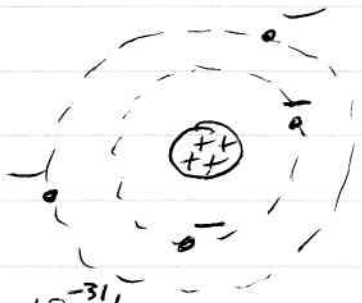
4.6 FOR CHARGE 'LIKE' CHARGE REPELS ++ −−
'UNLIKE' CHARGE ATTRACTS +−

FINDING TOTAL CHARGE ON AN OBJECT

$$q_{TOTAL} = (\text{SUM OF } +q) + (\text{SUM OF } -q)$$

EXCESS +
EXCESS −
0 ⇒ NEUTRAL EQUAL AMOUNT OF + AND −

ATOMS TEND TO BE NEUTRAL



SMALLEST UNITS OF CHARGE

ELECTRONS: ⊙− $-e$
$m_E = 9.11 \times 10^{-31}\,kg$

PROTONS: ⊕ $+e$
$m_p = \sim 1000(m_E)$

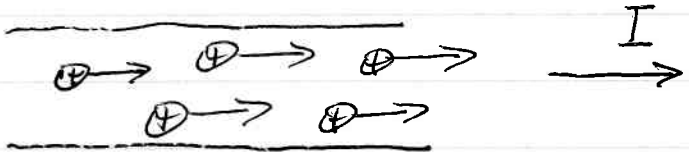
'QUANTIZED' - SMALLEST INTEGRAL AMOUNTS

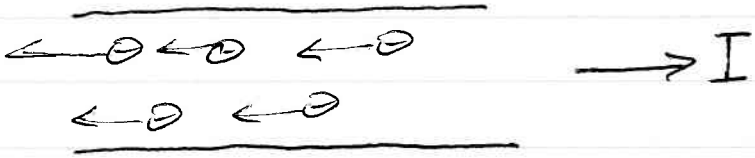
$$e = 1.602 \times 10^{-19}\,C$$

ELECTRONS ARE MORE LIKELY TO FLOW GIVEN A FORCE ON THEM THAN PROTONS BECAUSE THEY ARE LESS MASSIVE

FLOWING CHARGE = CURRENT I OR i

IN DIRECTION OF + FLOW





$$\text{CURRENT} = \frac{\text{NET TOTAL CHARGE}}{\text{TIME INTERVAL}} \qquad \frac{\text{UNITS}}{\frac{\text{COULOMBS}}{\text{S}}}$$

$$\frac{1\,C}{1\,s} = 1\,A$$

MEASURING CURRENT

AMMETER

A = AMPÉRÉ
= AMP
(DERIVED UNIT)

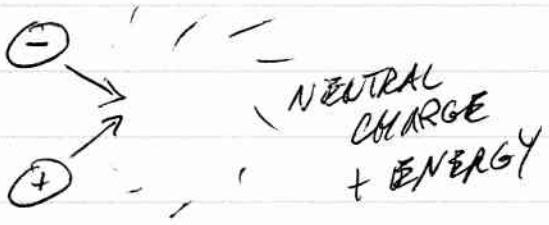
CHARGE IN AN ISOLATED SYSTEM IS CONSERVED OR THE NET CHARGE IS CONSTANT.

CHARGE CAN BE CREATED OR DESTROYED ONLY IN PAIRS.

3/7

ANTIMATTER: ANTI PROTON ⊖ $m_{+p} = m_{-p}$

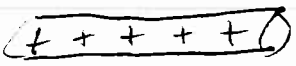
ANTI ELECTRON (POSITRON) $\cdot^{+}$ $m_{-E} = m_{+E}$



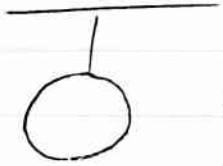
$E = m_p c^2$

↑ SPEED OF LIGHT 3×10^8 m/s

INDUCING CHARGE

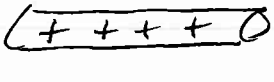


CHARGING BY INDUCTION



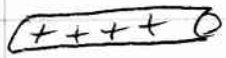
PITH OR WOODEN OR PLASTIC

NEUTRAL



STILL NEUTRAL, BUT IT'S POLARIZED

CHARGE IS UNEQUALLY DISTRIBUTED



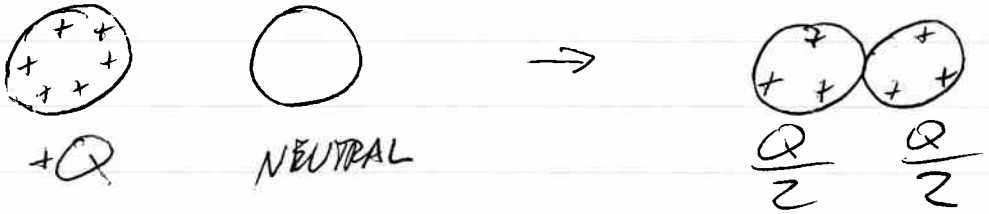
GROUND = ∞ SOURCE OF + OR −

CUT THE GROUND CONNECTION AND REMOVE THE ROD (+)

← IONIZED
= EXCESS OF CHARGE
= NET CHARGE

CHARGE SPREADS OUT ON SURFACE

EXPERIMENT WITH CHARGED OBJECTS:

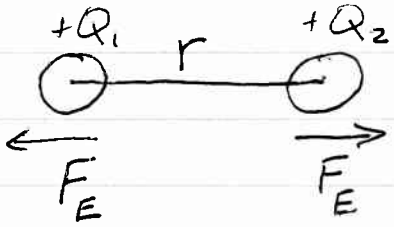


SAME FOR − CHARGED BALLS

MEASURING THE FORCES DUE TO ELECTRIC CHARGES

(DONE BY COULOMB)

'LIKE' REPELS



ELECTRIC FORCE DEPENDS ON:

- MAGNETUDE OF PRODUCT OF CHARGES
  - DOUBLE $Q_1 \Rightarrow 2F_E$
- $(\text{DISTANCE BETWEEN CENTERS})^2$
  - DROPS AS DISTANCE INCREASES
  - $2*r \rightarrow \frac{1}{4} F_E$

$$F_E \propto \frac{Q_1 \cdot Q_1}{r^2} \quad \text{OR} \quad F_E = \frac{k_E Q_1 Q_2}{r^2}$$

COULOMB'S ELECTRIC CONSTANT

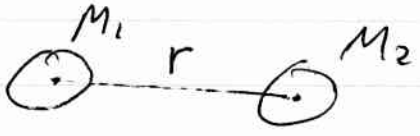
REPELS OR ATTRACTS

$$k_E = 8.99 \times 10^9 \frac{N \cdot m^2}{C^2}$$

SAME FORM AS FOR GRAVITY FAR FROM THE SURFACE

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

~~REPELS~~ ATTRACTS



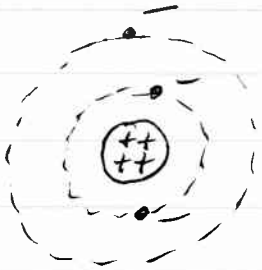
$$G = 6.6 \times 10^{-11} \frac{N \cdot m^2}{kg^2}$$

TYPICAL CHARGES ARE TINY

$10^{-6}\,C = (\mu C)$ $10^{-9}\,C = (nC)$ $10^{-12}\,C = (pC)$

WHY DO WE SEE LARGE MASS BUT NOT LARGE COLLECTIONS OF CHARGE?

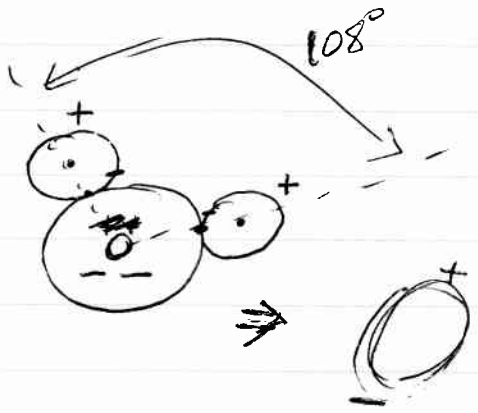
IONIZED ATOMS



+ ION

− ION

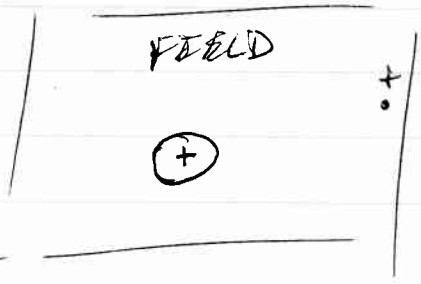
POLARIZED MOLECULE H_2O



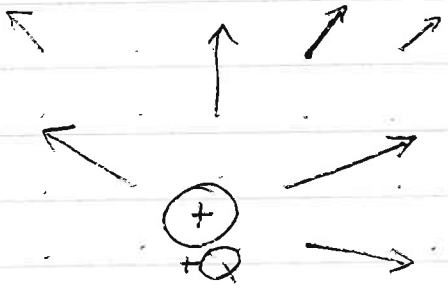
ELECTRIC FIELDS DUE TO 'POINT' CHARGES

↳ CHARGE AFFECTS THE SPACE AROUND ITSELF BY A FIELD,

ANOTHER CHARGE WILL BE AFFECTED BY THIS FIELD (BY MEANS OF FORCE)



7/7



MAP OUT ALL POINTS IN SPACE AROUND IT

$$\frac{\vec{F}_E}{+q} = \vec{E} = \frac{k_E Q}{r^2}$$

OUT + OR IN −

DEPENDING ON Q