The Hall coefficient is defined as the ratio of the induced [electric field](https://en.wikipedia.org/wiki/Electric_field) to the product of the current density and the applied magnetic field. It is a characteristic of the material from which the conductor is made, since its value depends on the type, number, and properties of the [charge carriers](https://en.wikipedia.org/wiki/Charge_carriers) that constitute the current.

Discovery[[edit](https://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=1)]

The Hall effect was discovered in 1879 by [Edwin Herbert Hall](https://en.wikipedia.org/wiki/Edwin_Hall) while he was working on his doctoral degree at [Johns Hopkins University](https://en.wikipedia.org/wiki/Johns_Hopkins_University) in [Baltimore](https://en.wikipedia.org/wiki/Baltimore), [Maryland](https://en.wikipedia.org/wiki/Maryland).[[2]](https://en.wikipedia.org/wiki/Hall_effect#cite_note-bridgeman-momoir-2) His measurements of the tiny effect produced in the apparatus he used were an experimental [tour de force](https://en.wiktionary.org/wiki/tour_de_force), accomplished 18 years before the [electron](https://en.wikipedia.org/wiki/Electron) was discovered and published under the name "On a New Action of the Magnet on Electric Currents".[[3]](https://en.wikipedia.org/wiki/Hall_effect#cite_note-3)[[4]](https://en.wikipedia.org/wiki/Hall_effect#cite_note-4)

## Theory[[edit](https://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=2)]

The Hall effect is due to the nature of the current in a conductor. Current consists of the movement of many small [charge carriers](https://en.wikipedia.org/wiki/Charge_carrier), typically [electrons](https://en.wikipedia.org/wiki/Electron), [holes](https://en.wikipedia.org/wiki/Electron_hole), [ions](https://en.wikipedia.org/wiki/Ion) (see [Electromigration](https://en.wikipedia.org/wiki/Electromigration" \o "Electromigration)) or all three. When a magnetic field is present, these charges experience a force, called the [Lorentz force](https://en.wikipedia.org/wiki/Lorentz_force).[[5]](https://en.wikipedia.org/wiki/Hall_effect#cite_note-5) When such a magnetic field is absent, the charges follow approximately straight, 'line of sight' paths between collisions with impurities, [phonons](https://en.wikipedia.org/wiki/Phonons), etc. However, when a magnetic field with a perpendicular component is applied, their paths between collisions are curved so that moving charges accumulate on one face of the material. This leaves equal and opposite charges exposed on the other face, where there is a scarcity of mobile charges. The result is an asymmetric distribution of charge density across the Hall element, arising from a force that is perpendicular to both the 'line of sight' path and the applied magnetic field. The separation of charge establishes an [electric field](https://en.wikipedia.org/wiki/Electric_field) that opposes the migration of further charge, so a steady [electrical potential](https://en.wikipedia.org/wiki/Electrical_potential) is established for as long as the charge is flowing.' [[]]

In [classical electromagnetism](https://en.wikipedia.org/wiki/Classical_electromagnetism) electrons move in the opposite direction of the current {\displaystyle I} (by [convention](https://en.wikipedia.org/wiki/Electric_current#Conventions) "current" describes a theoretical "hole flow"). In some semiconductors it *appears* "holes" are actually flowing because the direction of the voltage is opposite to the derivation below.

For a simple metal where there is only one type of [charge carrier](https://en.wikipedia.org/wiki/Charge_carrier) (electrons) the Hall voltage *VH* can be derived by using the [Lorentz force](https://en.wikipedia.org/wiki/Lorentz_force) and seeing that in the steady-state condition charges are not moving in the y-axis direction because the magnetic force on each electron in the y-axis direction is cancelled by a y-axis electrical force due to the buildup of charges. The {\displaystyle v\_{x}} term is the [drift velocity](https://en.wikipedia.org/wiki/Drift_velocity) of the current which is assumed at this point to be holes by convention. The {\displaystyle v\_{x}B\_{z}} term is negative in the y-axis direction by the right hand rule.

### Hall effect in semiconductors[[edit](https://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=3)]

When a current-carrying [semiconductor](https://en.wikipedia.org/wiki/Semiconductor) is kept in a magnetic field, the charge carriers of the semiconductor experience a force in a direction perpendicular to both the magnetic field and the current. At equilibrium, a voltage appears at the semiconductor edges.

The simple formula for the Hall coefficient given above becomes more complex in semiconductors where the carriers are generally both [electrons](https://en.wikipedia.org/wiki/Electrons) and [holes](https://en.wikipedia.org/wiki/Electron_hole) which may be present in different concentrations and have different[mobilities](https://en.wikipedia.org/wiki/Electron_mobility). For moderate magnetic fields the Hall coefficient is[[8]](https://en.wikipedia.org/wiki/Hall_effect#cite_note-Kasap2001-8)

### Contemporary applications[[edit](https://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=13)]

Hall effect sensors are readily available from a number of different manufacturers, and may be used in various sensors such as rotating speed sensors (bicycle wheels, gear-teeth, automotive speedometers, electronic ignition systems), fluid [flow sensors](https://en.wikipedia.org/wiki/Flow_sensor), [current sensors](https://en.wikipedia.org/wiki/Current_sensor), and [pressure sensors](https://en.wikipedia.org/wiki/Pressure_sensor). Common applications are often found where a robust and contactless switch or potentiometer is required. These include: electric [airsoft](https://en.wikipedia.org/wiki/Airsoft) guns, triggers of electropneumatic [paintball guns](https://en.wikipedia.org/wiki/Paintball_marker), go-cart speed controls, smart phones, and some global positioning systems.