

## HALL EFFECT

Link to: [physicspages home page](#).

To leave a comment or report an error, please use the auxiliary blog.

Reference: Griffiths, David J. (2007) Introduction to Electrodynamics, 3rd Edition; Prentice Hall - Problem 5.39.

The Hall effect occurs when a current-carrying substance is placed in a magnetic field that is perpendicular to the direction of the current. Suppose we have a wire with a rectangular cross-section that carries current in the  $+y$  direction. A magnetic field pointing in the  $+x$  direction is applied to the wire. From the Lorentz force law, a moving charge in the wire feels a magnetic force  $q\mathbf{v} \times \mathbf{B}$ , so it will be deflected in the  $\pm z$  direction, where the sign of the deflection depends on the sign of the charge and the direction of motion. If the charges are positive and flowing in the  $+y$  direction, they are deflected in the  $-z$  direction.

As a result, a charge imbalance is created inside the wire resulting in an electric field in the  $z$  direction. Equilibrium is established when the electric and magnetic forces balance, and this happens when  $q\mathbf{E} = -q\mathbf{v} \times \mathbf{B}$ . For positive charges, this means that  $E = vB$ , so if the wire has a thickness  $t$  in the  $z$  direction, the potential difference across the wire is  $Et = vBt$ .

If the charges are negative, then to produce the same current as above they would have to be moving in the  $-y$  direction. Since the direction of motion *and* the sign of the charges are both opposite to the first case, the negative charges will still be deflected downwards, so the direction of the induced electric field will be reversed. Thus by measuring the sign of the potential difference we can tell whether the charge carriers are positive or negative.