From https://github.com/PrometheusPi/particle-in-cell_tutorial

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Classical electrodynamics, the interplay between electric and magnetic fields and how they are changed based on charges and currents, is described by the four Maxwell's equations.

$$\vec{\nabla}\vec{E} = \frac{\rho}{\epsilon_0} \tag{1}$$

$$\vec{\nabla}\vec{B} = 0 \tag{2}$$

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \tag{3}$$

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J} - \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t} \tag{4}$$

with $\vec{E}$ being the electric and $\vec{B}$ being the magnetic field. $\vec{J}$ is the current and ρ the charge density. The differential operator $\vec{\nabla}$ defines the divergence and rotation and can be written as

$$\vec{\nabla} = \begin{bmatrix} \vec{e}_x \frac{\partial}{\partial x} \\ \vec{e}_y \frac{\partial}{\partial y} \\ \vec{e}_z \frac{\partial}{\partial z} \end{bmatrix}$$

ϵ_0 and μ_0 are constants. The first is called *vacuum permittivity* or *electric constant*. The second is named the *vacuum permeability* or *magnetic constant*. They are related to the speed of light c by the following relationship:

$$c^2 = \frac{1}{\epsilon_0 \mu_0}$$