

Maxwell's equations are the fundamental equations for the components $E_x(x, y, z, t)$, $E_y(x, y, z, t)$, and $E_z(x, y, z, t)$ of the electric field vector and the components $B_x(x, y, z, t)$, $B_y(x, y, z, t)$, and $B_z(x, y, z, t)$ of the magnetic field vector.

There are two Maxwell's equations without time derivatives, one for the electric field and one for the magnetic field:

$$\frac{\partial E_x}{\partial x} + \frac{\partial E_y}{\partial y} + \frac{\partial E_z}{\partial z} = \frac{\rho}{\epsilon_0}$$

$$\frac{\partial B_x}{\partial x} + \frac{\partial B_y}{\partial y} + \frac{\partial B_z}{\partial z} = 0$$

There are two sets of three equations each for the time derivatives of the electric field and of the magnetic field, respectively:

$$\frac{\partial E_x}{\partial t} = \frac{1}{\mu_0 \epsilon_0} \left(\frac{\partial B_z}{\partial y} - \frac{\partial B_y}{\partial z} \right) - \frac{J_x}{\epsilon_0}$$

$$\frac{\partial E_y}{\partial t} = \frac{1}{\mu_0 \epsilon_0} \left(\frac{\partial B_x}{\partial z} - \frac{\partial B_z}{\partial x} \right) - \frac{J_y}{\epsilon_0}$$

$$\frac{\partial E_z}{\partial t} = \frac{1}{\mu_0 \epsilon_0} \left(\frac{\partial B_y}{\partial x} - \frac{\partial B_x}{\partial y} \right) - \frac{J_z}{\epsilon_0}$$

$$\frac{\partial B_x}{\partial t} = - \left(\frac{\partial E_z}{\partial y} - \frac{\partial E_y}{\partial z} \right)$$

$$\frac{\partial B_y}{\partial t} = - \left(\frac{\partial E_x}{\partial z} - \frac{\partial E_z}{\partial x} \right)$$

$$\frac{\partial B_z}{\partial t} = - \left(\frac{\partial E_y}{\partial x} - \frac{\partial E_x}{\partial y} \right)$$

The Lorentz force law gives the electromagnetic force acting on a charge q in an electric and/or magnetic field at position (x, y, z) and time t :

$$F_x = qE_x + q(v_y B_z - v_z B_y)$$

$$F_y = qE_y + q(v_z B_x - v_x B_z)$$

$$F_z = qE_z + q(v_x B_y - v_y B_x)$$