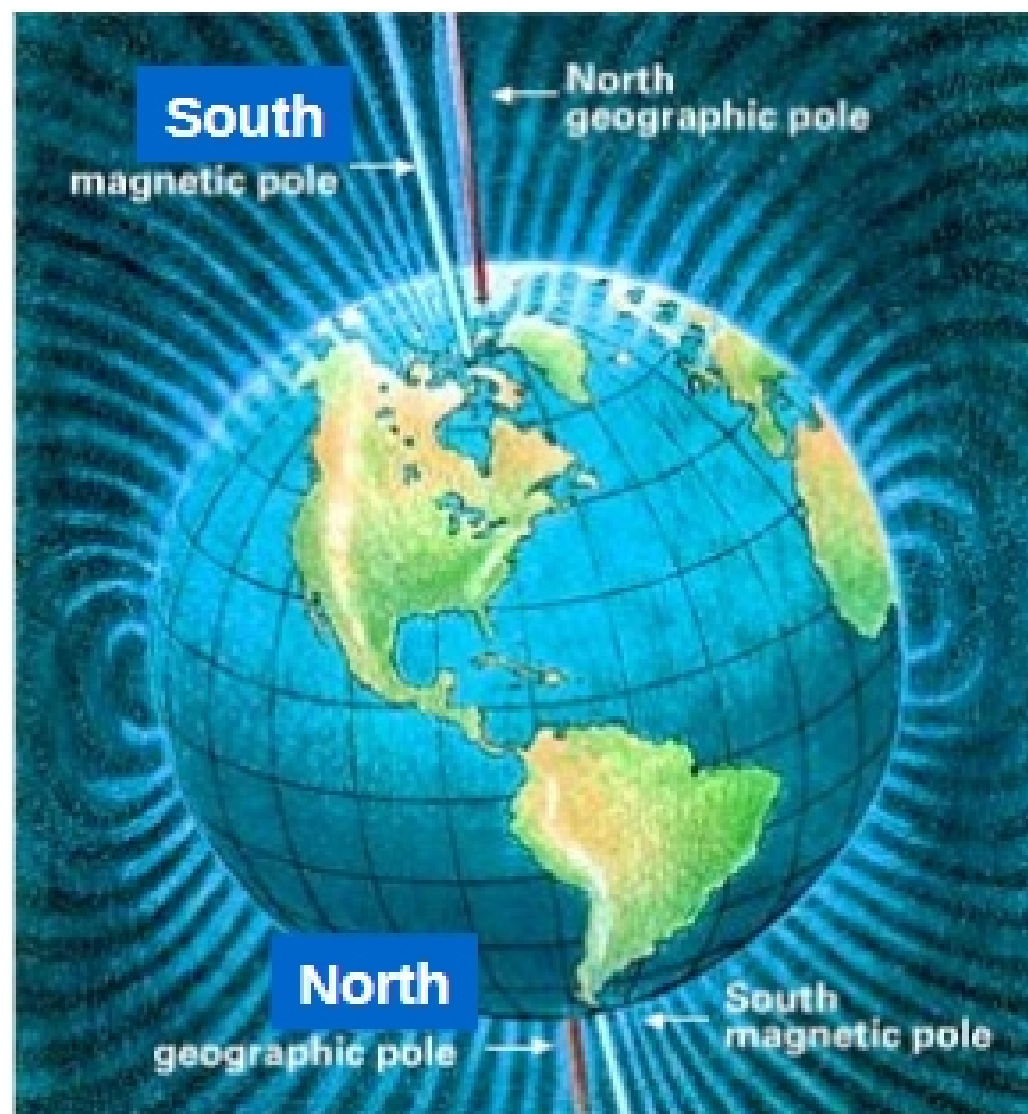


Electricity	Magnetism
<p>Electric charge, electric field and potential, current, resistance and capacitance</p>	<p>Moving electric charge, magnetic field, magnetic force on moving charges</p>
<p>Electric charge generates electric field: Gauss' Law $\Phi_E \equiv \oint \mathbf{E} \cdot d\mathbf{S} = Q / \epsilon_0$ Electric field exert forces on a charge inside it: $\mathbf{F} = q\mathbf{E}$ Electric potential and voltage: $\mathbf{E} = -\text{grad.}U$, Voltage = $\Delta U = \int_A^B \mathbf{E} \cdot d\mathbf{r}$ Electric field energy density: $u_E = \frac{1}{2} \epsilon_0 \mathbf{E}^2$ Capacitor stores electric energy: $PE = \frac{1}{2} CV^2$</p>	<p>Electric current generates magnetic field: Ampere's Law: $\oint \mathbf{B} \cdot d\mathbf{l} = \mu_0 I$ The magnetic field lines are always loops around the electric currents. Magnetic field exerts forces on moving charges: Lorentz force: $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$ On a section of a wire: $\mathbf{F} = I\mathbf{L} \times \mathbf{B}$ torque on a loop of a wire: $\boldsymbol{\tau} = I\mathbf{A} \times \mathbf{B} = \boldsymbol{\mu} \times \mathbf{B}$ Magnetic dipole: $\boldsymbol{\mu} = IA$</p>
<p>Electric field moves charges and moving charges form current: $I(t) = \frac{dq}{dt}$ Resistance and resistivity: $R = \rho \frac{L}{A}$, $u_E = \frac{1}{2} \epsilon_0 \mathbf{E}^2$</p>	<p>The Hall effect: $\Delta V = BI/(nqw)$</p>
<p>Circuits, power, battery emf, connection rules (R and C in series and parallel) and Kirchhoff's rules.</p>	

- Magnets were discovered in ancient times. The Chinese discovered the Earth magnet and invented the compass 220 BC.

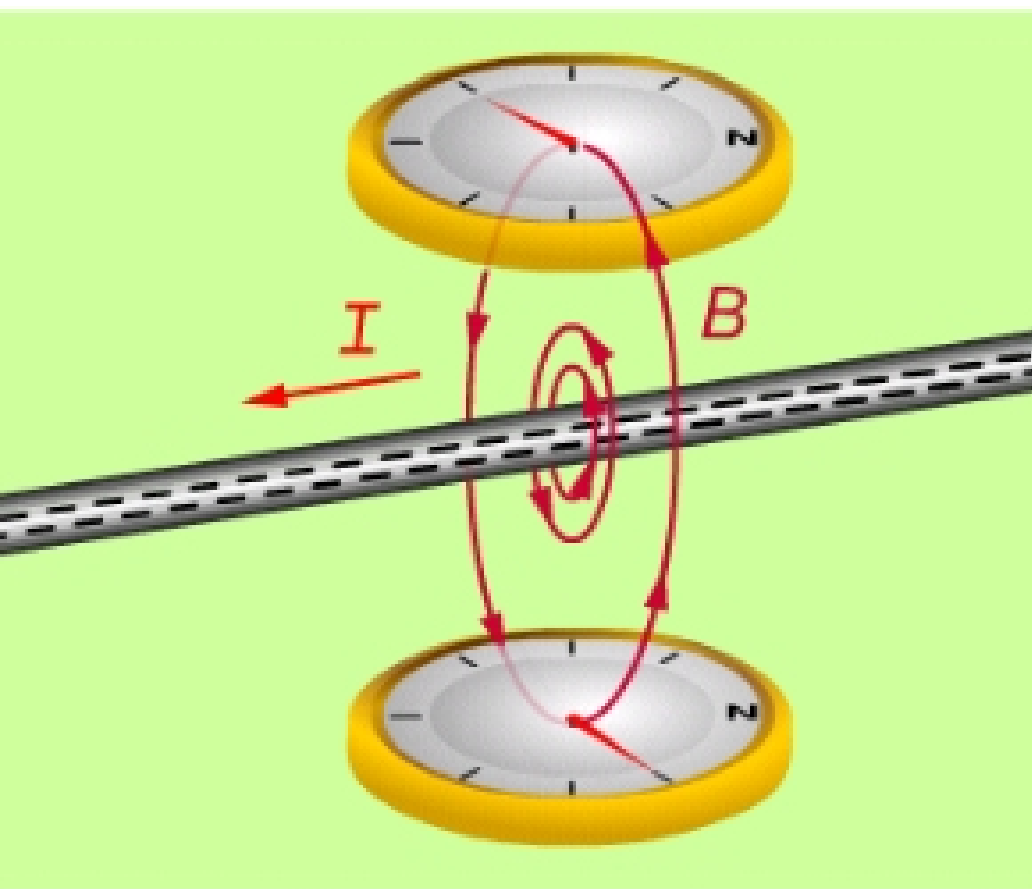


2000+ years

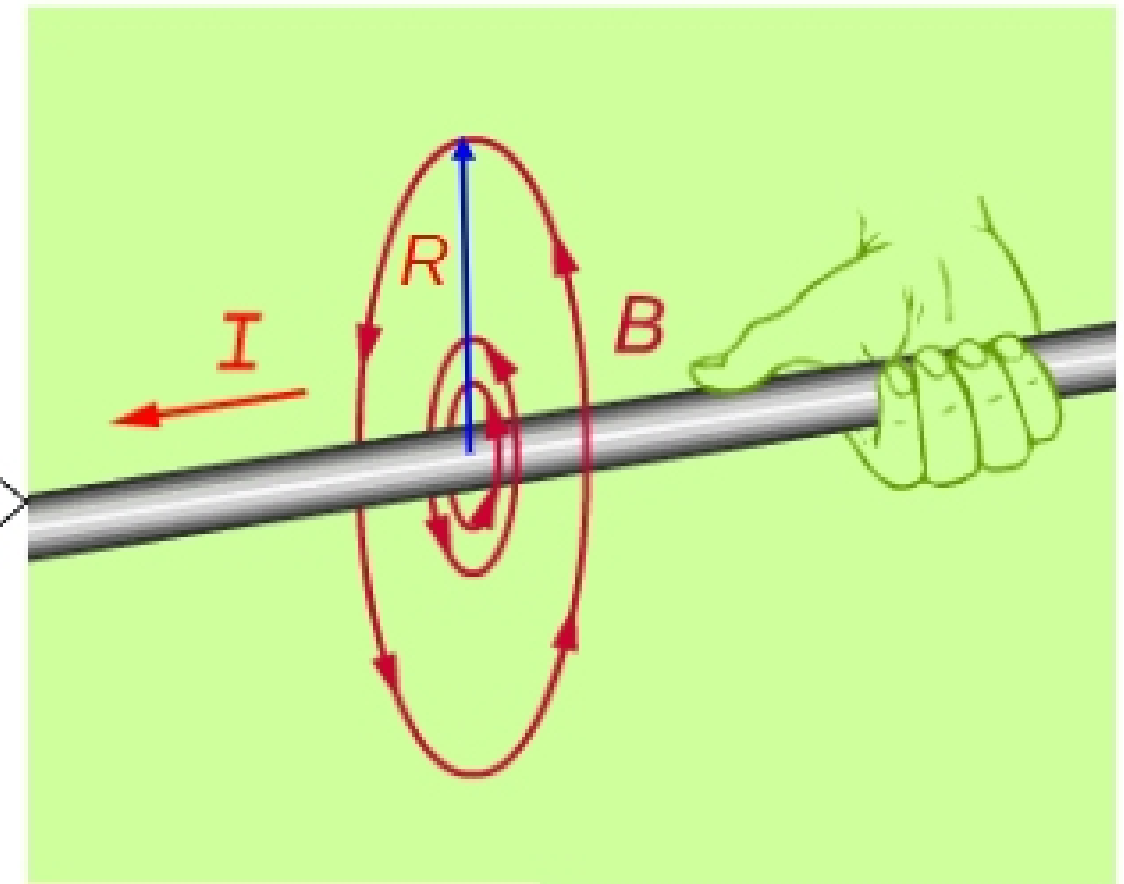


Earth's magnetic field (and the surface magnetic field) is approximately a magnetic dipole, with one pole near the north pole (see Magnetic North Pole) and the other near the geographic south pole (see Magnetic South Pole). An imaginary line joining the magnetic poles would be inclined by approximately 11.3° from the planet's axis of rotation. The cause of the field is explained by dynamo theory.

- In 1820, Hans Christian Oersted discovered that currents generate magnetic fields:



Direction: Right-hand rule



Magnitude:

$$B = \frac{\mu_0 I}{2\pi R}$$

B = magnetic field

μ_0 = permeability of free space

I = current

R = distance from center of wire

Constant $\mu_0 = 4\pi \times 10^{-7} \text{ N/A}^2$