Maxwell's Equations

All the tars and nicotine trapped in the filter are guaranteed not to reach your throat. Tareyton cigarette ad

Under President Eisenhower, America spent three-quarters of federal transportation dollars on building highways, and less than 1 percent on mass transit. *Bill Bryson*

Maxwell's Equations

- Gauss's Law: $\oint E \cdot dA = \frac{q_{in}}{\epsilon_0}$ (surface area)
- Gauss's Law of Magnetism: $\oint B \cdot dA = 0$
- Faraday's Law: $\mathcal{E} = -N \frac{d\Phi_B}{dt} = \oint E \cdot ds$ (line integral)
- Ampere-Maxwell Law: $\oint B \cdot ds = \mu_0 I + \mu_0 \epsilon_0 \frac{d\Phi_E}{dt}$ (line integral)
- These equations describe the interrelationship between electric fields, magnetic fields, electric charge, and electric current.

Differential Form

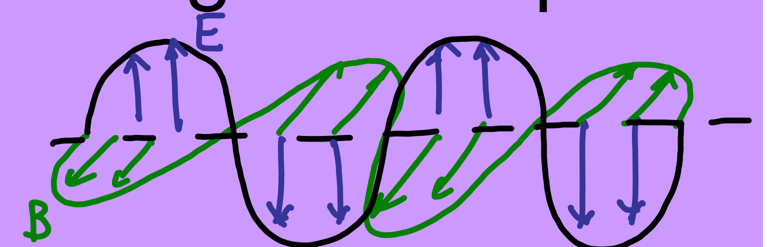
Maxwell's Equations in a vacuum

free space

- $\nabla \cdot E = 0$ — $\nabla \cdot$ divergence
- $\nabla \cdot B = 0$
- $\nabla \times E = -\mu_o(\partial B/\partial t)$ — $\nabla \times$ curl
- $\nabla \times B = -\varepsilon_o(\partial E/\partial t)$

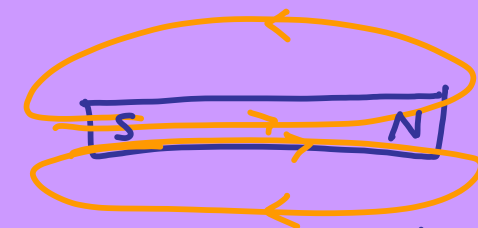
➢ These equations have a solution in terms of traveling sinusoidal plane waves, with the electric and magnetic field directions orthogonal to one another and the direction of travel, and with the two fields in in phase, traveling at the speed

$$c = \frac{1}{\sqrt{\mu_o \varepsilon_o}} = 3 \times 10^8 \frac{m}{s}$$



Applications of the 4 Equations

- Gauss's Law given q_{in}, solve for E-field



- Gauss's Law of Magnetism $\Rightarrow$ No monopoles

- Faraday's Law
  given $d\Phi_B$, solve for $\mathcal{E}$, I, F, E

- Ampere's Law given I solve for B