Electric Fields

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Electric fields very similar to gravitational fields except attractive & repulsive.

$$F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$$

$$\boxed{\text{sometimes } \frac{1}{4\pi\varepsilon_0} = k}$$

$$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{Fm^{-1}}$$

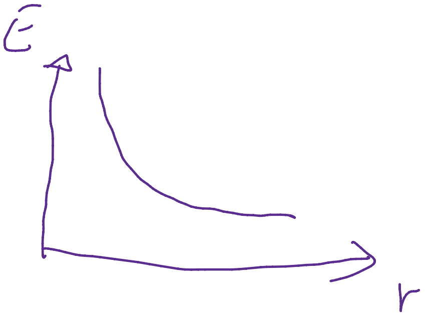
Again there one radial & constant fields.
Force between two charges that are point like

Electric Field strength

Force per unit charge -> the test charge = +1C. So effectively in the Force equation Q2 has been set to +1C.

$E = \frac{F}{Q}$ in N/C Like g, E is a vector

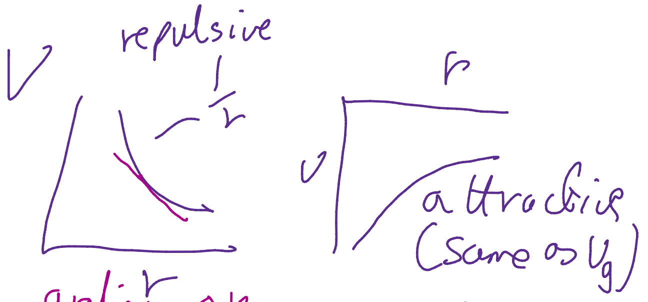
we can therefore say $E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$ where Q is the charge whose field ~~the~~ test charge is sitting in. This is another inverse square. $E \propto \frac{1}{r^2}$



Electric field strength in a uniform field

Often produced by two parallel plates connected to a pd - so lines

$E = \frac{V}{d}$ ← voltage V/m or N/C



Electric Potential (absolute potential) V

Potential energy - the potential energy per unit positive charge (that test charge again)

$$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

Sign depends on the sign of Q - the test charge is always positive
Like Vg this is the energy to move out to infinity.

gradient $\frac{\Delta V}{\Delta r}$ = field strength E

Electric Potential Energy

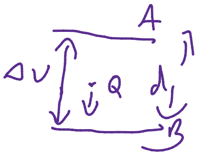
This is V x the second charge. So its the energy to move a charge which doesn't happen to be exactly +1C

Electric Potential Difference

Work done in moving a charge between two potentials

$$\Delta W = Q\Delta V$$

Proving Uniform Field Strength



$E = \frac{F}{Q}$ … ①

moving A → B work done = Force × distance

$\Delta W = Fd$

Also $\Delta W = Q\Delta V$ ∴ $Q\Delta V = Fd$ … ②

$\Rightarrow F = Q\frac{\Delta V}{d}$

from ① $EQ = F$

∴ $E\cancel{Q} = \cancel{Q}\underline{\Delta V}$

ΔV = p.d across plates = V

from ① $EQ = F$

∴ $E\cancel{Q} = \cancel{Q}\frac{\Delta V}{d}$ $\Delta V =$ a p.d across plate $= V$

∴ $E = \frac{V}{d}$

Equipotentials

For a point sphere equipotentials are spherical surfaces - you use on energy moving along a equipotential. For parallel plates they are straight lines.

Be aware of these diagrams