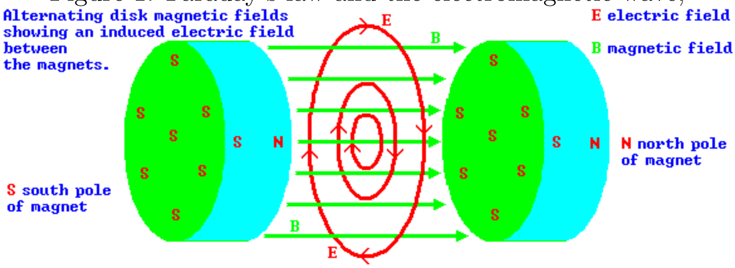
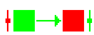
1 Faraday's law

Figure 1: Faraday's law and the electromagnetic wave,



A changing magnetic flux through a circular area generates a loop electric field which accelerates the electrons in a Betatron. Green is transformed into red.

 $+\text{B} \rightarrow \neg E \quad or \quad \neg B \rightarrow +E$

E and B are sine and cosine waves because they are ninety degrees out of phase. B is the cosine since it has a sign change in its derivative.
Lenz's law @ http://en.wikipedia.org/wiki/Lenz%27slaw
comes from the sign change in the derivative.
d(cos)/dt = -sin or d(-cos)/dt = sin
Faraday's law is applied twice per wavelength so there is no net sign change per wavelength since, -1*-1 = 1. This sign change does not occur in Ampere's law, noting
d(sin)/dt = cos or d(-sin)/dt = -cos, does not have a sign change.
Our *derivation of Faraday's law* starts with the idea that the rate of change of B is 4πB times the frequency of the wave.

$$\frac{d(B)}{dt} = 4\pi B * frequency = \frac{kg}{A * s^3} = \frac{Teslas}{second} \tag{1.1}$$

$$\frac{d(B)}{dt} = 4\pi B \frac{c}{2\pi r} \tag{1.2}$$

frequency = c/wavelength = c/(2πr).
wavelength = 2πr
Frequency measures how many loops something, moving at c, does in the ring = 2πr per second.

$$\frac{d(B)}{dt} = \frac{4\pi\neg E}{2\pi r} \tag{1.3}$$

B*c = -E, in an electromagnetic wave.

$$2 * \neg E = r\frac{d(B)}{dt} =$$

$$\frac{volts}{meter} = \frac{kg * m}{A * s^3} = \frac{kg * m}{s^2}\frac{1}{A * s} = \frac{force}{charge} \tag{1.4}$$

group terms and multipy by πr

$$Faraday's\ Law = 2\pi r * \neg E = \frac{d(\pi r^2 B)}{dt}\ or\ \oint \neg E * ds = \frac{d(\Phi_B)}{dt} =$$

$$volts = \frac{kg * m^2}{A * s^3} = \frac{energy}{charge} = \frac{watts}{amps} = amps * resistance \tag{1.5}$$

Toroidal red -E times the circumference of the loop equals the rate of change of the poloidal magnetic flux of green B times the area of the loop. Faraday's law.
When we divide the voltage on both sides of Faraday's law by the resistance of a loop or coil of wire then we get Ohm's law: volts/resistance = amps.
2πr*-E/resistance = (d(B*π*r^2)/dt)/resistance = amps or
E*ds/resistance = d(B)/dt/resistance = amps.
The toroidal amps in the loop equals the poloidal flux of amps through the area of the loop.
This is the reversing current seen on a galvanometer, when hooked to a coil of wire, while a magnet is inserted and removed from the coil of wire. This classic experiment is strong direct evidence for Faraday's law.

1.1 Integrals of Faraday's Law

$$\oint E * ds = \frac{\neg d(\Phi_B)}{dt} \tag{1.6}$$

integral form of Faraday's law from Hyperphysics @ http://hyperphysics.phy-astr.gsu.edu/hbase/electric/maxeq2.html#c3
or Wiki @ http://en.wikipedia.org/wiki/Faraday%27s_law_of_induction

$$\oint E * ds = 2\pi r \neg E, \tag{1.7}$$

the line integral of the electric field equals the circumference of the loop times E.

$$\frac{d(\Phi_B)}{dt} = \frac{d(\pi r^2 B)}{dt} \tag{1.8}$$

The rate of change of the magnetic flux equals the rate of change of the area of the loop times B.