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

electric potential V is electrical potential energy per unit charge

$$U = QV$$

electric potential is a scalar field. we can assign to all points in space a value that when we put a positive test charge at that point in space we can calculate the electrical potential energy that charge would have at that point in space.

$$V(x,y) = 45\ V \quad (1V = 1J/C)$$

put a $-2C$ charge at that point

$$U_{el} = ? \qquad U_{el} = QV = (-2C)(45V)$$

$$\boxed{U_{el} = -90J}$$

What if it were +2C?

$$U_{el} = +90J$$

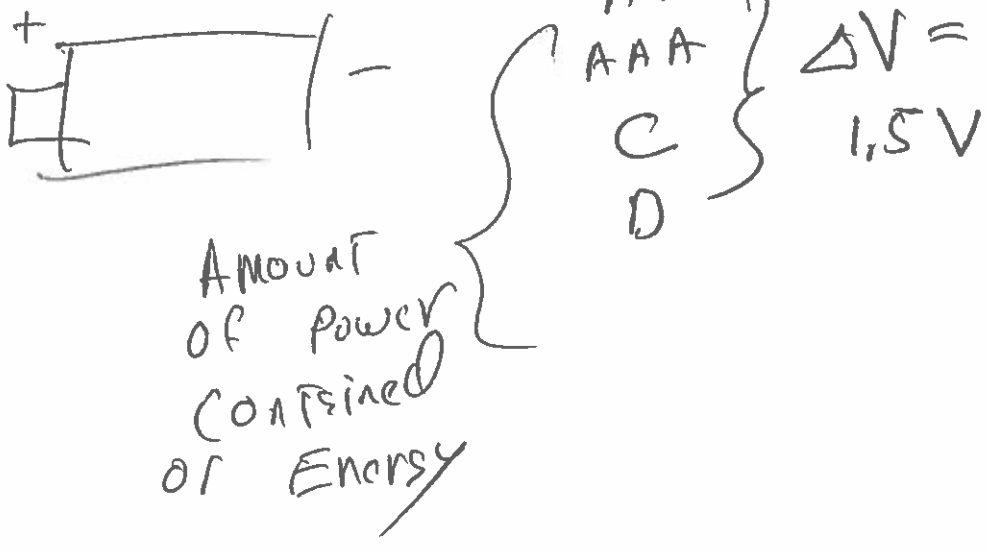
negative charges are attracted to regions of high +V

Positive Charges are repelled by regions of high +V.

Source of electrical Potential?

batteries ⇒ Voltaic Cells

batteries create potential through Chemical reactions,



Voltage vs current

current is the flow of electrical charge. It is how much charge passes a reference point in a given amount of time.

current is measured in AMPS

$$1\ A = 1\ C/s$$

2 basic types of current

1) A.C. - Alternating current (charges) go in both directions
   => wall outlets
2) D.C. - Direct current and current (charges) go in one direction
   => Batteries.

Current can be analogous to amount of water flowing in a pipe.

Voltage is electrical potential energy per charge

Voltage is analogous to height above Ground.

Current flows through a wire
Voltage is energy across a wire.

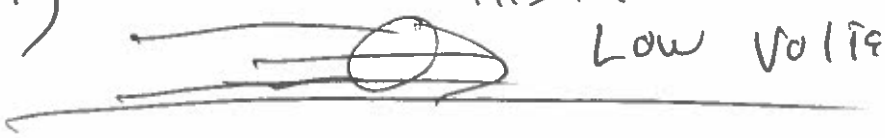
Which is worse current or volts?

Power = (current)(voltage)
Power is denser!

Consider 3 cases

Water Pipe on Ground

1) High current
Low voltage

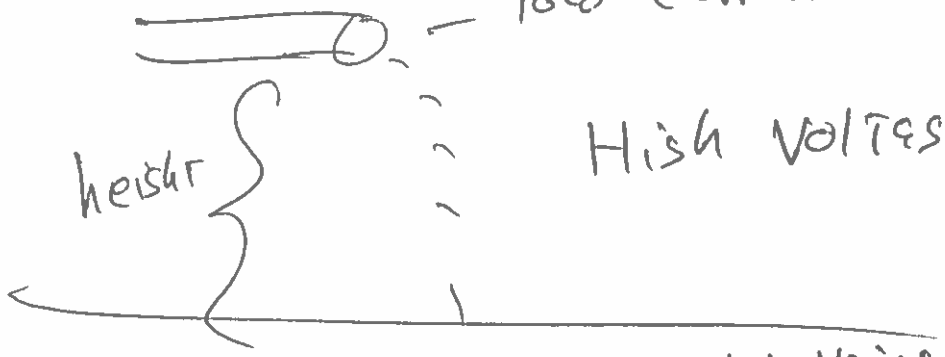


Ground gets wet, wasting water

No real damage

2) low current

High voltage

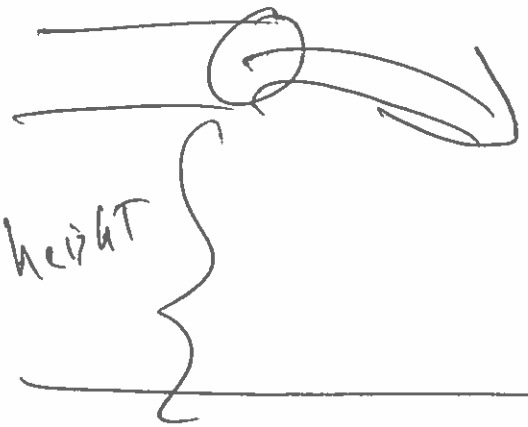


No real Damage

Walking across carpet.

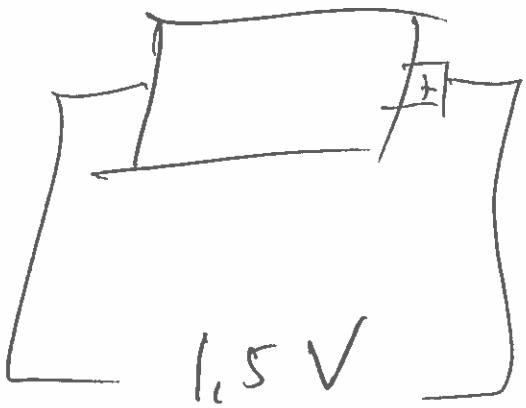
3) 3rd Rail of Subway

High voltage High current



creates Damage (Disgrade)

High Power And Dangerous



Use Earth Ground TO Make a Zero Potential reference Point.

Equipotential - means Same Potential along a line or a surface

By definition conducts must be equipotentials.

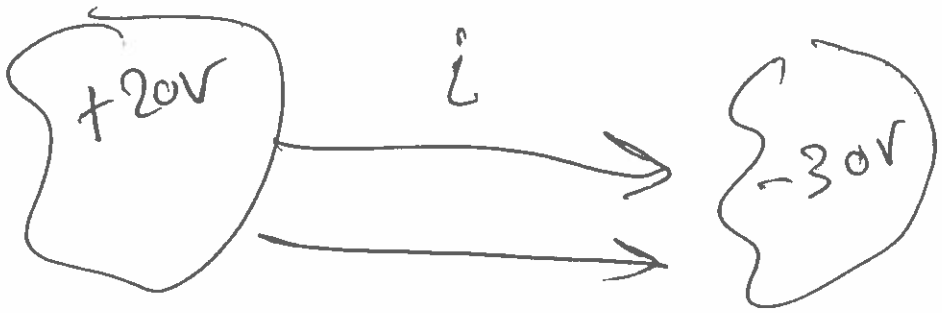
In Physics Positive current Goes from high Positive Potential to lower negative Potential.

Copper is a Good conductor
Because it has 1 outer e^- easily removed. So Majority of charge carriers are negative.

BUT Aluminum has a majority of positive charge carriers (holes).

Hall experiment which can determine the sign of the majority charge carrier.

Cu, Ag, Au — are negative
Al, Mg — are positive.



$$U_{el} = \frac{k Q_1 Q_2}{r}$$

$Q_A = +1\,\mu C$

$Q_B = -2\,\mu C$

$d = 1.0\,m$

$$U_{el} = \frac{k Q_A Q_B}{d}$$

$$U_{el} = \frac{\left(8.99 \times 10^{9} \frac{N m^2}{C^2}\right)\left(1 \times 10^{-6} C\right)\left(-2 \times 10^{-6} C\right)}{1.0\,m}$$

$$U_{el} = -2\,\frac{(8.99)\ 10^{9}\ (10^{-12})}{1}\ \frac{N m^2}{C^2}\ \frac{(C^2)}{m}$$

$$U_{el} = -17.98 \times 10^{-3}\ \underbrace{N m}_{J}$$

$$\boxed{U_{el} = -0.01798\ J}$$