LAKSHYA JEE

LAKSHYA KO HAR HAAL ME PAANA HAI

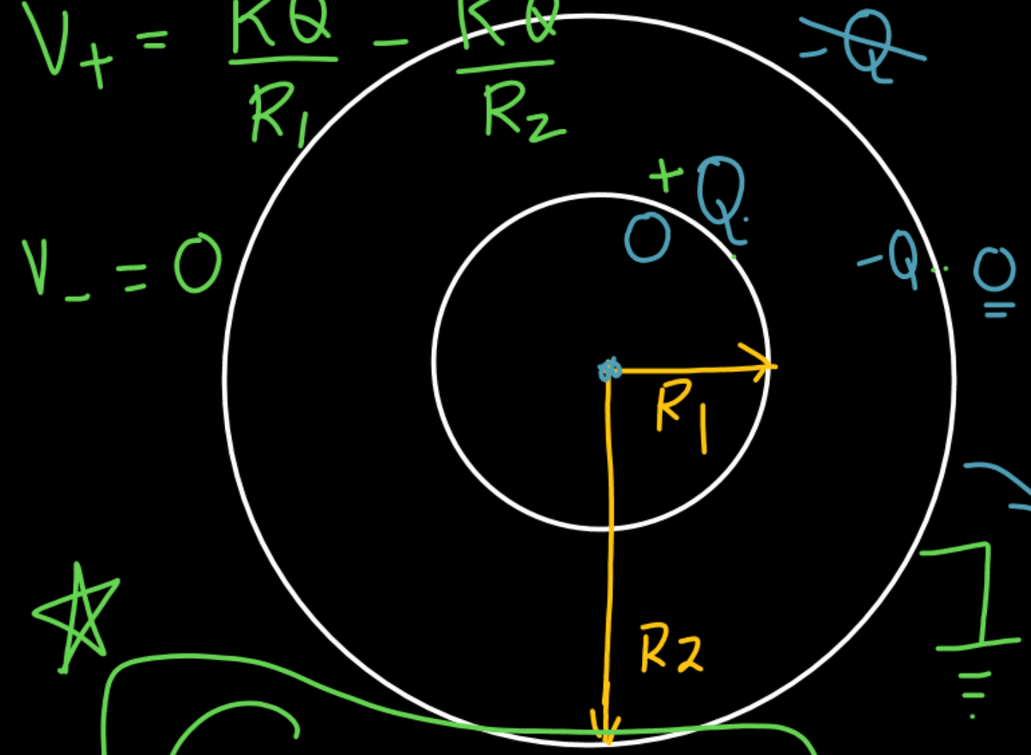
Electric Potential & Capacitance

-Er. Rohit Gupta

Today's GOALS!

Capacitors

Spherical capacitors



$V_+ = \frac{KQ}{R_1} - \frac{KQ}{R_2}$ $\quad -Q$

$V_- = 0$

$V_+ = KQ\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$E = 0$ $\quad V_- = 0$

$V = 0$

$\Delta V = V_+ - V_-$

$\Delta V = KQ\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

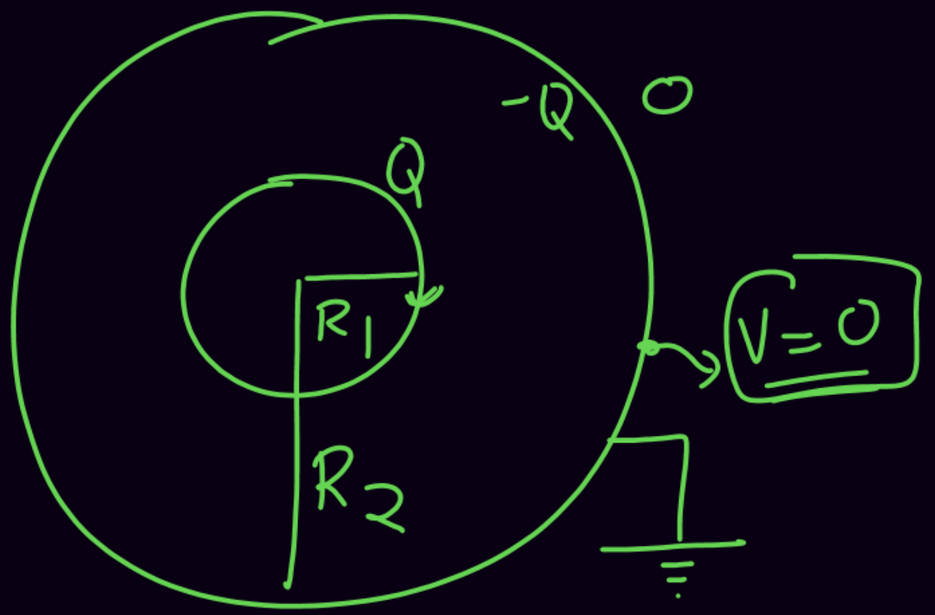
$C = \frac{Q}{\Delta V} = \frac{Q}{KQ\left(\frac{1}{R_1} - \frac{1}{R_2}\right)} = \frac{R_1 R_2}{K(R_2 - R_1)}$

$C = \frac{4\pi\varepsilon_0 R_1 R_2}{R_2 - R_1}$

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

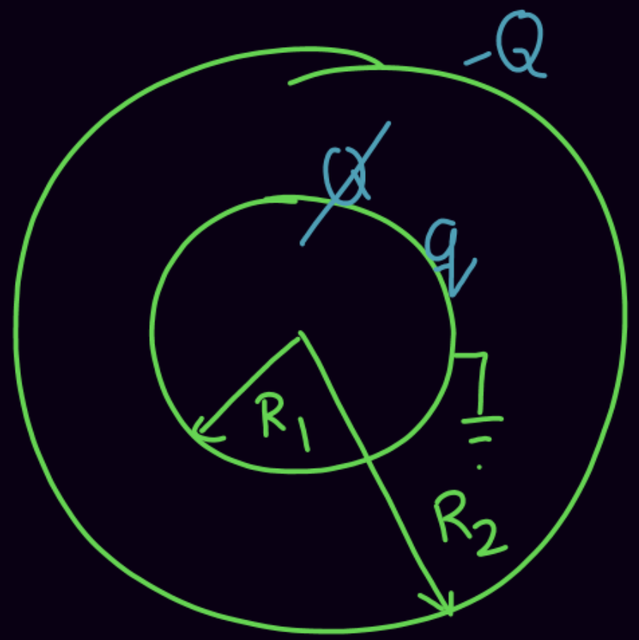
$$\Delta V = V_+ - V_- = \frac{Q}{C}$$

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



$$V_+ = \frac{KQ}{R_1} - \frac{KQ}{R_2}$$

$$V_- = 0$$



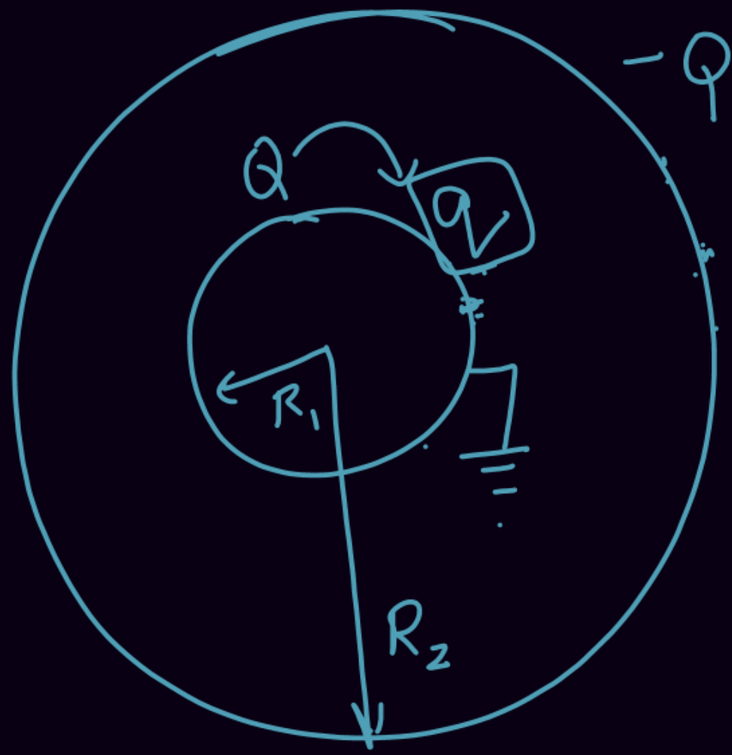
$$C = \frac{Q}{\Delta V} = C/V = \frac{C^2}{U}$$

$$= \frac{it}{\frac{W}{Q}} = \frac{i^2 t^2}{W}$$

$$= \frac{i^2 t^2}{F \cdot d} \Rightarrow [C] = \left[\frac{A^2 T^2}{M L T^{-2} L}\right]$$

$$[C] = [M^{-1} L^{-2} T^4 A^2]$$

Unit $\Rightarrow \frac{\text{Farad.}}{Kg^{-1} m^{-2} s^4 A^2}$



$$V_{R_1} = \frac{Kq}{R_1} - \frac{KQ}{R_2} = 0$$

$$q = \frac{R_1 Q}{R_2}$$

$$V_{R_2} = \frac{Kq}{R_2} - \frac{KQ}{R_2}$$

$$= \frac{K}{R_2}\left[\frac{R_1 Q}{R_2} - Q\right] = \frac{KQ}{R_2}\left(\frac{R_1 - R_2}{R_2}\right)$$

$$\Delta V = V_{R_1} - V_{R_2}$$

$$= 0 - V_2$$

$$= -V_2$$

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

$$= \frac{Q}{-V_2}$$

$$= \frac{Q}{-\left(\frac{KQ(R_1 - R_2)}{R_2^2}\right)}$$

$$\boxed{C = \frac{4\pi\varepsilon_0 R_2^2}{R_2 - R_1}}$$

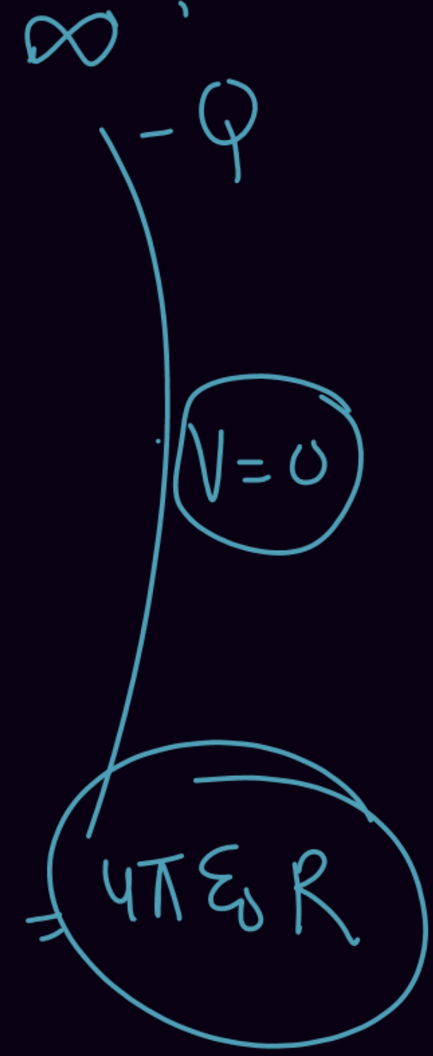
Isolated sphere

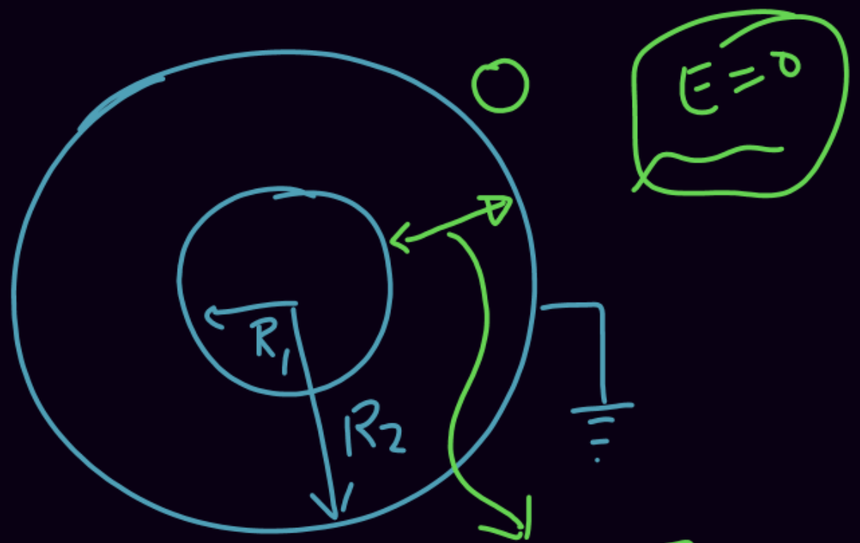
$$V_R = \frac{KQ}{R}$$

$$\Delta V = V_R - V_\infty$$

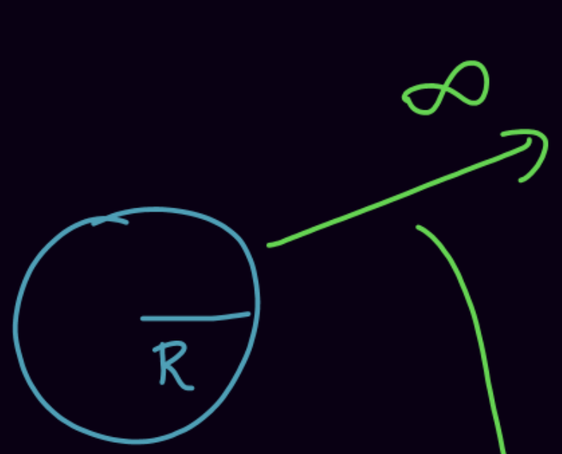
$$\Delta V = \frac{KQ}{R} - 0$$

$$C = \frac{Q}{\Delta V} = \frac{Q}{\frac{KQ}{R}} = \frac{R}{K} = 4\pi\varepsilon_0 R$$



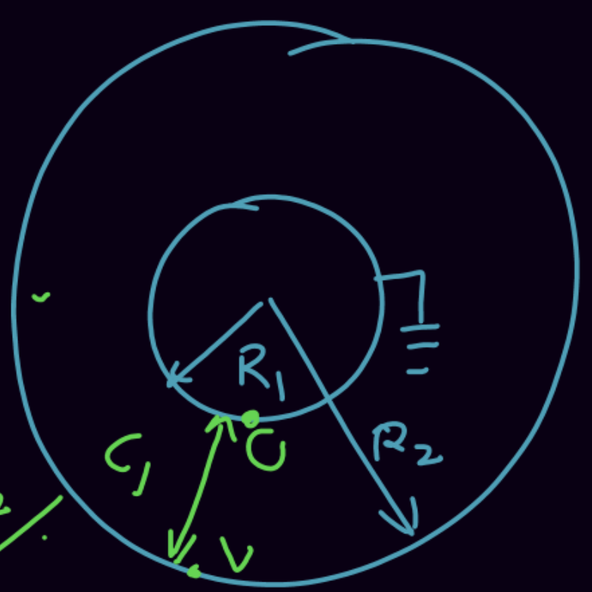


$$C = \frac{4\pi\varepsilon_0 R_1 R_2}{R_2 - R_1} \Rightarrow$$



$$C = \frac{4\pi\varepsilon_0 R_1}{1 - \frac{R_1}{R_2}}$$

$$C = \frac{4\pi\varepsilon_0 R}{1 - \left(\frac{R}{\infty}\right)} = 4\pi\varepsilon_0 R$$



$$C = \frac{4\pi\varepsilon_0 R_2^2}{R_2 - R_1}$$

Parallel

$$C_{eq} = C_1 + C_2$$

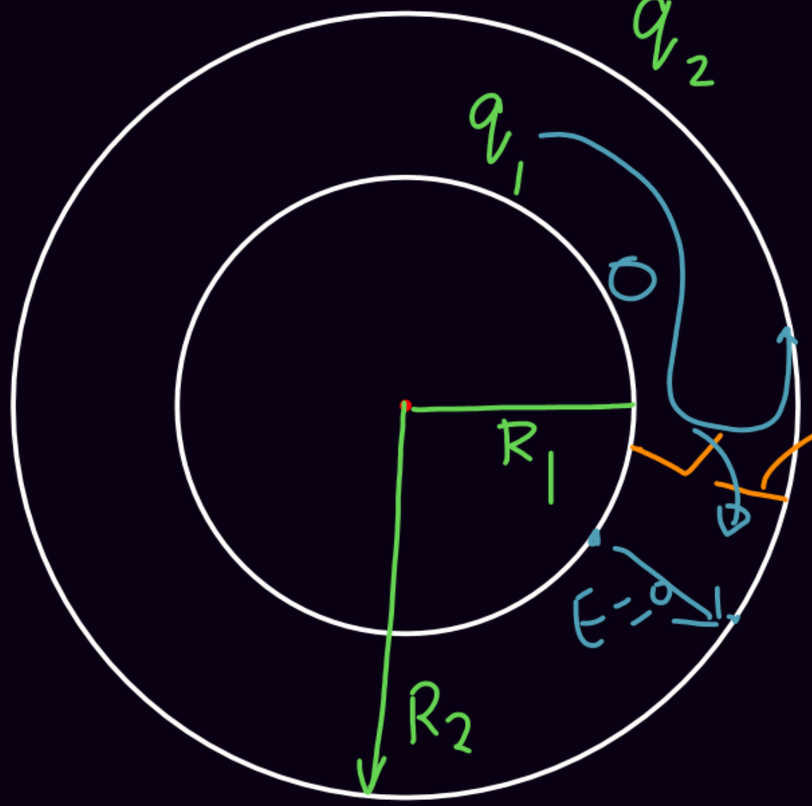
$$C_{eq} = C_1 + C_2$$

$$= \frac{4\pi\varepsilon_0 R_1 R_2}{R_2 - R_1} + 4\pi\varepsilon_0 R_2$$

$$= 4\pi\varepsilon_0 R_2 \left(\frac{R_1}{R_2 - R_1} + 1 \right)$$

$$= 4\pi\varepsilon_0 R_2 \left(\frac{R_1 + R_2 - R_1}{R_2 - R_1} \right)$$

$$\boxed{C_{eq} = \frac{4\pi\varepsilon_0 R_2^2}{R_2 - R_1}}$$

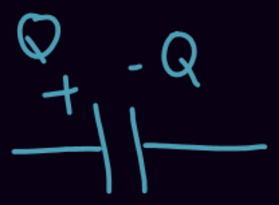


Conducting wire.

Find the charges on inner & outer spheres after the switch is closed.

In the dir. of field potential decreases.

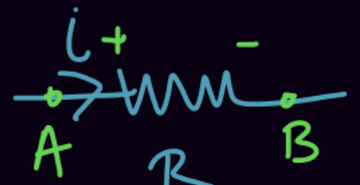
Series Combination



C

$\leftarrow \Delta V \rightarrow$

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



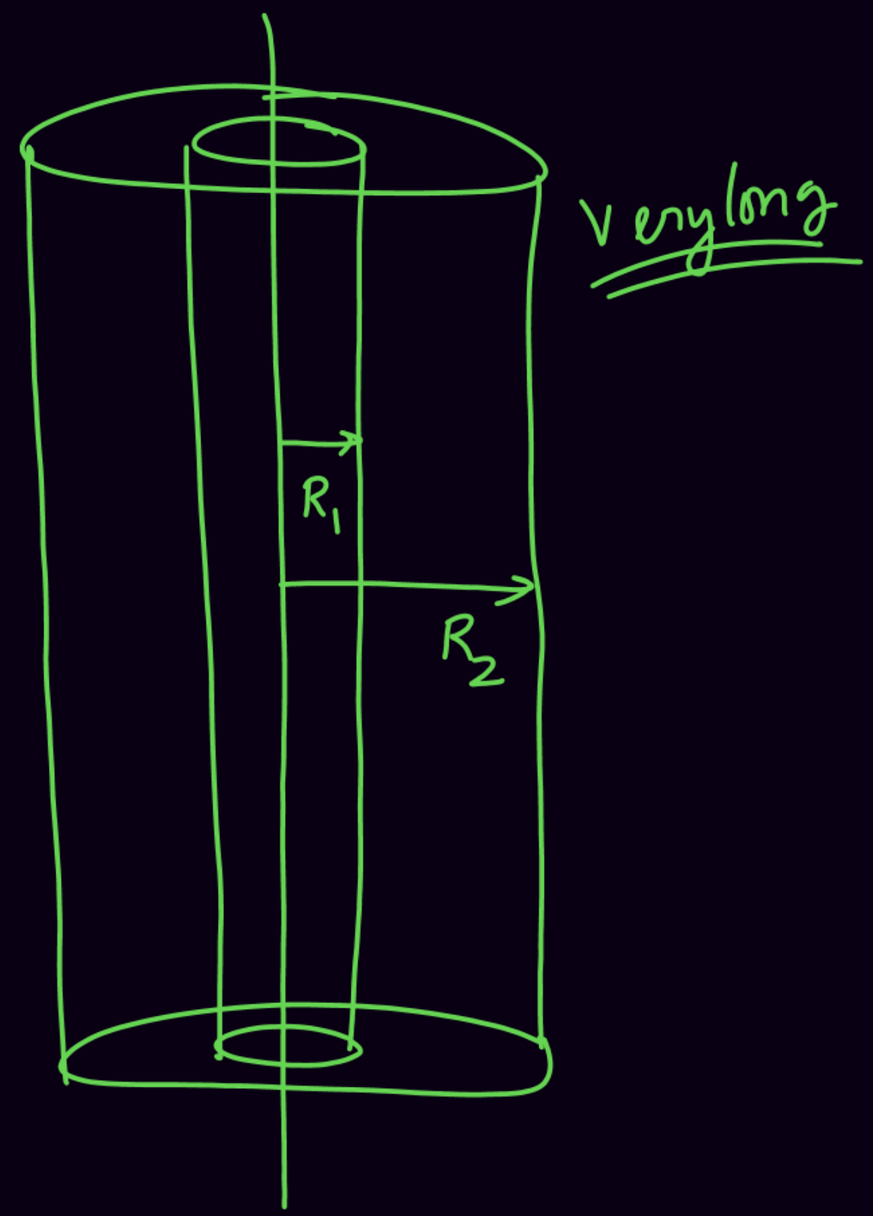
$V_A > V_B$

$V_A - V_B = iR$ ohm's law

H.W:

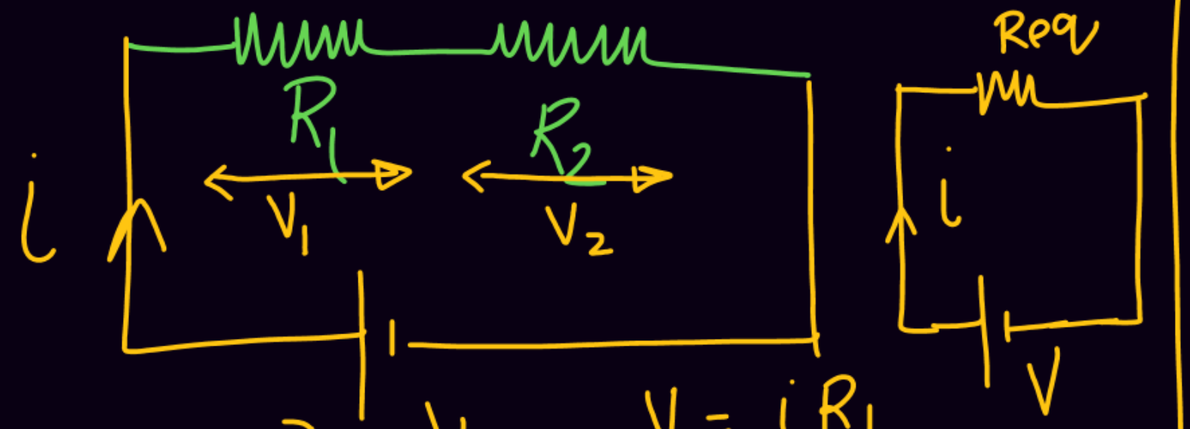
Very long

Find C



Series Combination

Same Current –



$V_1 = iR_1$

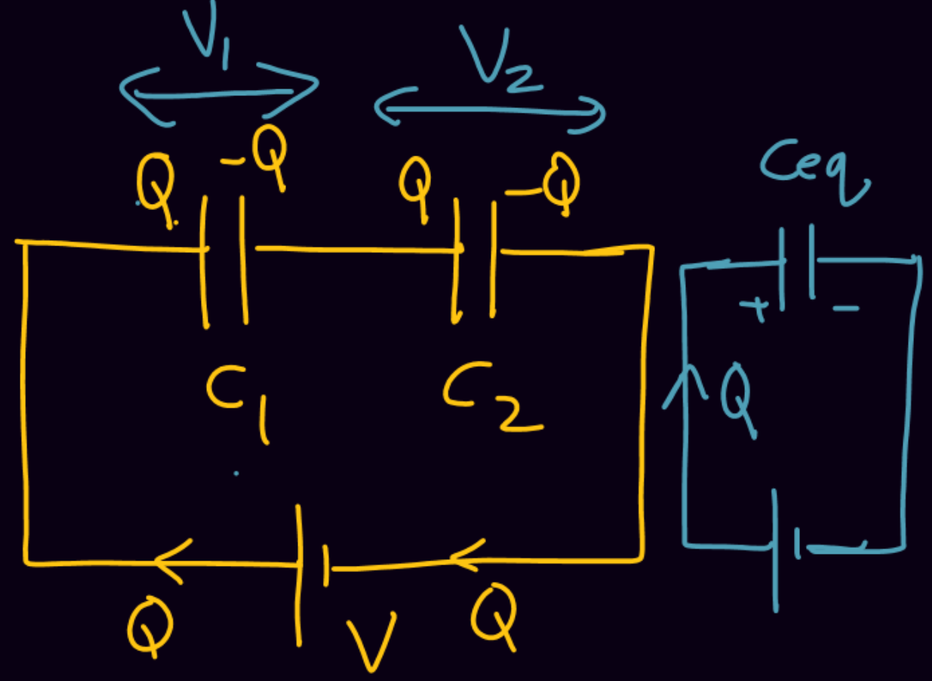
$V_2 = iR_2$

$V = iR_{eq}$

$V_1 + V_2 = iR_{eq}$

$iR_1 + iR_2 = iR_{eq}$ *i

$R_{eq} = R_1 + R_2$



$V_1 = \frac{Q}{C_1}$

$V_2 = \frac{Q}{C_2}$

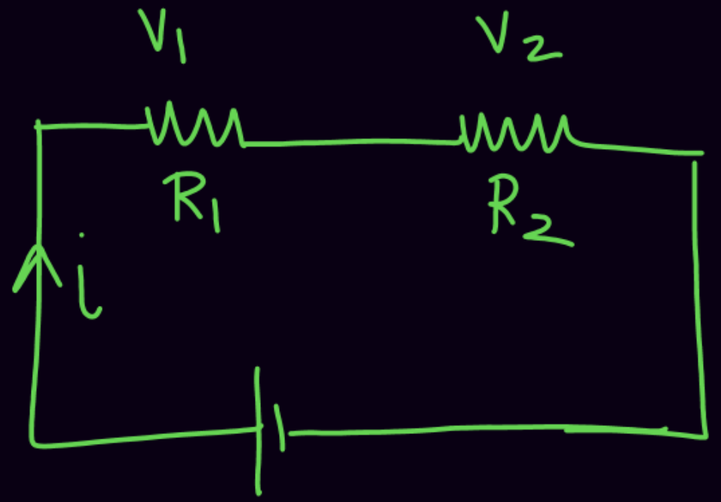
$V = \frac{Q}{C_{eq}}$

$V = V_1 + V_2$

$\frac{Q}{C_{eq}} = \frac{Q}{C_1} + \frac{Q}{C_2}$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

Series combination is potential divider



$$V_1 = iR_1$$

$$V_2 = iR_2$$

$$\frac{V_1}{V_2} = \frac{R_1}{R_2} \quad (1)$$

$$V = V_1 + V_2 \quad (2)$$

$$\frac{V_1}{V_2} + 1 = \frac{R_1}{R_2} + 1$$

$$\frac{V_1 + V_2}{V_2} = \frac{R_1 + R_2}{R_2}$$

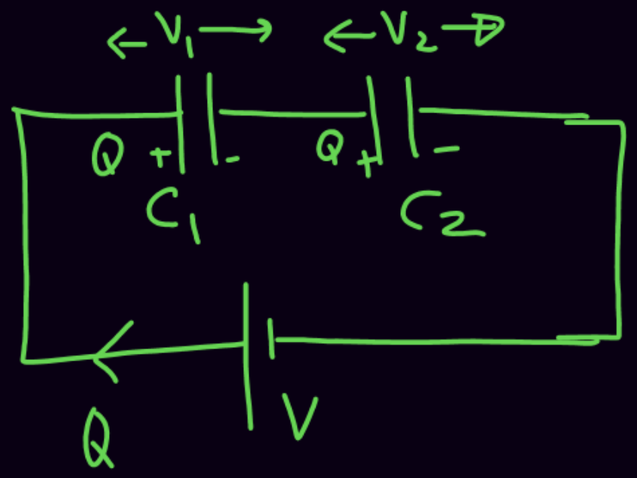
$$\frac{V}{V_2} = \frac{R_1 + R_2}{R_2}$$

$$V_2 = \frac{R_2 V}{R_1 + R_2}$$

$$V_1 = \frac{R_1 V}{R_1 + R_2}$$

$$V_1 = \frac{R_1 V}{R_1 + R_2} \qquad \frac{V_1}{V_2} = \frac{R_1}{R_2}$$

$$V_2 = \frac{R_2 V}{R_1 + R_2}$$



$$V_1 = \frac{Q}{C_1}$$

$$V_2 = \frac{Q}{C_2}$$

$$\frac{V_1}{V_2} = \frac{C_2}{C_1}$$

$$V_1 + V_2 = V$$

$$V_2\left(\frac{V_1}{V_2} + 1\right) = V$$

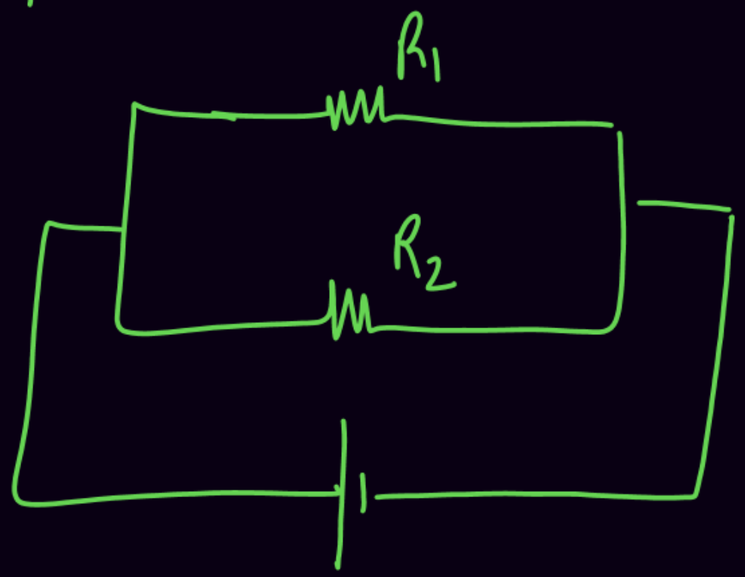
$$V_2\left(\frac{C_2}{C_1} + 1\right) = V$$

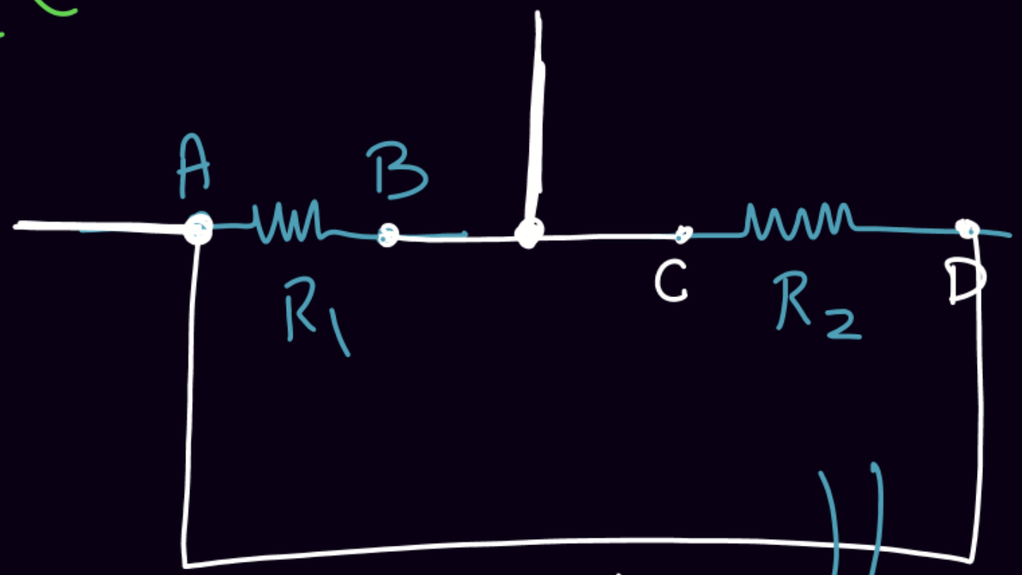
$$V_2\left(\frac{C_1 + C_2}{C_1}\right) = V$$

$$V_2 = \frac{C_1 V}{C_1 + C_2} \quad *$$

$$V_1 = \frac{C_2 V}{C_1 + C_2} \quad *$$

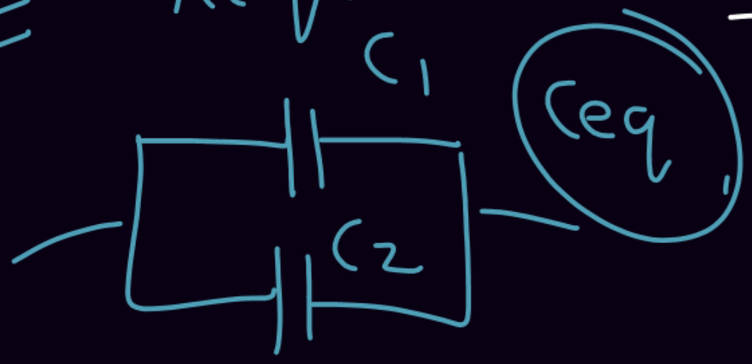
Parallel Combination (Same potential drop)

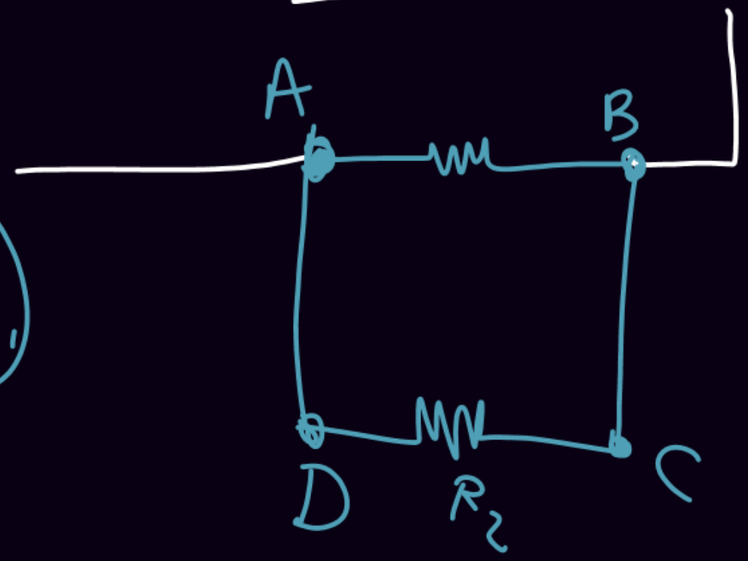




M.N.

Req.





Thank You Lakshyians