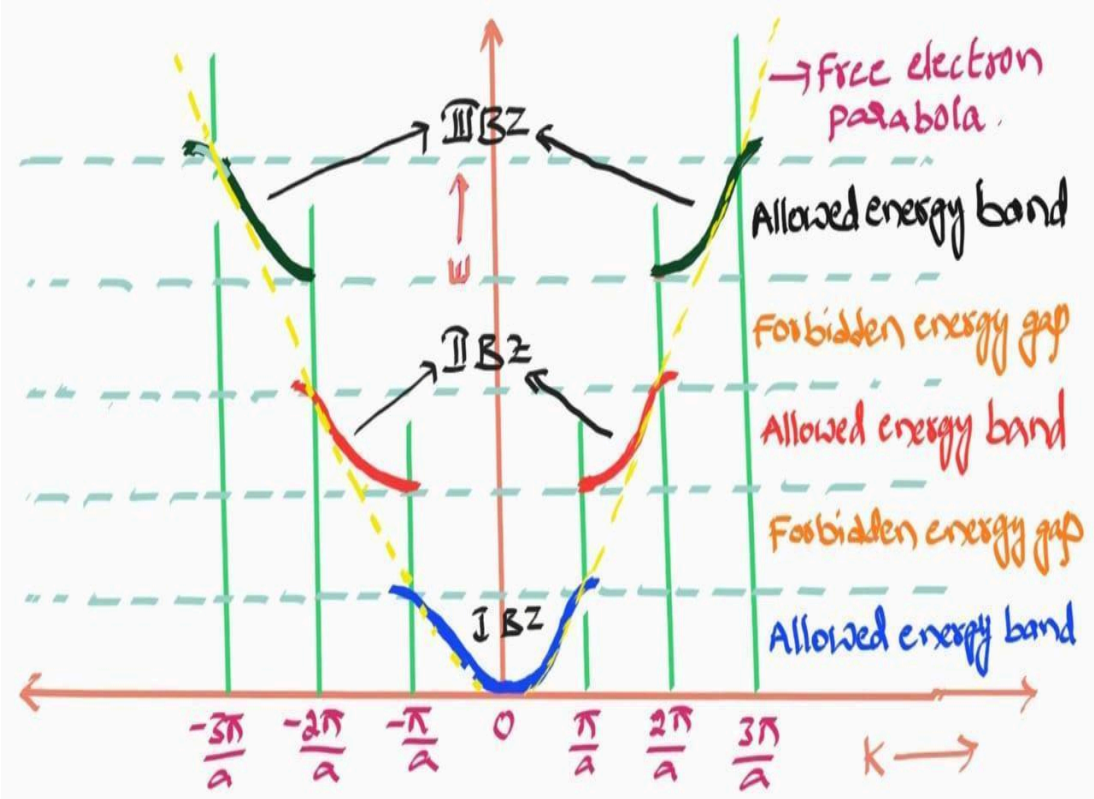
- **From the Kronig-Penney model**, the energy of a particle is given by

$$E = h^2k^2/8\pi^2m \text{ ---------- (1)}$$

- Since, $\alpha = k \Rightarrow k = \pm n\pi/a$ & $n = 1, 2, 3, ...$

$\therefore k = \pm \pi/a, \pm 2\pi/a, \pm 3\pi/a, ... \pm n\pi/a$ are Reciprocal Lattice points.

- **Now plot a graph** between energy(E) of electron values on y-axis and wave vector(K) values on x-axis, we get a dashed line parabola called an E-K cure or E-K diagram.



- **From the graph, we conclude that:**
- The continuous E-k curve appears within energy bands, where electrons are allowed to exist. These are represented as allowed energy bands.
- The discontinuities or energy gaps appear at the Brillouin zone boundaries (or between the curves), where no electrons are allowed to exist. These are represented as forbidden energy gaps.

- The curvature of each band indicates the effective mass of electrons and holes.
- The E-K diagram is divided into Allowed energy bands and Forbidden energy gaps.
- Electrons have energy values only between allowed energy bands, called Brillouin Zones and these are functions of the wave vector (k).
- The three Brillouin Zones shown in the E-K diagram are

  (i)First Brillouin zone:

  $k = -\pi/a$ to $+\pi/a$

  (ii)Second Brillouin zone:

  $k = -\pi/a$ to $-2\pi/a$ & $+\pi/a$ to $+2\pi/a$

  (iii)Third Brillouin zone:

  $k = -2\pi/a$ to $-3\pi/a$ & $+2\pi/a$ to $+3\pi/a$ and so on…