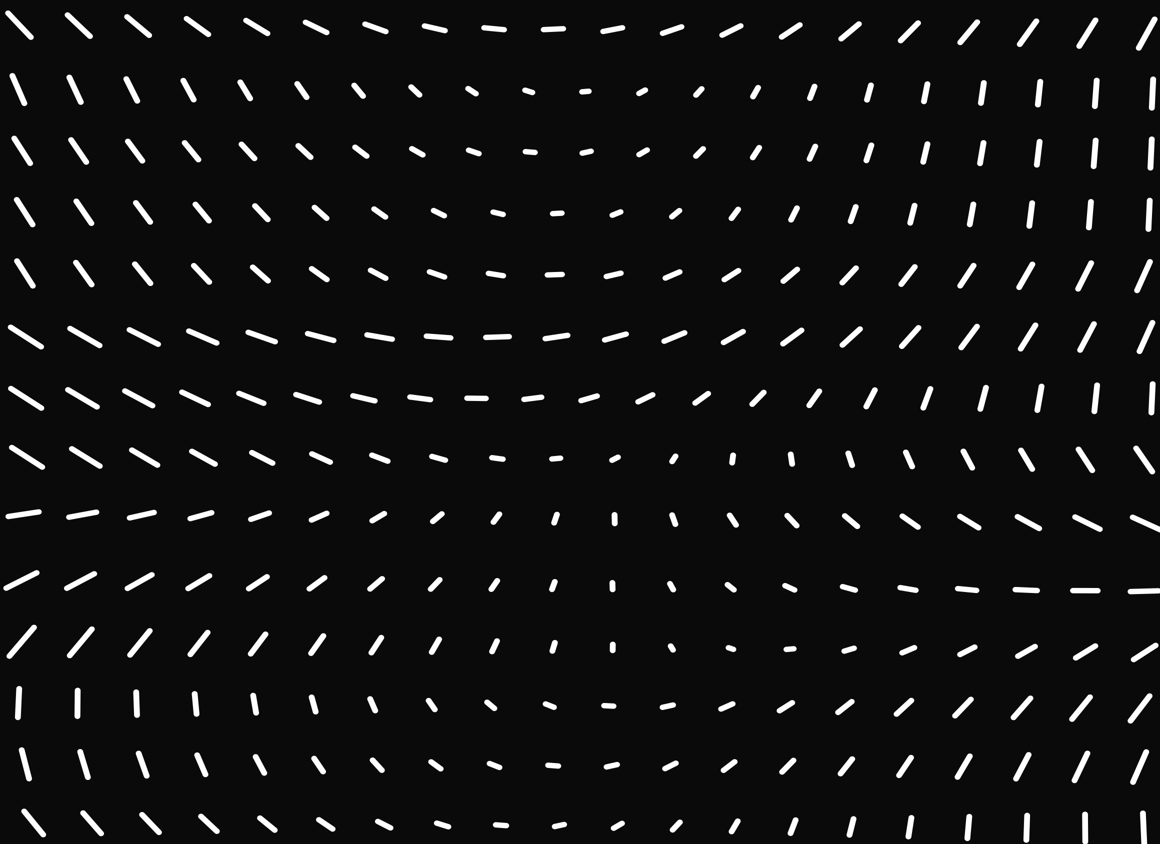


Final

Monday Dec 9th : 8 am

Topics that definitely

* Definite *

✓ * $\vec{E}$ How to find electric field : point charges, line, sheet ...

✓ * Electric Potential

- relation with elec potential energy and $\vec{E}$

Vel

✓ * Circuits (no AC circuits
no complicated time varying circuits)
no LR

Yes: Series, Parallel
Kirchhoff's laws
Resistors and batteries.

✓ * Magnetic field and force

Configurations solenoid etc...
moving charge

cross product formula

✓ * Interference

Wild Cards (Maybe)

✓ * Gauss' law.
✓ * Magnetic Induction (Faraday 'and Lenzes laws)

* Refraction

✓ * Optics (lenses and mirrors)

Just what listed.

Horario de Estudio

* Important
— Yet to practice

Miércoles: **electric Field**:

✓ * Understand the electric field model
  - Understand how a charge or charges create an electric field
  - Understand that a test charge feels a force due to the electric field

✓ * Know how to calculate the electric field due to - point charges
  - line
  - sheet

✓ * Know how to find the electric force exerted by an electric field on a point charge

✓ * Understand how to interpret electric field lines

Electric potential

✓ * Relation with electric potential energy and $\vec{E}$

✓ * Understand the concept of electric potential energy and be able to calculate the electric potential energy of a system of charges

✓ * Be able to use the principle of energy conservation

✓ * Be able to calculate the electric potential due to point charges

✓ * Relationship between electric potential and:
- ✓ electric potential energy
- ✓ electric field

✓ * Know how to interpret equipotential surfaces

Juves : **DC Circuits**

✓ * Understand resistance, emf and current and know Ohm's law.

✓ * Be able to calculate the power delivered to a circuit and dissipated from a circuit

✓ * Be able to analyze series and parallel circuits

✓ * Be able to use Kirchhoff's laws to analyze DC circuits

Gauss' Law

✓ * Understand the meaning of electric flux through a surface and be able to calculate it

✓ * Understand the meaning of charge enclosed inside a closed surface and be able to calculate it

✓ * Understand how Gauss' law relates: electric flux through a closed surface to the net charge enclosed within that surface

Viernes! # The Magnetic Field Model

* Understand the magnetic field model
  - ✓ * Understand how a moving charge (ie: a current carrying wire) creates a $\vec{B}$
  - ✓ * Understand how a moving test charge feels a magnetic force due to the $\vec{B}$

✓ * Be able to find the magnitude and direction of the $\vec{B}$ due to a:
  - long straight wire.
  - solenoid

✓ * Be able to find the direction of the magnetic field due to a loop of current-carrying wire

✓ * Be able to solve for the magnitude and direction of the magnetic force exerted on a moving charge

✓ - Understand motion in a uniform magnetic field

Faraday's and Lenz's Law

* Understand the relationship between induced emf in a loop of wire and rate of change in flux through that wire as described by Faraday's law.
* Understand how to find the direction of the induced current using Lenz's law

Sabado:

Interference

* Understand the conditions for constructive and destructive interference when 2 coherent sources of light superpose
* Understand when to use the far field approximation to calculate the path length difference
* Be able to solve problems relating to the double slit experiment

Geometric Optics: Mirrors and Lenses

* Understand how to complete principal ray diagrams for both lenses and mirrors
* Understand the meaning of focal length for both lenses and mirrors

* Know how to solve for image distance and magnification for both lenses and mirrors

Domingo: Electromagnetic Waves

* Understand light as an electromagnetic wave
  - What is "waving" in a light wave
  - What is required to create a light wave
* * * * * - Know the electromagnetic spectrum
* How to write the wave function for both the electric and magnetic fields in an EM wave
* Understand the law of reflection
* Understand the law of refraction (Snell's law), and how to use it to solve problems

Notes:

Electric Field

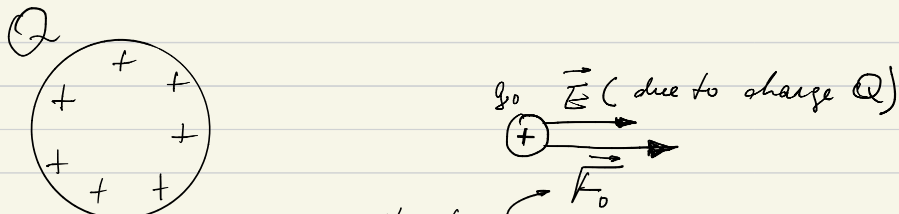
- Understand how a charge or charges create an electric field

$$\vec{E} = \frac{\vec{F}_0}{q_0}$$

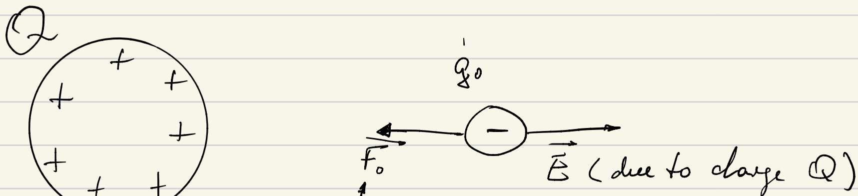
$\vec{F}_0$: electric force on a test charge q_0 due to other charges

q_0: Value of test charge

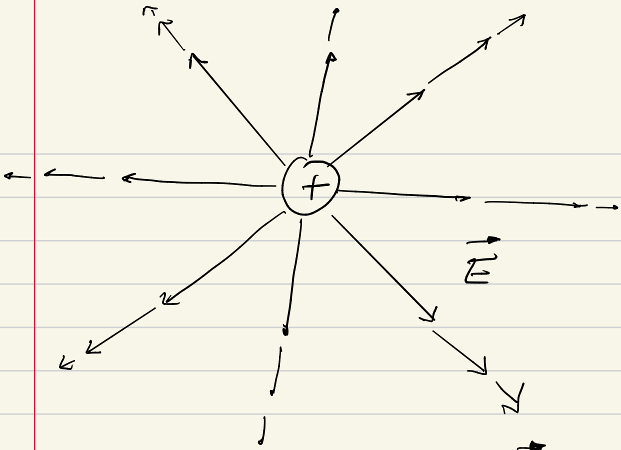
$\vec{E}$: Electric field (elect. force per unit charge)



The force on a positive test charge q_0 points in the direction of the electric field

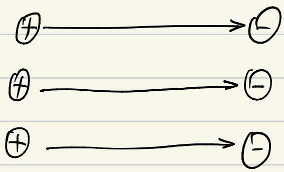


The force on a negative test charge q_0 points opposite to the electric field



2 charges to create an electric force

if Q is + $\vec{E}$ points away from Q
if Q is − $\vec{E}$ points towards Q



$$E = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \hat{r}$$

$$E(r) = \frac{\lambda}{2\pi\epsilon_0} \frac{1}{r}$$

infinite line

Gauss' Law:

- electric flux & calculate it
- charge enclosed
- gauss law → electric flux → net charge enclosed

$$\Phi_E = \oint \underbrace{\vec{E}\cdot d\vec{A}}_{\substack{\text{Gaussian}\\ \text{surface}\\ r}} = \underbrace{\frac{Q_{enc,\,total}}{\epsilon_0}}_{\substack{\text{Actual}\\ \text{surface}\\ R}}$$

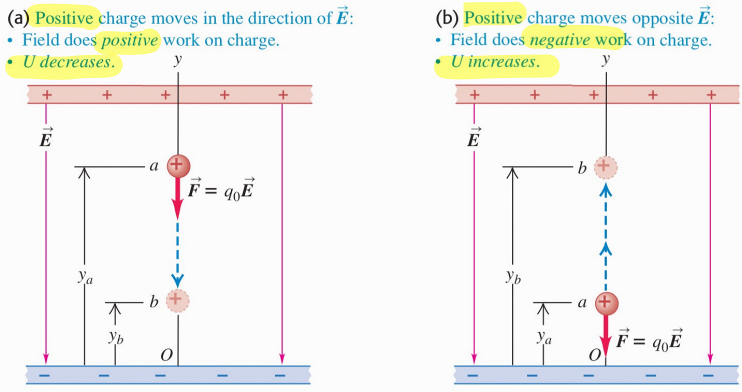
$$A_{sphere} = 4\pi r^2$$
$$V_{sphere} = \frac{4\pi r^3}{3}$$

Steps to solve

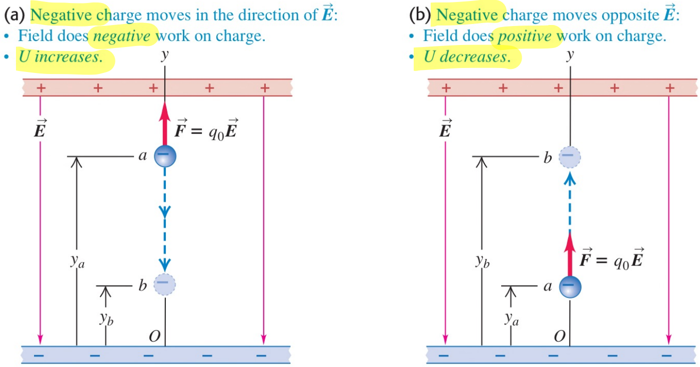
1) Draw Gaussian Surface
2) Evaluate the integral $\oint \vec{E}\cdot d\vec{A}$
3) Find Q_{enc}
4) Apply Gauss' Law

Electric Potential

23.3 A positive charge moving (a) in the direction of the electric field $\vec{E}$ and (b) in the direction opposite $\vec{E}$.



23.4 A negative charge moving (a) in the direction of the electric field $\vec{E}$ and (b) in the direction opposite $\vec{E}$. Compare with Fig. 23.3.



Moving with the direction of $\vec{E}$ means moving in the direction of decreasing electric potential.

* Potential difference is the work per unit charge

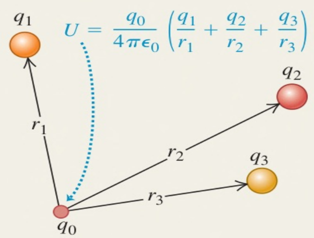
$$W_{a \to b} = U_a - U_b \qquad (23.2)$$

$$U = \frac{1}{4\pi\epsilon_0}\frac{qq_0}{r} \qquad (23.9)$$

(two point charges)

$$U = \frac{q_0}{4\pi\epsilon_0}\left(\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3} + \cdots\right) = \frac{q_0}{4\pi\epsilon_0}\sum_i \frac{q_i}{r_i} \qquad (23.10)$$

(q_0 in presence of other point charges)



$$V = \frac{U}{q_0} = \frac{1}{4\pi\epsilon_0}\frac{q}{r} \qquad (23.14)$$

(due to a point charge)

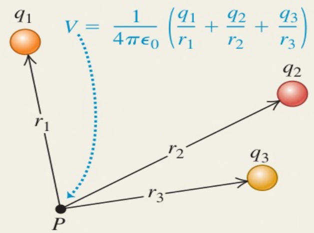
$$V = \frac{U}{q_0} = \frac{1}{4\pi\epsilon_0}\sum_i \frac{q_i}{r_i} \qquad (23.15)$$

(due to a collection of point charges)

$$V = \frac{1}{4\pi\epsilon_0}\int \frac{dq}{r} \qquad (23.16)$$

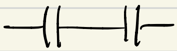
(due to a charge distribution)

$$V_a - V_b = \int_a^b \vec{E} \cdot d\vec{l} = \int_a^b E\cos\phi \, dl \qquad (23.17)$$



DC Circuit

Capacitor in Series

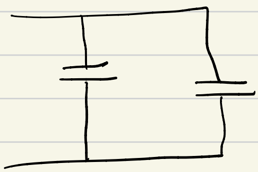


Q is the same

$V_{ab} = V_a + V_b$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

Capacitor in Parallel



V is the same

$Q = Q_1 + Q_2$

$C_{eq} = C_1 + C_2$

---

* A source of emf delivers power $\mathcal{E}I$ into a circuit when current flows: from $- \rightarrow +$ $(+P_{out})$

* A source of emf takes power $\mathcal{E}I$ into a circuit when current flows: from $+ \rightarrow -$ $(-P_{out})$

$$V_{ab} = \mathcal{E} - Ir$$

emf of source

Terminal Voltage source with internal resistance

Internal resistance of source

Current through source

$I^2 r$ → rate at which electrical energy is dessipated in the internal resistance of the source

$\mathcal{E} I - I^2 r$ → net electrical power output of the source

$$\mathcal{E} - Ir - IR = 0$$

Kirchoff's junction : conservation of charge

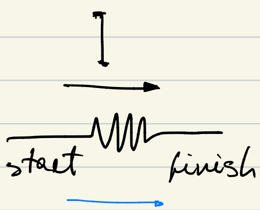
" loop : conservation of energy

Conservation of energy

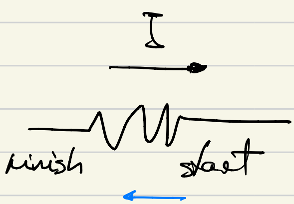
Travel with I

↓

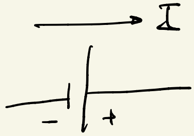
(−) → negative



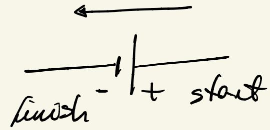
$\Delta V = -IR$



$\Delta V = +IR$



$\Delta V = \mathcal{E}$

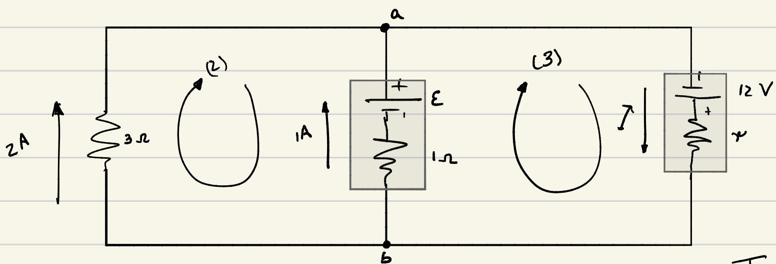


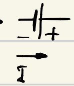
$\Delta V = -\mathcal{E}$

$\sum I = 0$

$\sum V = 0$

Ejemplo:



Trick: Choose direct of $I \rightarrow$ 

1) Junction Rule First

* a junction

$I_{in} = 2A + 1A = 3A$

$I_{out} = I$

$I = 3$

2) Loop Rule $\rightarrow$ Choose direction of loop.

Loop 3 CW

$(- \rightarrow +)$ (a favor)

$+12V \;—\; I r = +12V - 3r$

$+12 - 3r - 1A \times 1\Omega + \mathcal{E} = 0$

Loop 2 CW

$$-\mathcal{E} + 1A \times 1\Omega - 2A \times 3\Omega = 0$$

$$-\mathcal{E} + 1 - 6 = 0$$

$$\mathcal{E} = -5V$$

Battery was plugged wrong

$$12 - 3r - 1 + (-5) = 0$$

$$12 - 3r - 6 = 0$$

$$6 - 3r = 0$$

$$r = 2\Omega$$

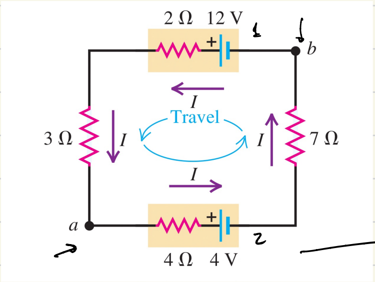
Practice

$I = ?$

$V_{ab} = ?$

$P_1 = ?$

$P_2 = ?$



→ recharging

$$-7I + 12 - 2I - I3 - I4 - 4V = 0$$

$$12 - 4 = 16I$$

$$8 = 16I$$

$$0.5A = I$$

9.5

$$P_1 = I\mathcal{E}$$

$$P_1 = 0.5 \times 12 = 6W$$

$$P_2 = 0.5 \times 4 = -2W$$

Magnetism

Field and Forces

Only 3 equations

$$\vec{F}_B = q\vec{v} \times \vec{B}$$

$$B_{\text{long wire}} = \frac{\mu_0 I}{2\pi r} \qquad B_{\text{solenoid}} = \mu_0 n I$$

Notes: * Magnetic forces act only on moving charges

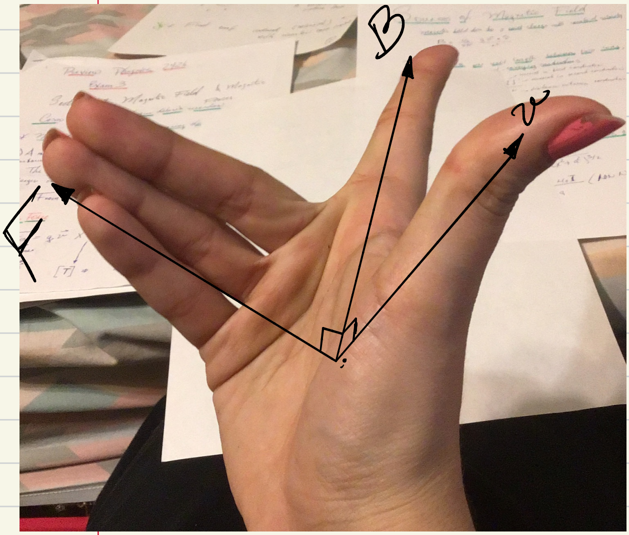
1) A moving charge or a current creates a magnetic field in the surrounding space (in addition to its electric field)

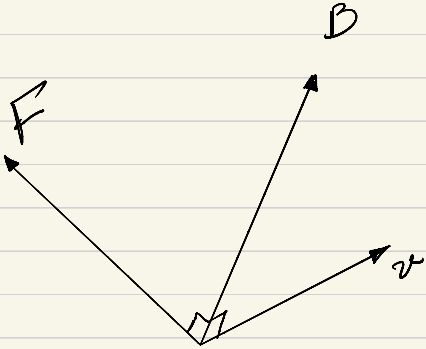
2) The magnetic field exerts a force $\vec{F}$ on any other moving charges or current that is present in the field

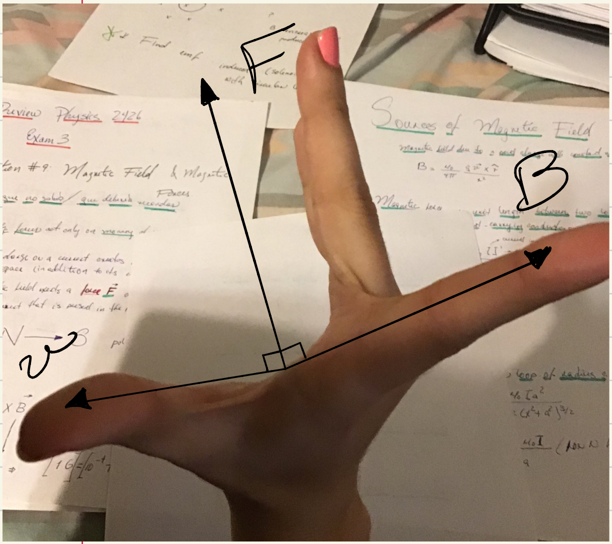
N → S pole

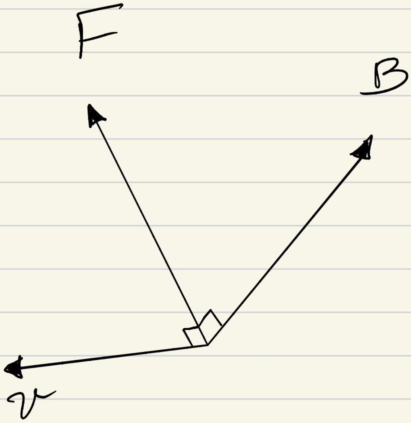
$$\vec{F}_B = q\vec{v} \times \vec{B} = |q|\, vB \sin\phi$$

$$\vec{v} \times \vec{B}\ q = \vec{F}_B$$


B
v
F


F
B
v

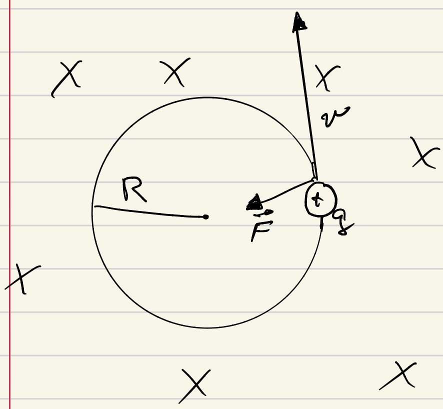

F
B
v


F
B
v

Magnetic field due to a point charge with constant velocity.

$$B = \frac{\mu_0}{4\pi} \frac{q\,\vec{v} \times \hat{r}}{r^2}$$

$$\vec{F}_{total} = q\left(\vec{E} + \vec{v} \times \vec{B}\right) \rightarrow \text{Lorentz Force}$$



$$R = \frac{mv}{|q|B}$$

Electromagnetic Induction

*Learn

a) Flux is + $(\Phi_B > 0)$

and becoming more positive (+) $\left(\frac{d\Phi_B}{dt} > 0\right)$

$\mathcal{E} < 0$ (−)

$+ + \to -$

b) Flux is + $(\Phi_B > 0)$

and becoming more negative (−) $\left(\frac{d\Phi_B}{dt} < 0\right)$

$\mathcal{E} > 0$ (+)

$+ - \to +$

c) Flux is − $(\Phi_B < 0)$

and becoming more negative (−) $\left(\frac{d\Phi_B}{dt} < 0\right)$

$\mathcal{E} > 0$ (+)

$- - \to +$

d) Flux is − $(\Phi_B < 0)$

and becoming more positive (+) $\left(\frac{d\Phi_B}{dt} > 0\right)$

$\mathcal{E} < 0$ (−)

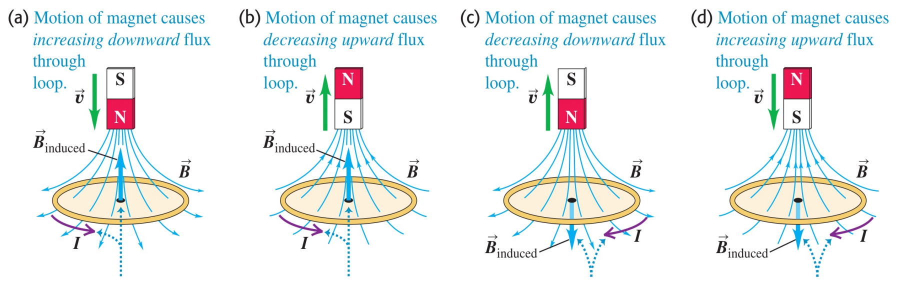
$- + \to -$

Lenz's Law

The induced current produces its own magnetic flux which opposes the change in flux that induced the current.

Shorter version :

Nature resists a change in flux



The induced magnetic field is *upward* to oppose the flux change. To produce this induced field, the induced current must be *counterclockwise* as seen from above the loop.

The induced magnetic field is *downward* to oppose the flux change. To produce this induced field, the induced current must be *clockwise* as seen from above the loop.

in do   de up

up

de do   in up

down

Geometric Optics

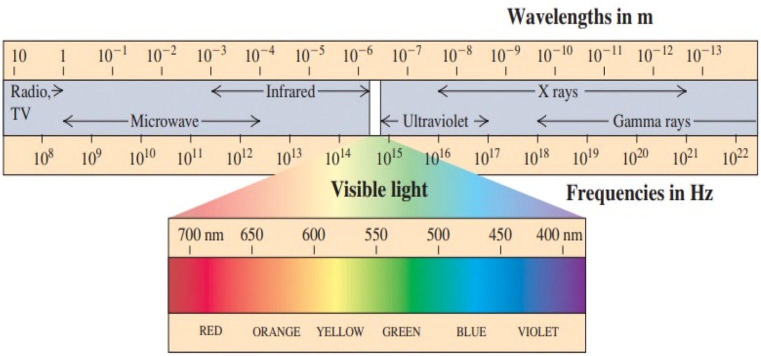
Geometric Optics

$$f_{mirror} = \frac{R}{2} \qquad \frac{1}{f_{lens}} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad \frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \qquad m \equiv \frac{y'}{y} = -\frac{s'}{s}$$

	focal length f	Magnification m	Image Distance s'
Converging Concave	+	+ upright images	+ for real images
Diverging Convex	−	− inverted images	− for virtual images

Sign Convention

32.4 The electromagnetic spectrum. The frequencies and wavelengths found in nature extend over such a wide range that we have to use a logarithmic scale to show all important bands. The boundaries between bands are somewhat arbitrary.



Frequencies

Radio < micro wave < Infra red < red < violet < ultraviolet

< X rays < Gamma rays .