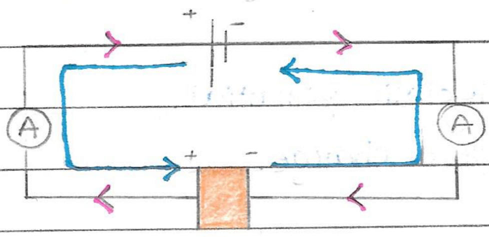
24 - Capacitance

Q-1) What is a capacitor?

> A capacitor stores electrostatic energy (charge)



e⁻ flow

conventional current.

dielectric medium (insulator)

The negative terminal of the power supply pushes electrons onto one plate, making it negatively charged. Electrons are repelled from the other plate, making it positively charged. The capacitor is fully charged when the two plates have equal and opposite charges, and the two ammeters give the same reading. To discharge the capacitor, connect it's two leads together, and the electrons would flow back.

$$k = \frac{\varepsilon}{\varepsilon_0}$$

ε = permitivity of medium

ε_0 = permitivity of free space

k = di-electric constant / relative permitivity.

Q-2) Why do capacitors store energy, and not charge?

> When charging a capacitor, work is done to move electrons from one plate, and push them onto the other plate. The electrons that are deposited onto the other plate repel the further incoming electrons, so work has to be done. So the electrons have energy, ∴ energy is stored on a capaction.

The net charge on the two plates would be zero since they are equal and opposite, ∴ energy is stored.

Q-3) Uses of capacitors :

- blocking DC
- Smoothing the output of a rectifier
- time delay in electronic circuits
- tuning circuits in radio receivers.
- Store energy in electric circuits.

Q-4) What is capacitance?

> Capacitance is the charge per unit potential difference.

OR

Capacitance is the ratio of charge on a conductor (capacitor) to the potential of a conductor (potential difference of a capacitor).

$$C = \frac{Q}{V}$$

unit = Farad.

$1F = \frac{1C}{1V}$ when a charge of 1C increases the potential (p.d) by 1V, then the capacitance is 1F.

Parallel plate capacitor :

$$C = \frac{A \varepsilon_0 k}{d}$$

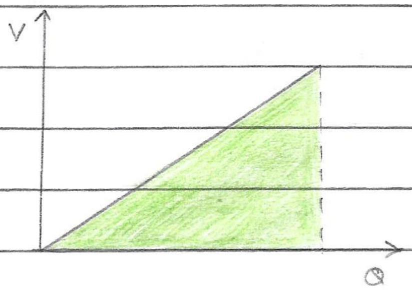
A = area of plates

k = dielectric constant

d = seperation of plates.

Q-5) Calculating work done/energy stored in a capacitor.

$$W = \tfrac{1}{2} QV$$
$$= \tfrac{1}{2} CV^2$$
$$= \tfrac{1}{2} \frac{Q^2}{C}$$



work done = area under V-Q graph.

Q-6) Capacitors in series and parallel.

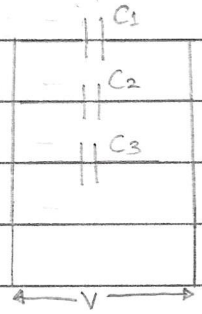
Parallel.

V is the same accross C_1, C_2 & C_3.

$Q = VC$

$CV = C_1V + C_2V + C_3V$

$C = C_1 + C_2 + C_3$.



In parallel, capacitance adds up.

Series.

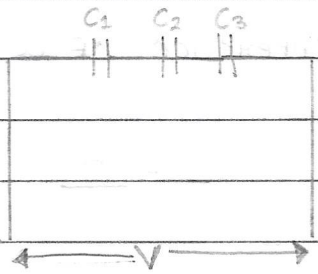
Q is the same accross C_1, C_2 & C_3.

$V = V_1 + V_2 + V_3$

$V = Q/C$

$$\frac{Q}{C} = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}.$$

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}.$$



In series, capacitance reduces.

Q-7) Capacitance of a sphere

> $C = \frac{Q}{V}$

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

$\therefore C = Q \div \frac{Q}{4\pi \varepsilon_0 r}.$

$\therefore C = 4\pi \varepsilon_0 r.$