What is mass?

Mass is a fundamental property of matter that indicates how difficult it is to change the object's motion.

What is momentum?

momentum is a fundamental property of matter that indicates how difficult it is to change a moving object's motion.

What is charge?

charge is a fundamental property of matter that indicates how an object will be affected by electric and magnetic fields.

Two kinds of charge

1) positive

2) negative

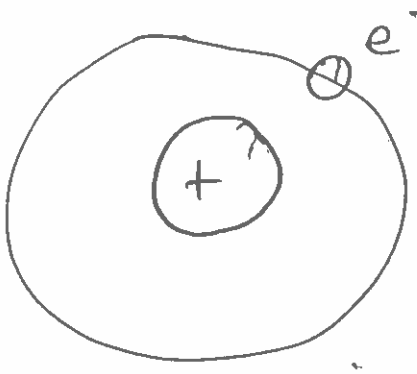
Laws of Charges

1) Like charges Repel } Ben Franklin
2) Opposite charges attract

When was e^- discovered? 1897 J.J. Thomson

1912 Rutherford provides data Discrediting Plum-Pudding model.

1913 Bohr – Produces Bohr model



1935 – Neutron is discovered

Atoms – Nucleus with Protons & Neutrons
electrons orbiting nucleus

What is Current?

Current is the Amount of charge that moves past a reference point in a reference amount of time (usually 1 sec)

$$i = \frac{dQ}{dt}$$

Current can be Direct Current (steady flow in 1 direction.) ⇒ Batteries

Current can be Alternating current (current periodically reverses direction) ⇒ Wall outlet

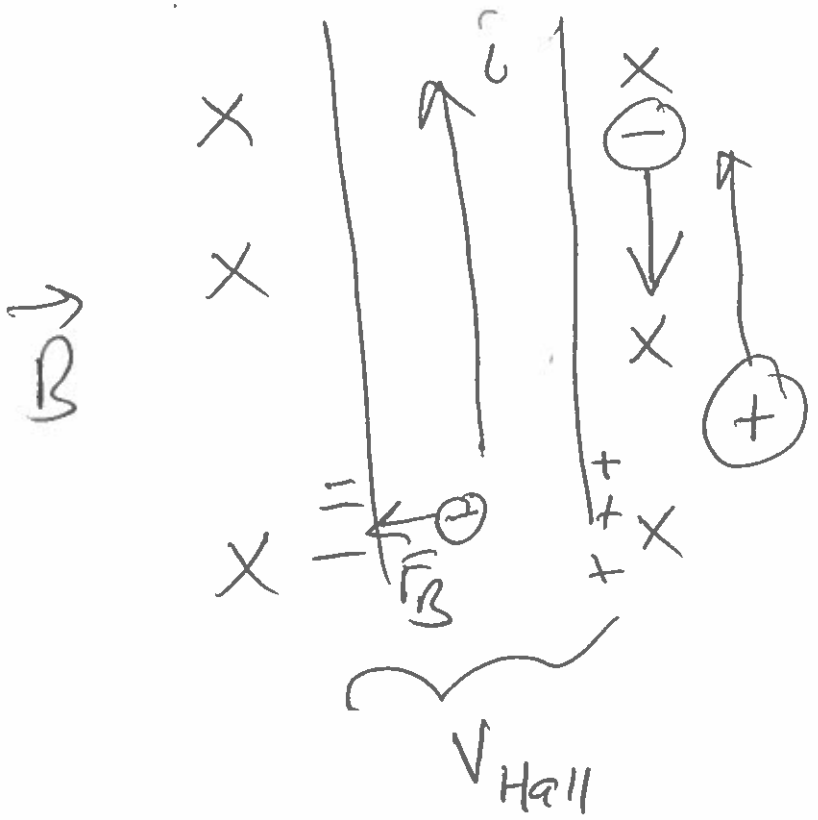
All A.C. Power created in Generators

Steam Drives Turbines which rotate coils in magnetic fields. Faraday Induction creates A.C. Current.

What is the charge carrier?

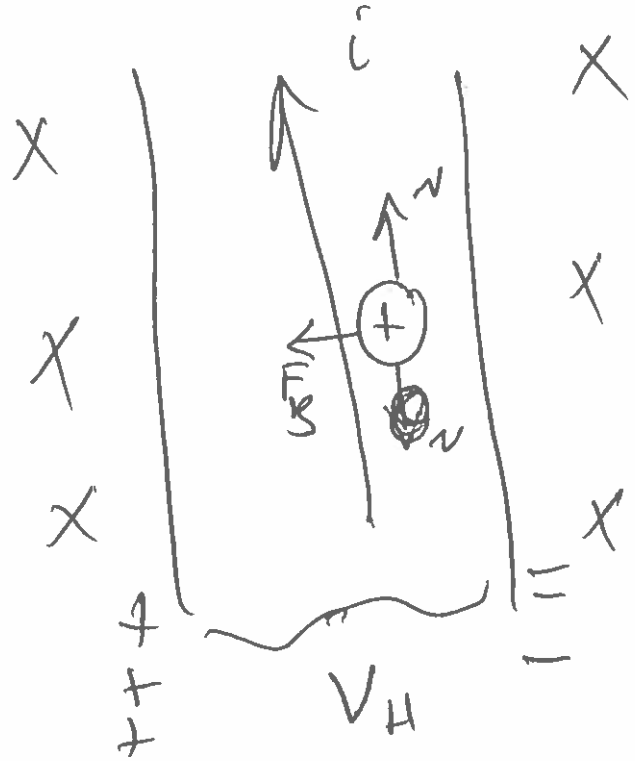
1) e^- — negative dominant charge carrier

2) hole — Positive dominant charge carrier



Negative Charge dominant

Cu, Ag Au

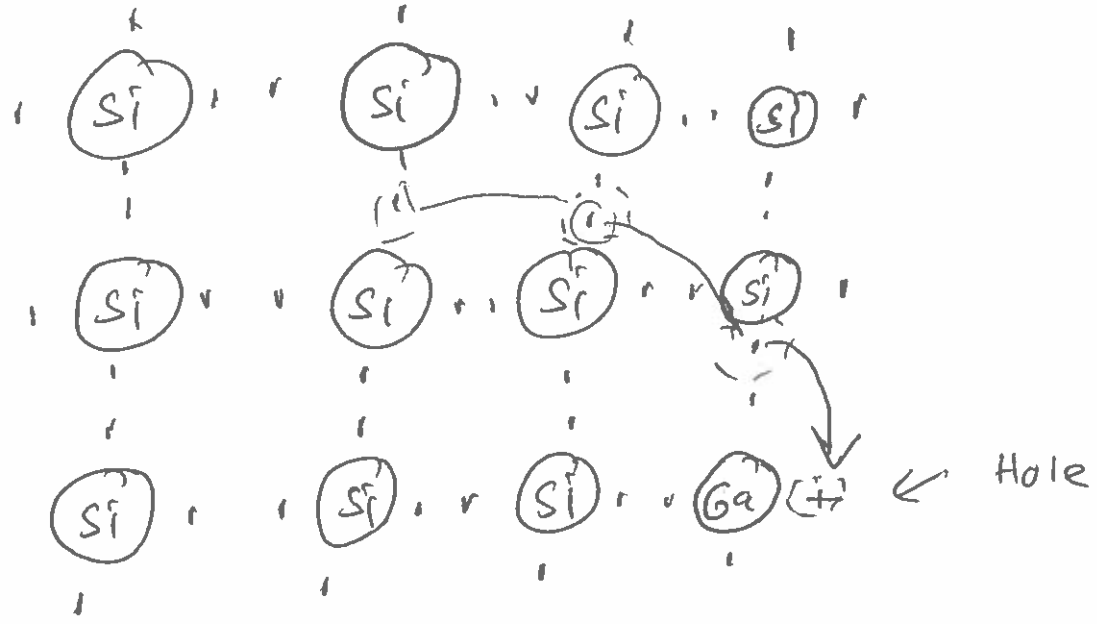


Positive Charge dominate

Mn, Al,

Cu electronic structure

$3d^{10}\ 4s^{1}$



Conventional current moves from + to −

What is voltage?

Voltage (potential difference) is electrical potential energy per unit charge.

What is electric field?

Short definition is electric field is Electrical force per unit charge.

$$U = -\vec{\nabla} \cdot \vec{F}$$

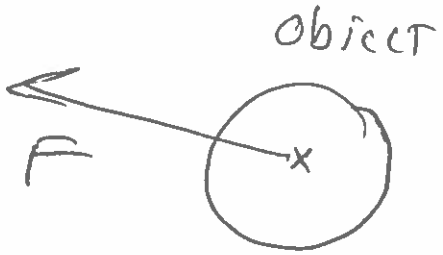
$$V = -\vec{\nabla} \cdot \vec{E}$$

Electric field is a mathematical construct assisning to every point in space a value that provides the electric force when a positive test charge is placed at that point.

$$\vec{F} = q\vec{E}$$

Field solves action at a distance.

Field created by a source



$$F_{grav} = \frac{G M_1 M_2}{r^2}$$

$$\text{Field} = \frac{F}{\text{source}} = \frac{F_g}{m} = \frac{GM}{r^2} = g$$

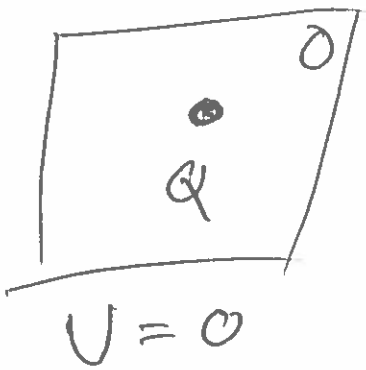
$$W = mg$$

$$E = \frac{kQ}{r^2} \qquad F = \frac{kQ_1Q_2}{r^2} = QE$$

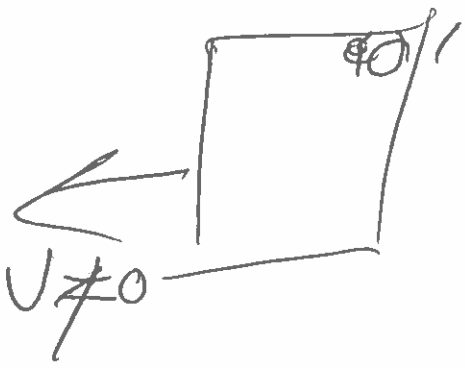
Static Electric fields are created by Charge

Static Magnetic fields are created by moving Charge (current)

$\vec{E}$ only



$\vec{E}$ $\vec{B}$



Voltage like gravitational potential energy does not have absolute zero pt.

$V_b = 1.5\,V$

$U = QV$