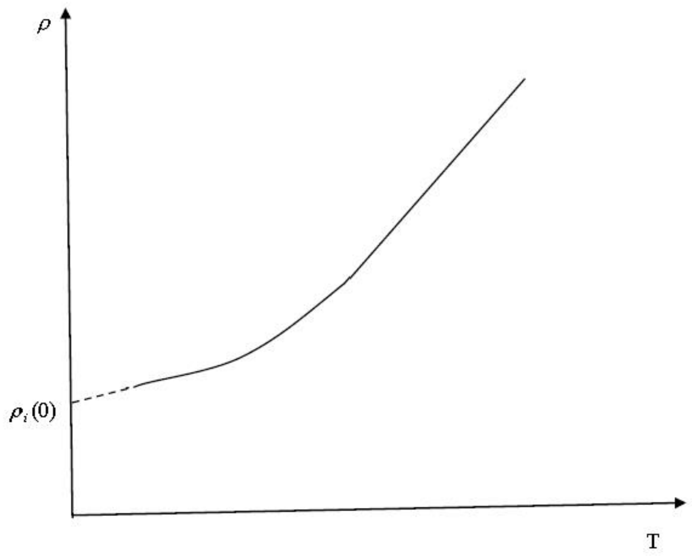



**Resistivity ratio** is defined as the ratio of resistivity at room temperature to the residual resistivity of a metal.

### MOTION IN MAGNETIC FIELDS

For a fermi sphere displaced by $\delta\vec{k}$ acted on by a force F and a friction as represented by collision, the motion is described by $\hbar(\frac{1}{\tau}+\frac{d}{dt})\delta\vec{k}=\vec{F}$ where the free particle acceleration is given by $\hbar\frac{d\delta k}{dt}$ and the effect of collisions due to friction is given by $\frac{\hbar}{\tau}\delta k$, where $\tau$ is collision time.

Consider the motion of a particle in a uniform magnetic filed. The Lorentz force on electrons is given by $\vec{F}=-e(\vec{E}+\vec{v}\times\vec{B})$.

If $m\vec{v}=\hbar\delta\vec{k}$, then substituting for $\hbar$ and equating gives $m(\frac{d}{dt}+\frac{1}{\tau})\vec{v}=-e(\vec{E}+\vec{v}\times\vec{B})$.

Suppose a uniform magnetic field lies along z axis ($\vec{B}=B_0\hat{z}$) then the component equations will be

$m(\frac{d}{dt}+\frac{1}{\tau})v_x=-e(E_x+B_0v_y)$

$m(\frac{d}{dt}+\frac{1}{\tau})v_y=-e(E_y-B_0v_x)$

$m(\frac{d}{dt}+\frac{1}{\tau})v_z=-eE_z$

In a steady state in a static electric field, $\frac{dv}{dt} = 0$. Drift velocity becomes

$v_x = -\frac{e\tau}{m} E_x - w_0 \tau v_y$

$v_y = -\frac{e\tau}{m} E_y + w_0 \tau v_x$

$v_z = -\frac{e\tau}{m} E_z$

where $w_0 = e\frac{B_0}{m}$ is cycloton frequency.

## HALL EFFECT

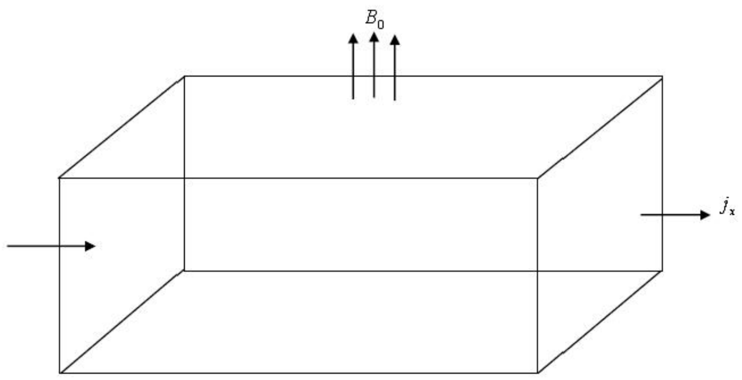
The hall field is the electric field developed across the two faces of a conductor in the direction $\vec{j} \times \vec{B}$ where a current $\vec{j}$ flows across a magnetic field $\vec{B}$. The hall effect is thus the production of the voltage (a hall voltage) across an electric conductor traverse to an electric current in a conductor.

The hall effect comes about due to the nature of current flowing in the conductor. Current consists of the movement of many small charge carriers, typically electrons, holes or both. Moving charges experience a force called Lorentz force when magnetic field is present and is not parallel to their motion.

When such a magnetic field is applied, their path is curved so that the moving charges accumulate from one face of the material. This leaves equal and opposite charges exposed on the other face where there is scarcity of charges. The result is an asymmetric distribution of charge density across the hall element that is transverse to the applied magnetic field.

The separation of charges establishes an electric field that opposes immigration of further charges so that a steady electric potential builds up for as long as a charge is flowing.

Consider a rod-shaped specimen in a longitudinal electric field $E_x$ and transverse magnetic field $B_0$.




If current cannot flow out of the rod in the y direction, then drift velocity $\delta v_y = 0$ and thus from

$v_x = -\frac{e\tau}{m}E_x$ and $w_0\tau v_x = \frac{e\tau}{m}E_y$,

Then $E_y = -w_c\tau E_x = -\frac{eB_0\tau}{m}E_x$.

Recall that the current density is defined by $\frac{ne^2\tau}{m}E_x$.

$j = ne^2\tau\frac{E}{m}$.

Then, $j = ne^2\tau\frac{E_x}{m}$.

If we introduce a ratio $\frac{E_y}{j_x B_0} = -\frac{eB_0\tau}{m}.E_x.\frac{m}{B_0 ne^2\tau E_x}$.

$\frac{E_y}{j_x B_0} = -\frac{1}{ne} \equiv R_H$.

where $R_H$ is the hall coefficient which is negative for free electrons. The lower the carrier concentration the graeter the magnitude for the hall coefficient.

## INTRODUCTION TO BAND THEORY OF SOLIDS

Electrons in a crystal are arranged in energy bands separated by regions of energy for which no wave-like electron orbitals exist. Such regions are called energy gaps or band gaps. We may visualise the difference between conductors, insulators and semi-conductors by plotting the available energies for the electron in the material.