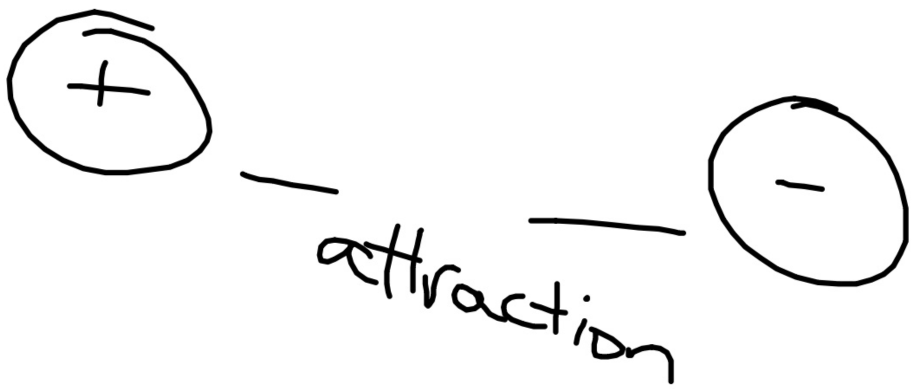
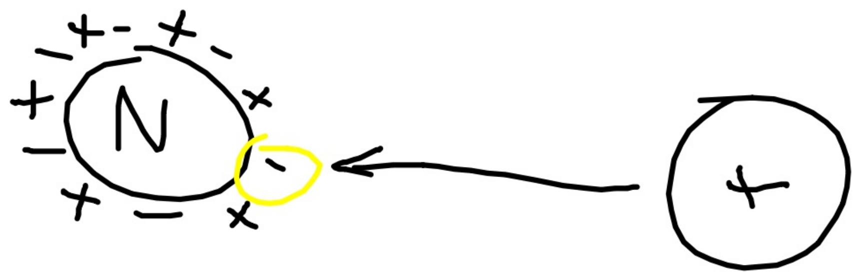
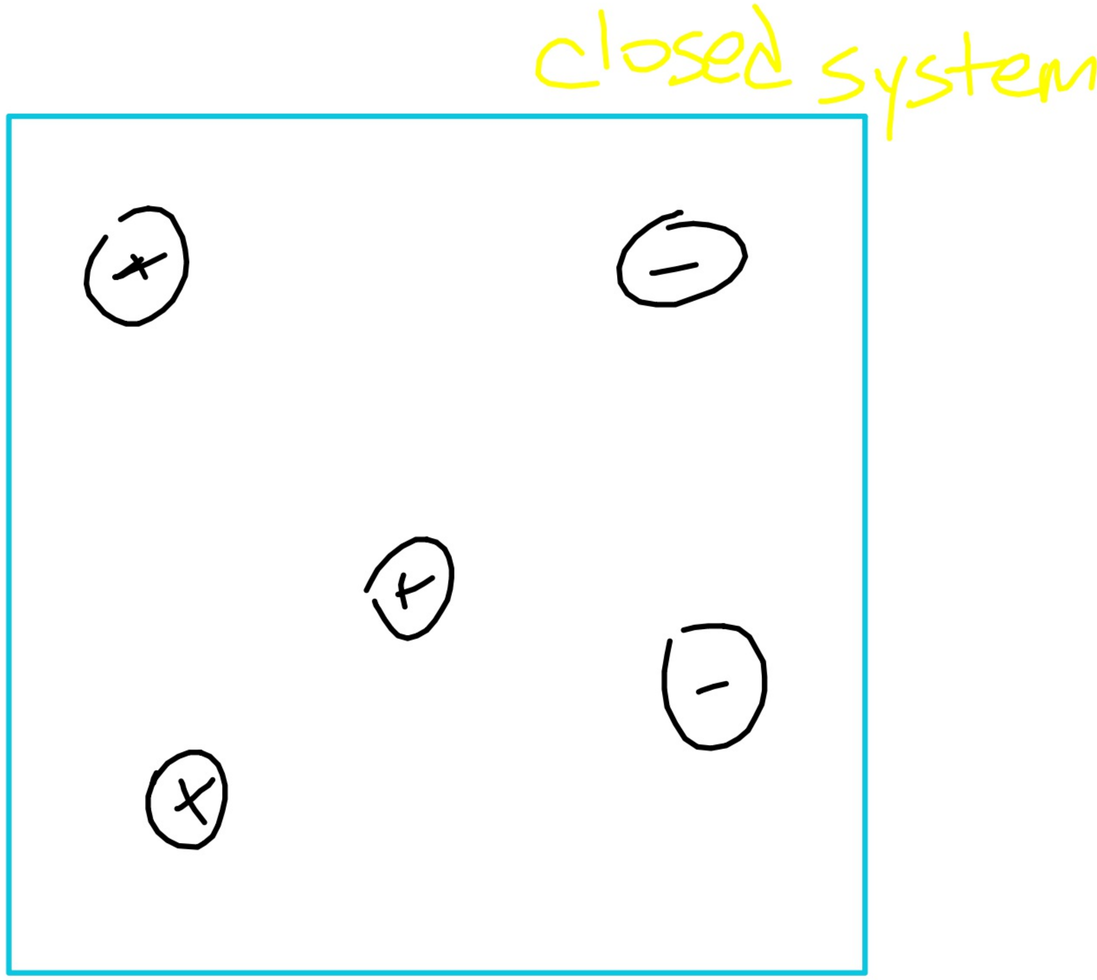
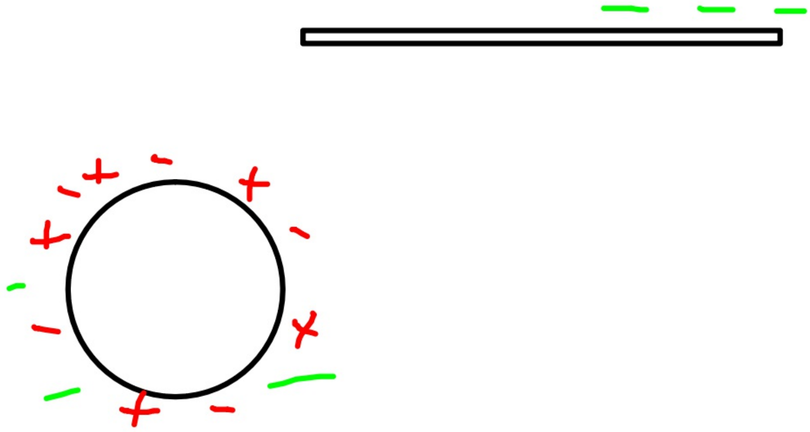

+
−
attraction

Electric Fields


N


closed system
+
−
+
−
+



variable q Q

Charge unit

Coulomb

C

$1C = 1A \cdot 1s$

Elementary Charge

$e^- = -1.6 \times 10^{-19} C$

variable = $\underline{I}$ → current

Ampere is unit of current

A

$I = \frac{Q}{t} \Rightarrow \frac{C}{s} = A$

Amps

q_1 = charge 1

q_2 = charge 2

$$F \propto \frac{q_1 q_2}{r^2}$$

r = dist.

q1
q2

$$F = \frac{k q_1 q_2}{r^2}$$

$$F = \frac{q_1 q_2}{(4\pi \varepsilon_0) r^2}$$

$K = 9 \times 10^9$ N

$$K = \frac{1}{4\pi \varepsilon_0}$$

na
vacuum

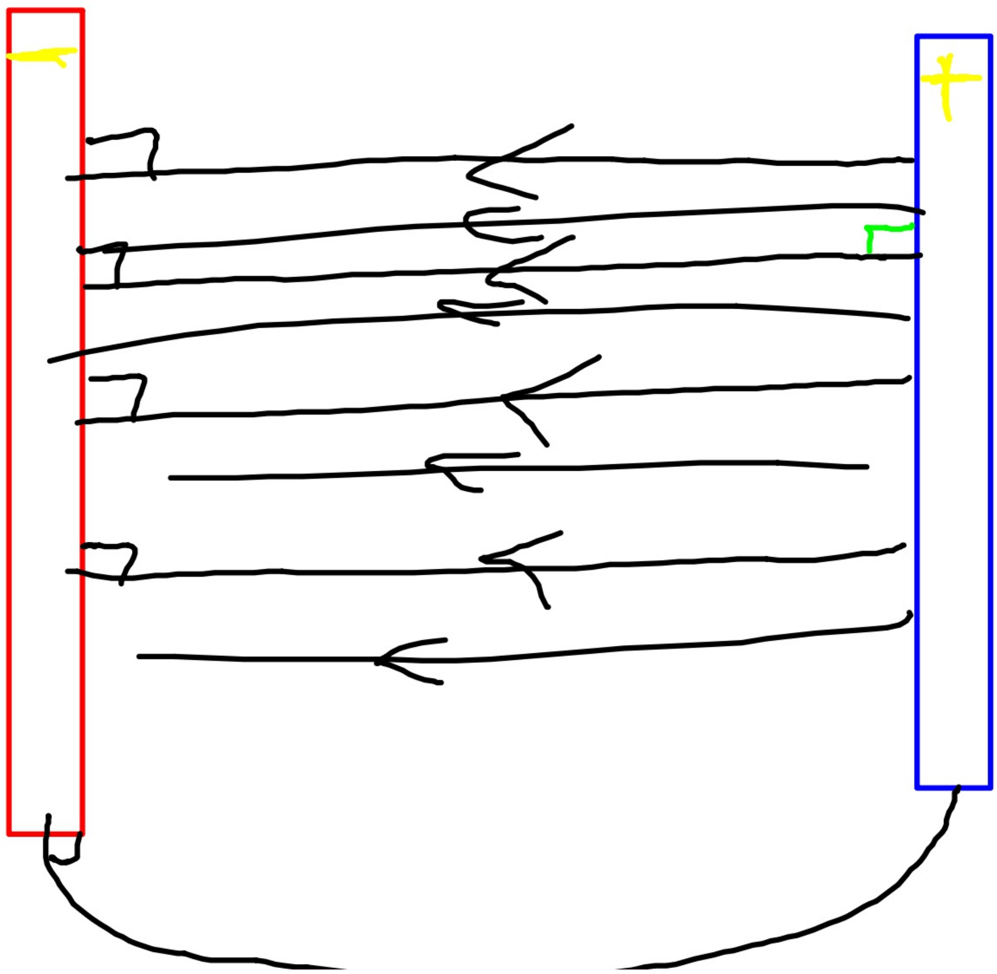
$\varepsilon_0 = 8.854 \times 10^{-12}\ C^2 N^{-1} m^{-2}$

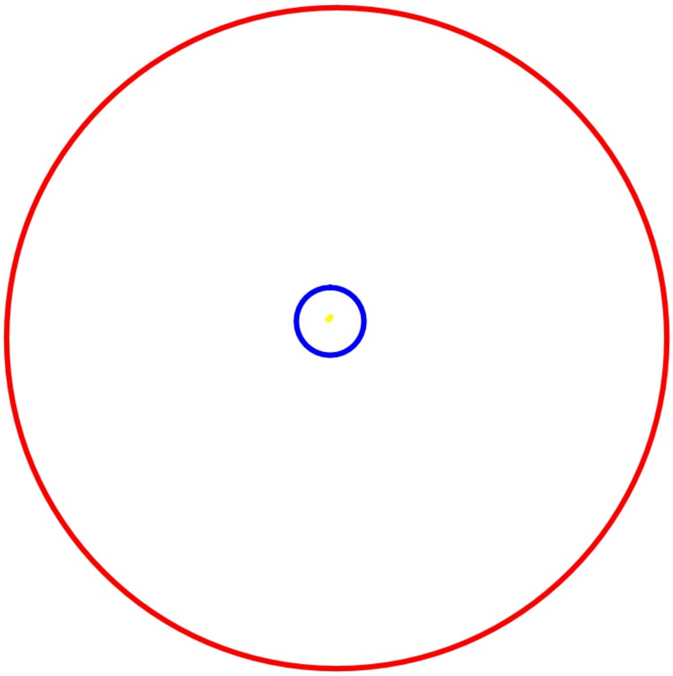
permitivity of space

$$F = \frac{q_1 q_2}{(4\pi\varepsilon_0) r^2}$$

$$\frac{1}{4\pi\varepsilon_0} =$$


F
1-
1m
2+





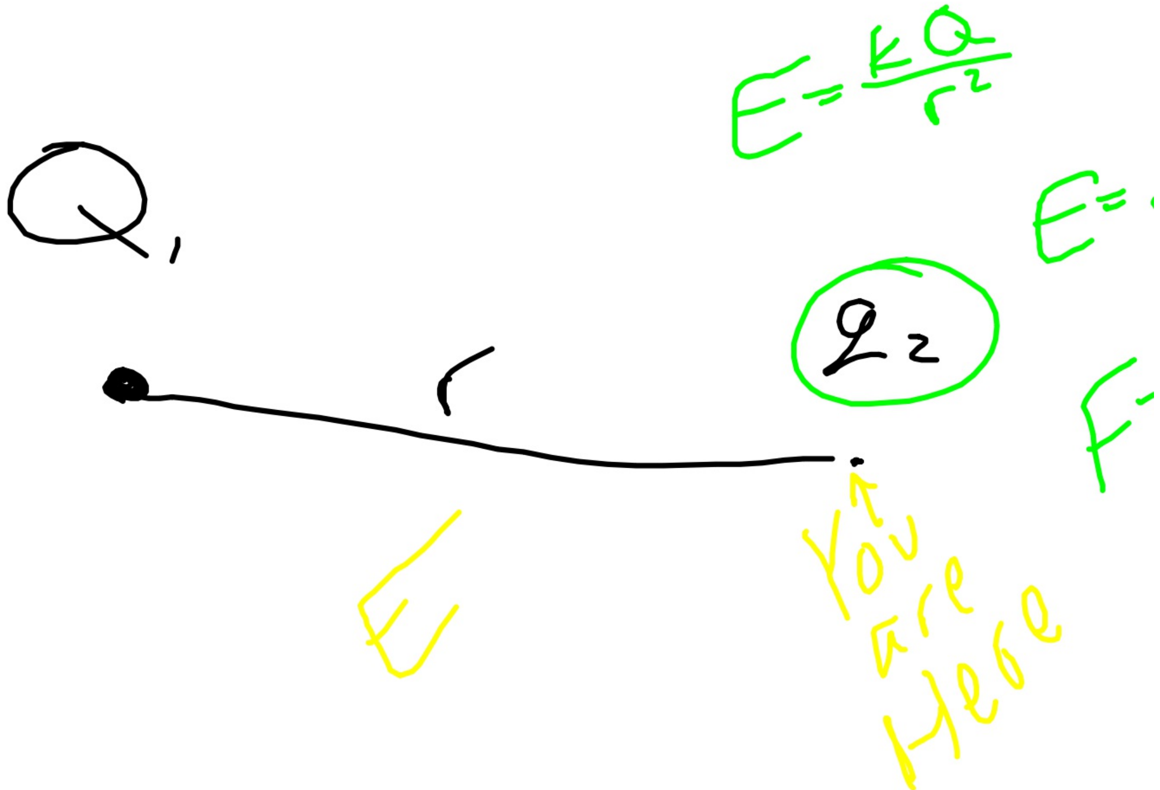
Electric Field → $E = \frac{F}{q}$ Electric F

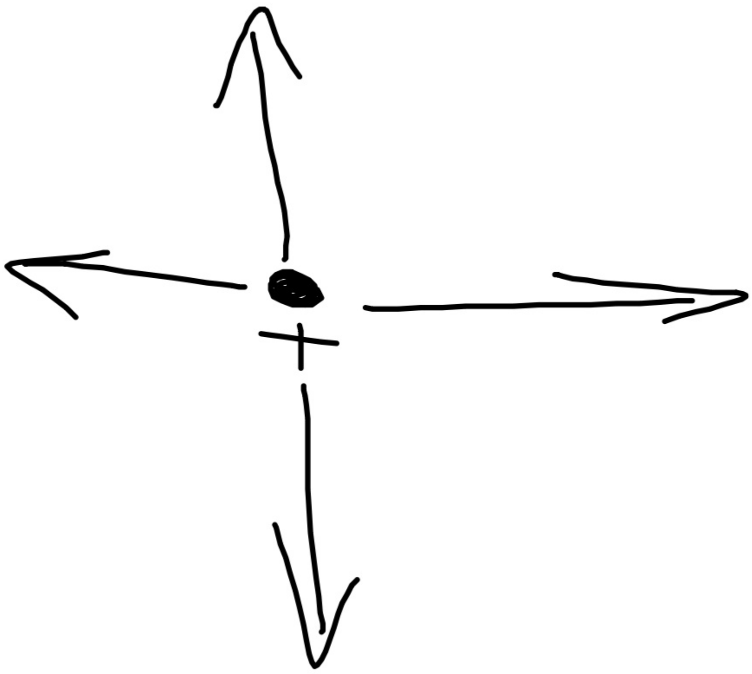
charge

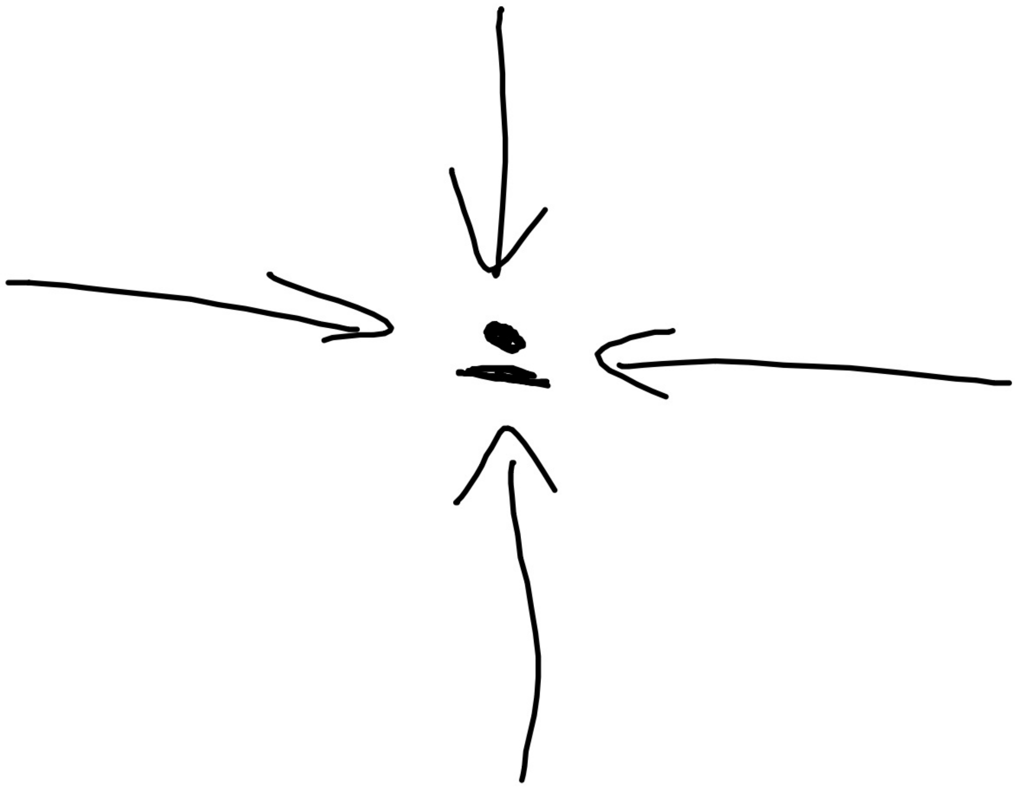
$\frac{N}{C}$

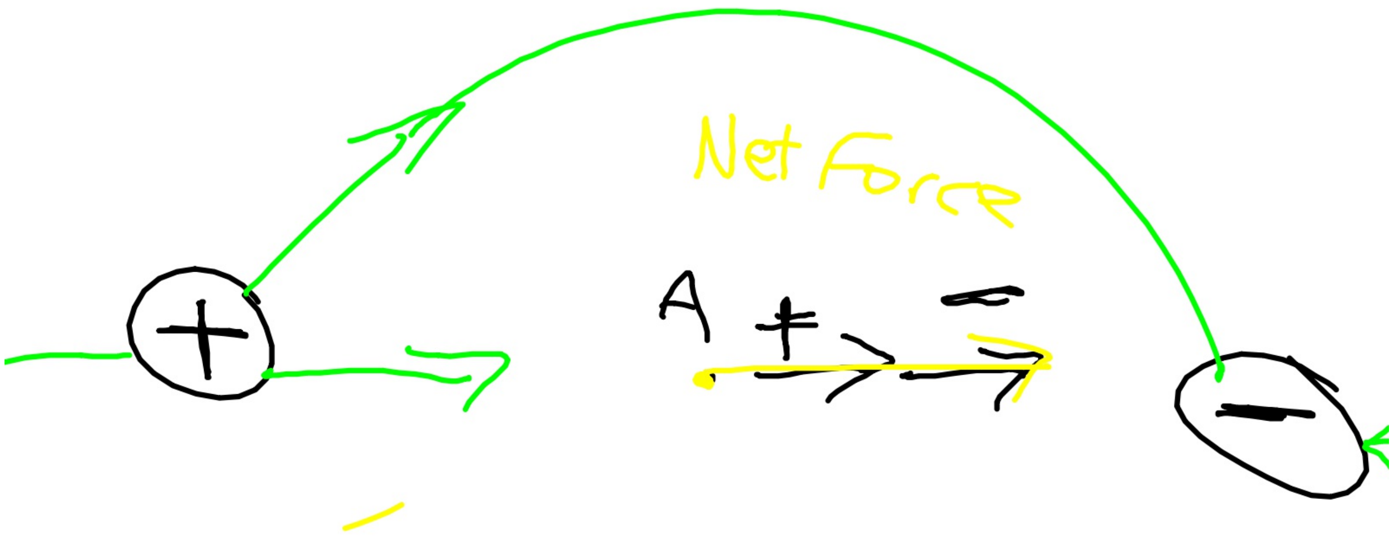
$E = \frac{kQ}{r^2}$

$F = \frac{kQ \cdot q_2}{r^2}$


Q1
r
Q2
E
You are Here
E = kQ/r²
E =
F =






Net Force
A

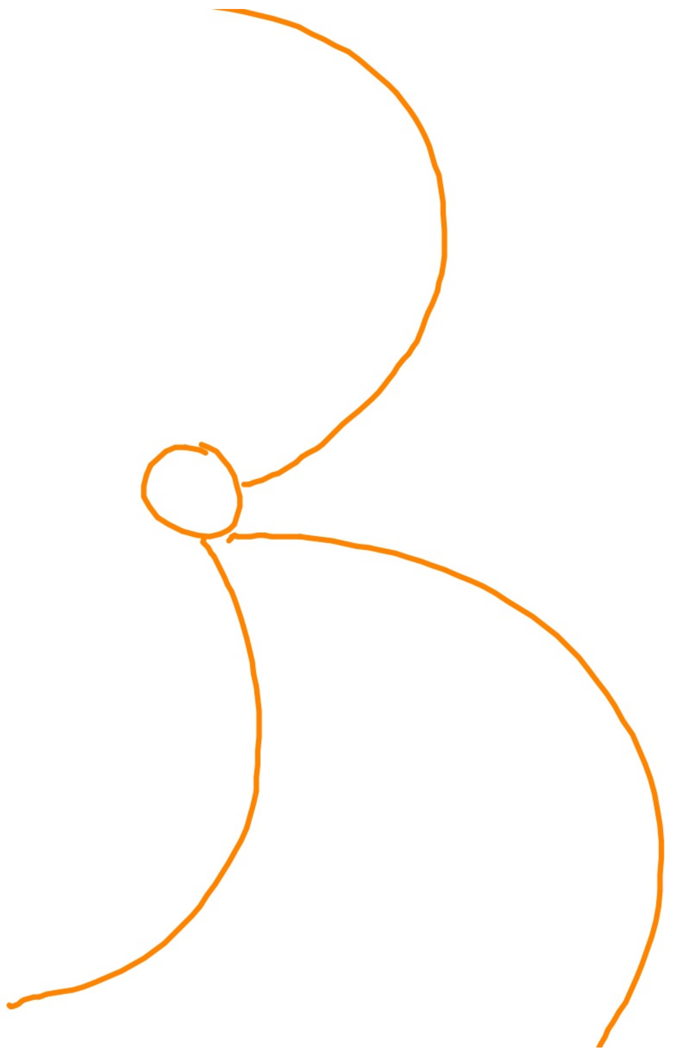
A massless point with a charge of +1.2 C is 480 m away from a massless point with a charge of -3.1 C. Calculate the force between the two charges.

$$F = \left| \frac{9\times10^{9} \cdot (1.2) \cdot (-3.1)}{480^2} \right| \qquad F = \frac{k \cdot q_1 \cdot q_2}{r^2}$$

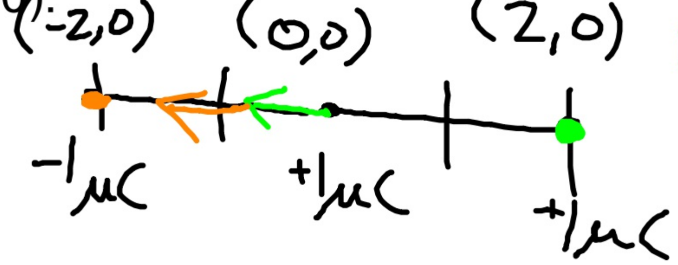
$= 145312.5$

150000 N

yes



In a grid with coordinates corresponding to 1 cm, a +1 μC at (2,0) and a -1 μC at (-2,0) exerts what net force on a +1 μC at (0,0).



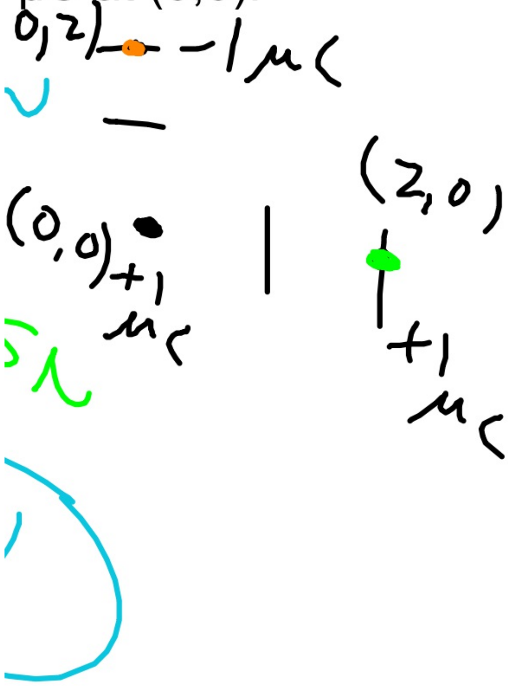
$$F = \frac{kq_1q_2}{r^2}$$

$$= \frac{(9\times10^{9})(1\times10^{-6})(1\times10^{-6})}{(.02)^2}$$

$$F = 22.5N \times 2 =$$

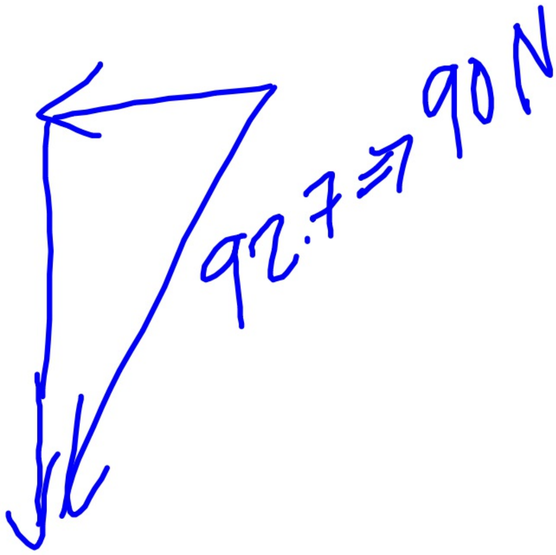
$$50N$$

In a grid with coordinates corresponding to 1 cm, a +1 µC at (2,0) and a -1 µC at (0,2) exerts what net force on a +1 µC at (0,0).

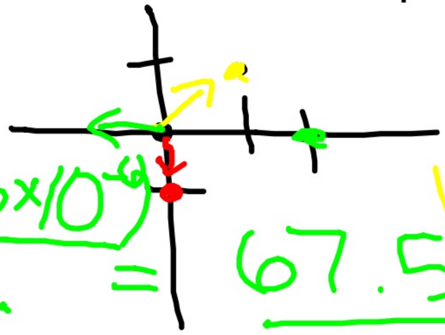


In a grid with coordinates corresponding to 1 cm, a +1 μC at (2,0) and a -1 μC at (0,-1) exerts what net force on a +1 μC at (0,0).

$$F = \frac{k q_1 q_2}{r^2}$$



In a grid with coordinates corresponding to 1 cm, a +3 μC at (2,0), a -2 μC at (1,1) and a -6 μC at (0,-1) exerts what net force on a +1 μC at (0,0).



$\ldots 3\times10^{-6}) = 67.5N$

$$\frac{(9\cdot10^{9})(1\cdot10^{-6})(-6 \ldots}{(0.01)^2} = 540N$$

$$\frac{9.0\times10^{9}\times1.0\times10^{-6}\times2\times10^{-6}}{(0.0141)^2} = 90N$$

$C = 4 \times 6$ N

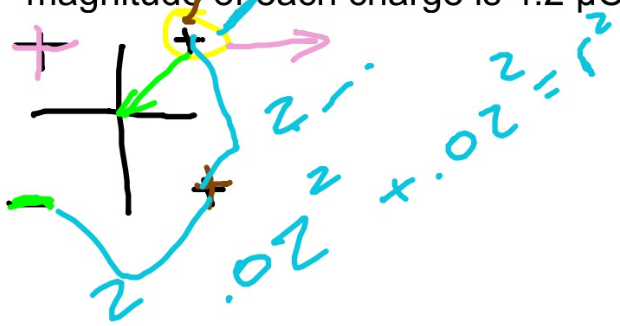
4 equal magnitude charges are placed at (1,1), (1,-1), (-1,1), and (-1,-1). Find the net force at the origin if the point charge there is 1/2 the charge of the other four if the 4 are 1 μC.

$F = k\frac{q_1 q_2}{r^2}$

$\frac{(9\times10^{9})(1\times10^{-6})(0.5\ldots}{2\times10^{-4}}$

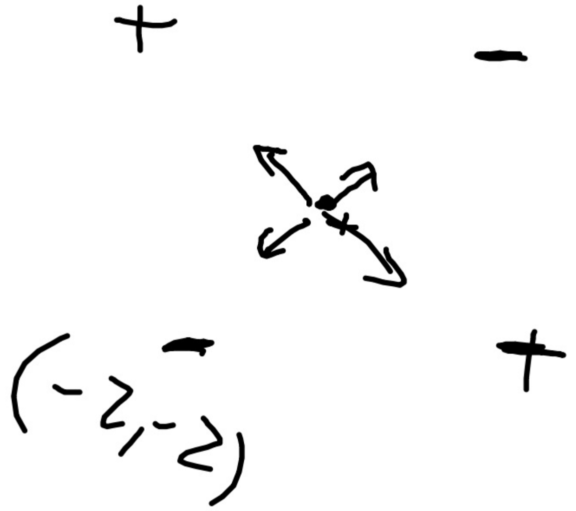
$22.5N \cdot 2 \Rightarrow 45N$

4 equal magnitude charges are placed at (1,1), (1,-1), (-1,1), and (-1,-1). Find the net force at (1,1) caused by the other charges if the magnitude of each charge is 4.2 μC.

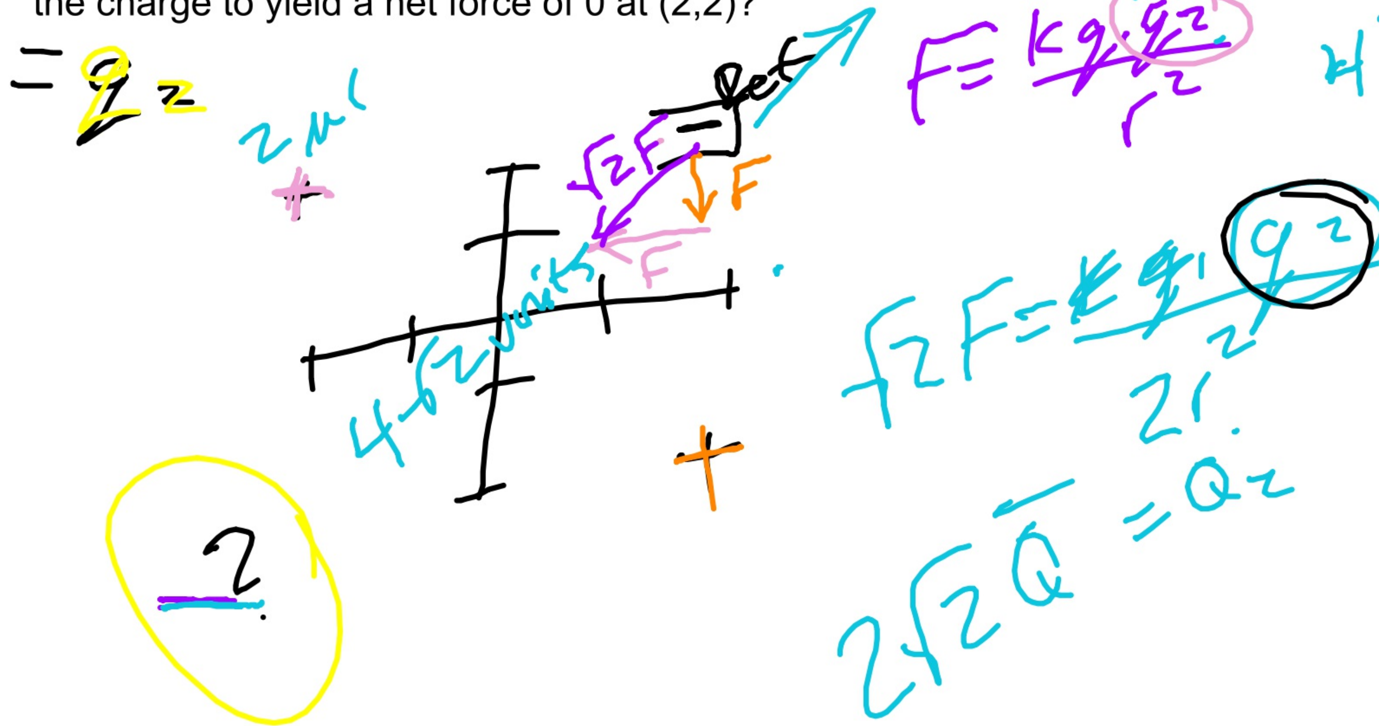


$$\frac{9(10)^9 \cdot (4.2\times10^{-6})^2}{(.02)^2}$$

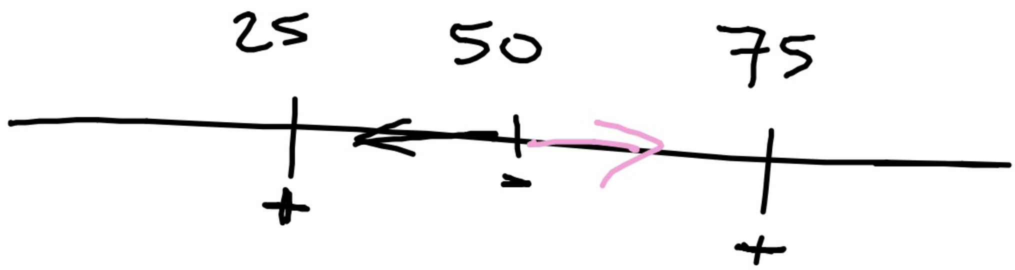
3 charges of equal magnitude are placed on the corners of square $(2,2)^-$, $(2,-2)^+$, and $(-2, 2)^+$. Where does a 4th equal charge$^-$ need to be placed to yield a net force of 0 at the origin?



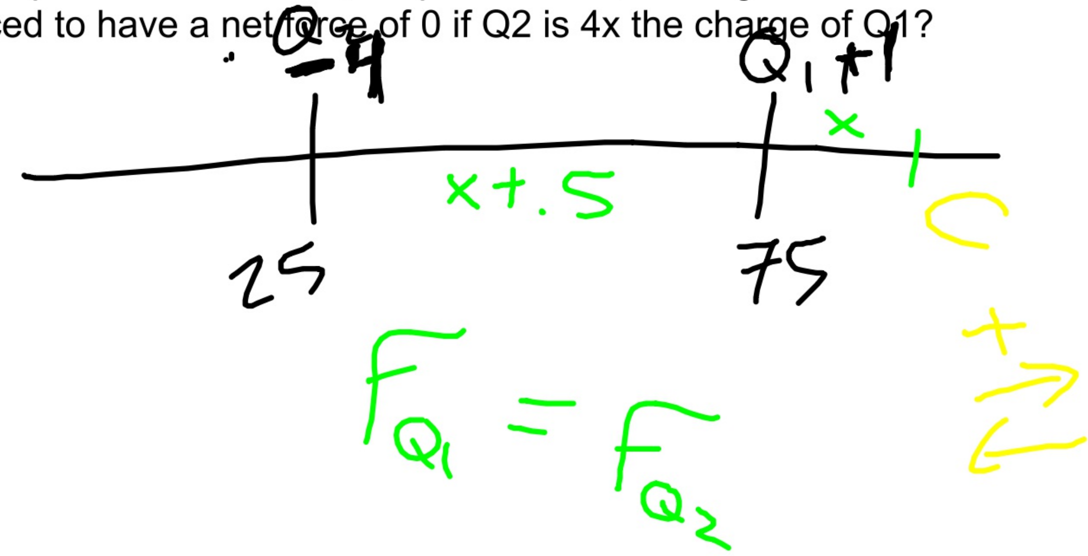
3 charges of equal magnitude are placed on the corners of square $(2,2)^-$, $(2,-2)^+$, and $(-2, 2)^+$. A 4th charge is placed at (-2,-2). What is the sign and magnitude of the charge to yield a net force of 0 at (2,2)?



You have a meter stick with 2 equal charges placed on it. Q1 is placed at 75 cm and Q2 is placed at 25 cm. Q1 and Q2 are both positive. Where is a test charge placed to have a net force of 0?



You have a meter stick with 2 charges placed on it. Q1 is placed at 75 cm and Q2 is placed at 25 cm. Q1 is positive & Q2 is negative. Where is a + test charge placed to have a net force of 0 if Q2 is 4x the charge of Q1?



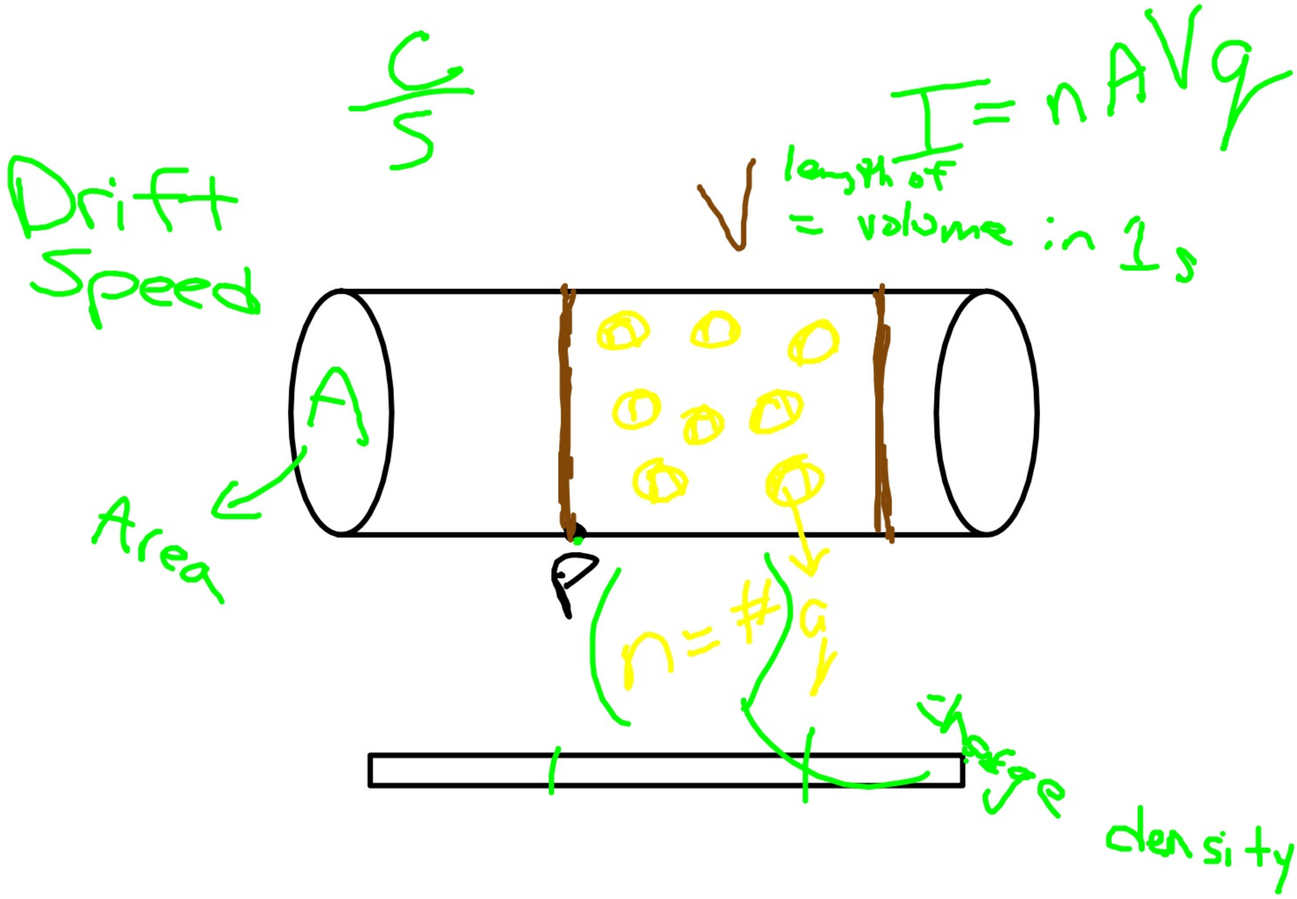
$$I = \frac{q}{t}$$

current (I)

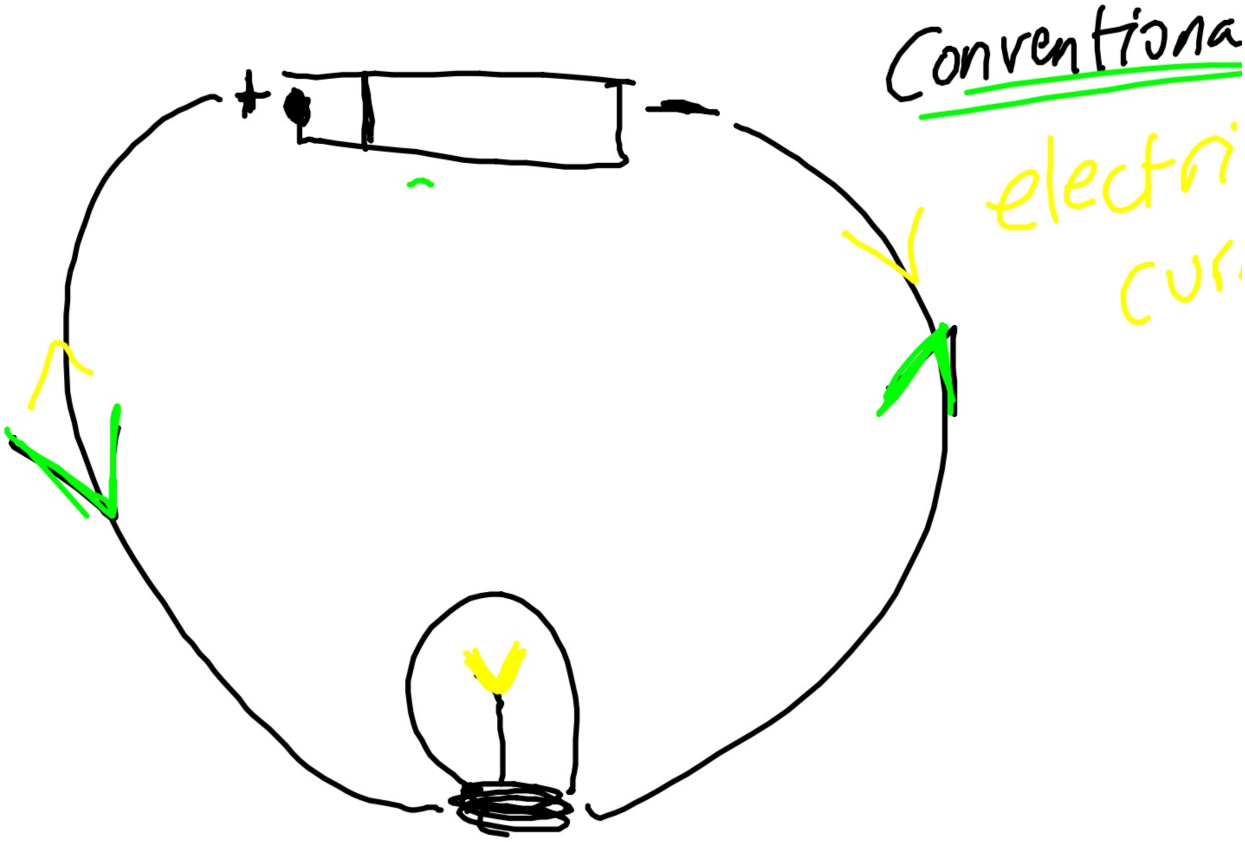
charge (q)

time (t)

unit $= \frac{C}{s} \Rightarrow A$



C/S
I = nAVq
Drift Speed
V
length of
= volume in 1 s
A
Area
P
n = #
q
charge density


+
-
Conventiona
electri
cur

$$\text{Potential Diff.} = \frac{\text{Energy}}{\text{charge}}$$

$$V = \frac{J}{C} \qquad V = \frac{W_{ork}}{Q_{charge}}$$

$Energy = VQ$ $\quad I = \frac{Q}{t}$

$Energy = VI\Delta t$

$$\frac{E}{\Delta t} = VI$$

$P = IV$

If you have a 4.5 W lamp that has a potential difference of 6 volts, find the current.

$P = I \cdot V$ $\quad 4.5 = I \cdot 6 \quad I = 0.75A$

Find the energy transferred in 3 minutes.

$E = VI\Delta t = 6(.75)(180) = 810\,J$

Find the charge passed in 3 minutes

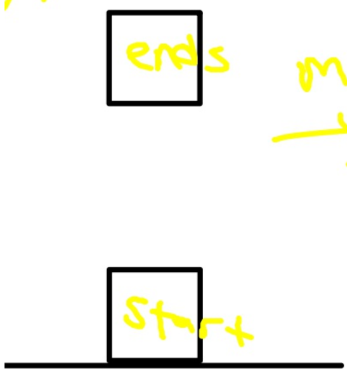
$$\text{Potential Difference} = \frac{\text{energy}}{\text{Charge}}$$

$$6 = \frac{810}{C}$$

Charge = 135 C

An electric motor that is connected to a 12 V supply is able to raise a 0.10 kg load through a distance of 1.5 m in 7 s. The motor is 40% efficient. Calculate the average current in the motor while the load is being raised.

A



$$\frac{mgh}{t} = P_{out}$$

$$\frac{P_{out}}{P_{in}} = eff.$$

$$\frac{P_o}{.4} = P_i = IV$$

$$I = 44\,mA$$

Electromotive force vs Potential difference

emf - when energy is transferred to the electrons

battery, turbine, photovoltaic cells

pd - when energy is transferred from the electrons

motor, lamps,

Electronvolt - unit of energy

eV - energy gained by an electron when it moves through a potential difference of one volt.

$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$

$$E = QV$$

1V

A lamp is lit for 3 hours. Calculate the energy transfer to the lamp when the pd across it is 120 V and the current is 25 mA.

$$E = VI\Delta t$$

$$E = 120(0.025)(10800)$$

$$E = 32400\,J$$

A battery cell has a terminal voltage of 2.5 V and can deliver a charge of 720 C before it becomes discharged.

1. Calculate the maximum energy the battery can deliver.

$E = 1800 J$

$E = QV \quad E = (2.5)(720)$

2. If the current in the battery never exceeds 10. mA, estimate the lifetime of the battery.

$(t).01 = \frac{720}{t}(t)$

$\frac{720}{.01} = t \quad I = \frac{Q}{t}$

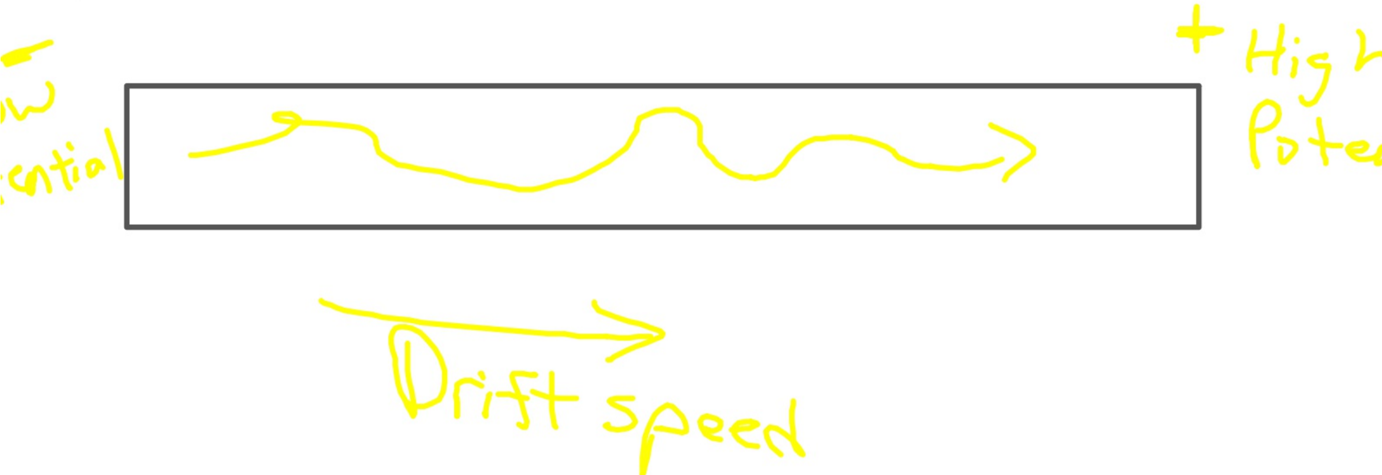
$\rightarrow 72000 s$

An electron, initially at rest, is accelerated through a potential difference of 120 V. Calculate the gain in kinetic energy for the electron. Also, calculate the electron's final speed.

$$E = (1.6 \times 10^{-19})(120)\,J = \frac{1}{2}mv^2$$

$$m_e = 9.11 \times 10^{-31}\ kg \qquad v = 6 \times 10^{6}\ m/s$$

Explain electrical conduction in metals



A copper wire of diameter 0.75 mm carries a current of 0.15 A. There are 9.2×10^{22} charge carriers in each cubic meter of copper. The charge on each charge carrier (electron) is 1.6×10^{-19} C. Calculate the drift speed of the charge carriers.

$$I = nAvq \qquad A = \pi\left(\frac{d}{2}\right)^2$$

$$v = \frac{I}{nq\pi\left(\frac{d}{2}\right)^2} = 23\ m/s$$

In a nuclear accelerator a proton is accelerated from rest gaining an energy of 150 MeV. Calculate the final speed of the proton if its mass is 1.7×10^{-27} kg.

$KE = \frac{1}{2}mv^2$

$(150 \times 10^{6}\ eV)(1.6 \times 10^{-19}\ \frac{J}{eV}) = \#J$

$v = \sqrt{\frac{2KE}{m}}$

$v = 1.7 \times 10^{8}$ m/s

Two point charges of magnitude +7.5 µC and -4.5 µC are 7.25 m apart in a liquid that has a permittivity of 3.1×10^{-12} C^2/Nm^2. Find the force between the charges.

$$F = \frac{q_1 q_2}{(4\pi\varepsilon_0) r^2} \Rightarrow \frac{7.5\times10^{-6} \cdot 4}{(4\pi \cdot 3.1\times10}$$

$$0.016$$

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

urrent — charge — time

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

Field

$$F = \frac{k q_1 q_2}{r^2}$$

Force — dist.

$$I = nAvq$$

charge density — cross sect. Area — dr...

$$K = \frac{1}{4\pi\epsilon_0}$$

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

Work/Energy