Electromagnetism Review Map

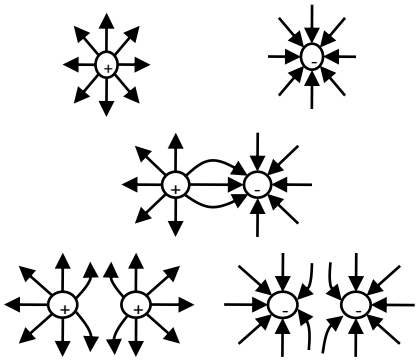
Charge

Charge is a fundamental quantity of matter that is *quantized* – comes in multiples of *elementary charge* (1.60×10^{-19} C)

Law of Conservation of Charge – charge is not created or destroyed, but only moves from one place to another

Electric Fields

Exist in regions near charged objects and are the medium through which charges interact



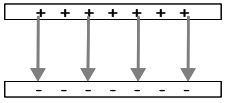
The amount of electrostatic force between two charged objects can be determined using Coulomb's Law

$$F_e = \frac{kq_1q_2}{r^2}$$

A charged object in an electric field will experience a force proportional to its charge and to the field strength and.

$$E = \frac{F_e}{q}$$

Parallel Plates



Field is of uniform strength at all points between the plates and 0 outside the plates.

A charge placed between the plates will:
- experience a constant force
- accelerate at a constant rate

Charging Objects

ONLY ELECTRONS ARE TRANSFERED DURING CHARGING

polarization (induction) – redistribution of charge without contact. This process is only temporary

conduction – transfer of charge by direct contact. Objects will end up with the same charge

induction (with grounding) – transfer of charge while the charged object is grounded. Object will gain opposite charge from the one used to charge it. ("charged by induction")

grounding – the dissipation of charge by touching an object to a larger one that can absorb the excess charge

Electroscope

A device for detecting charge

When charged, the leaves repel one another and spread apart

Determining Charge

An object brought near a charged electroscope will cause the leaves to:

diverge – if it has the same charge as the electroscope
converge – is it has the opposite charge of the electroscope

Vectors – magnitude and direction

electric field strength
force

Scalars – magnitude only

charge	*power*
current	*energy*
voltage	*time*
resistance	*resistivity*

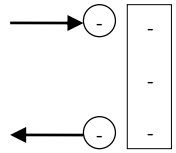
Voltage

Storage of energy using electric fields

$$V = \frac{W}{q}$$

Work done against a field stores energy

Object released in field gains KE



When dealing with small numbers of charges, energy is often recorded or calculated in electron-volts
1 eV = 1.6×10^{-19} J

Electrical Current

Flow of charge from high voltage to low – measured in coulombs per second or amperes (A)

$$I = \frac{\Delta q}{t}$$

Resistance

Natural opposition to flow of charge – measured in ohms. Resistance is proportional to length, resistivity, and temperature of a conductor and inversely proportional to its cross-sectional area.

$$R = \frac{\rho L}{A}$$

Ohm's Law

The relationship between voltage, current, and resistance exhibited when a resistor has constant resistance

$$R = \frac{V}{I}$$

Power

Rate at which energy is used – in circuits this is directly proportional to both voltage and current.

$$P = IV = \frac{V^2}{R} = I^2R$$

Electrical Energy

The end product of power and time is the production and use of energy.

$$W = Pt = IVt = \frac{V^2t}{R} = I^2Rt$$

Series Circuit

A circuit in which all components are connected end-to-end.

The equivalent resistance is the sum of all of the resistances.

$R_{eq} = R_1 + R_2 + \ldots$

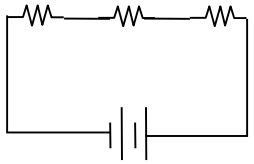
Current has only ONE path through which to flow.

$I = I_1 = I_2 = \ldots$

Voltage is distributed proportionally to each resistor.

$V = V_1 + V_2 + \ldots$

Adding resistors will increase overall resistance and decrease current.



Parallel Circuit

A circuit in which all components have equal access to the voltage source.

The same voltage is provided to each resistor.

$V = V_1 = V_2 = \ldots$

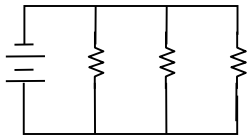
The equivalent resistance is lower than the smallest resistance.

$1/R_{eq} = 1/R_1 + 1/R_2 + \ldots$

Current has multiple paths through which to flow.

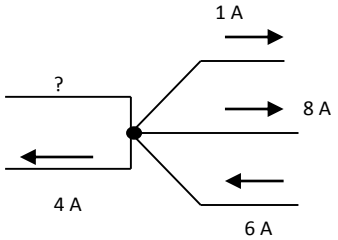
$I = I_1 + I_2 = \ldots$

Adding resistors will decrease overall resistance and increase current.



Junction Rule

Total current flowing into and out of a junction must be equal. This is a consequence of the Law of Conservation of Charge.



Total In = 6A

Total Out = 13A

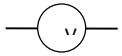
So the unknown branch must be 7A toward the junction

Circuit Measurement Devices

voltmeter – measures the potential difference between two points in a circuit.

High resistance device

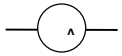
Must be connected to the OUTSIDE of the circuit.



ammeter – measures the current passing through a given point in a circuit.

Low resistance device

Must be connected to the INSIDE of the circuit.



Magnetism

Magnetic fields are the result of the motion of electric charges.

Field lines point from north to south outside a magnet.