23 - Coulomb's Law.

Q-1) What is Coulomb's law?

> Any two point charges exert an electrical force on each other that is proportional to the product of their charges and inversely proportional to the square of the distance between them.

(vector)

$$F = \frac{Q_1 Q_2}{4\pi \varepsilon_0 r^2} \qquad \varepsilon_0 = 8.85 \times 10^{-12} \ C^2/Nm^2$$

$$F = EQ$$

- Attractive charges (unlike) ; Force = Negative
- Repulsive charges (like) ; Force = Positive

* When considering charges as uniformly charged spheres, the distance is measured from the centre of the spheres, because they behave as if the charge was concentrated at the centre.

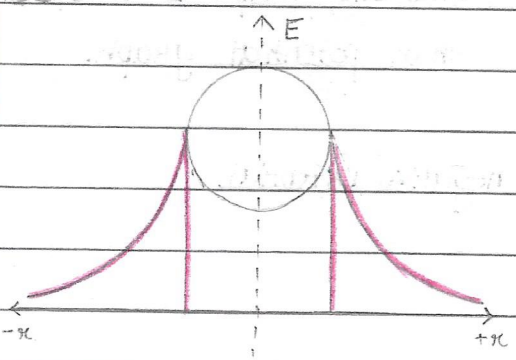
Q-2) What is electric field strength?

> It's the force per unit positive charge at a point.

(vector)

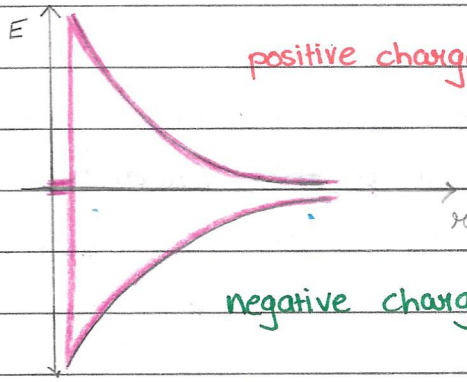
$$E = \frac{F}{Q} = \frac{\Delta V}{\Delta d}$$ → * Field strength = − potential gradient.

$$E = \frac{Q}{4\pi \varepsilon_0 r^2}$$ Q = charge producing the field.



Intensity inside sphere = 0
because the charges don't reside inside the sphere ; only outside.

Intensity (field strength) - distance graph.



positive charge (repulsive)

negative charge (attractive)

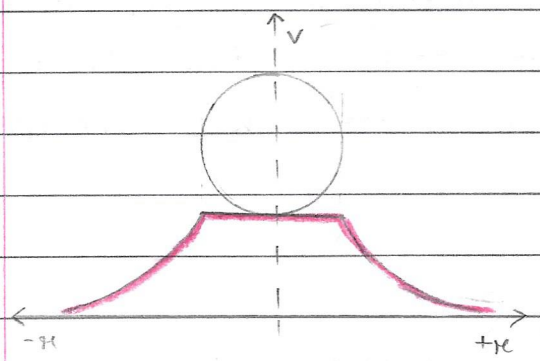
* intensity graph is steeper than potential graph.

Q-3) What is electric potential?

> Electric potential is the work done in bringing a unit positive charge from infinity to that point.
(scalar)

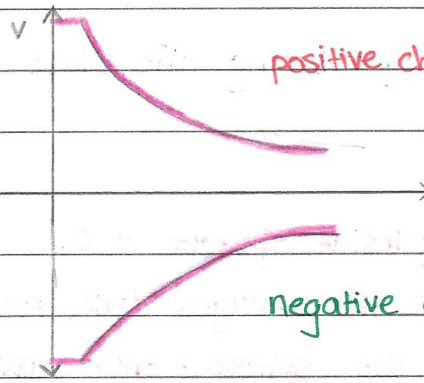
$$V = \frac{Q}{4\pi\varepsilon_0 r}$$

Q = charge producing the field.



potential inside sphere is same as potential at surface of sphere.
∴ it behaves as a point charge.

Electric potential - distance graph.



positive charge = positive potential

* intensity graph is steeper than potential graph.

negative charge = negative potential

Q-4) Electric potential energy / work done.

> Moving a two charges towards each other

* Attractive (unlike charges) = work got out. (decreases)
* Repulsive (like charges) = work got in. (increases).

$W = QV$ $\quad (qV)$

V = electric potential.
Q = test charge.

OR

$W = \frac{Qq}{4\pi\varepsilon_0 r}$

* Electric potential energy is the energy possessed by a charge q placed in an electric field produced by a charge Q.

Q-5) Compare electric and gravitational fields.

> Similarities:

- Radial field lines
- Both obey inverse square law
  - ie $F \propto 1/r^2$

> Differences:

- gravitational = only attractive
- electric = both attractive and repulsive

- gravitational arise due to masses of object
- electric arise due to charges of objects.