Revision Booster WORKSHOP for NEET & JEE Main

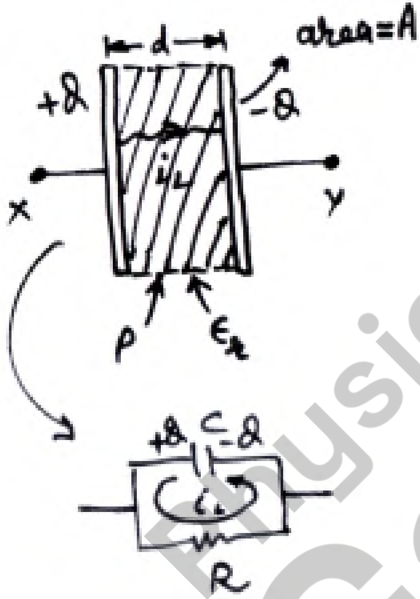
Current & Capacitance

Notes of Revision Booster Workshop for JEE Main & NEET

9000+ Classes available on PHYSICS GALAXY Mobile app

Questions Based on

Discharge in a Leaky Capacitor



$$R_{xy} = \frac{\rho d}{A}$$

$$C_{xy} = \frac{\epsilon_0 \epsilon_r A}{d}$$

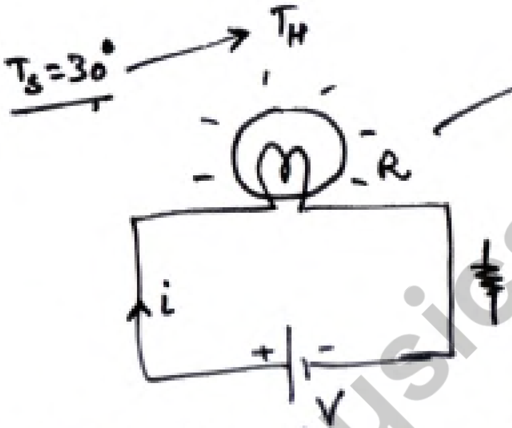
Parallel

$$i_L = \frac{Q}{RC} e^{-t/RC}$$

time constant $\tau = RC = \rho \epsilon_0 \epsilon_r$

QUESTIONS BASED ON

VARYING RESISTANCE OF A BULT



$$R_H = R(1+\alpha\Delta T)$$

$$i = \frac{V}{R}$$

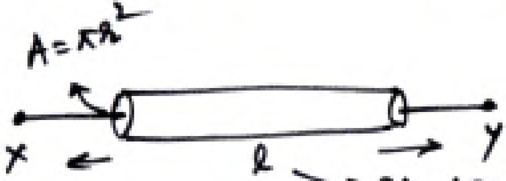
$$\frac{5R}{4} = R(1+\alpha\Delta T)$$

$$\Delta T = \text{——}$$

find temp of bulb when $i \rightarrow \frac{4i}{5} \Rightarrow R \rightarrow \frac{5R}{4}$

Questions Based on

Variation in Resistance by Deformation



$l \to 3l/2$ (50% increase)

V → Const

$V = lA$ → $3l/2$, $\frac{2A}{3}$

$$R_{xy} = \frac{\rho l}{A}$$

new resistance $R_{new} = \frac{\rho(3l/2)}{2A/3} = \frac{9}{4} R_{xy} = 2.25 R_{xy}$

125% increase in resistance.

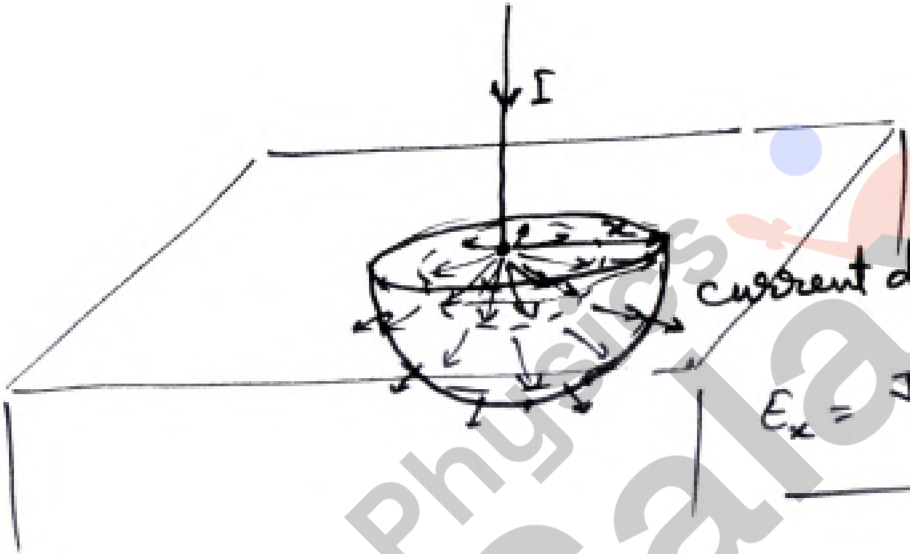
If temp is inc by ΔT

if $\rho \to$ constant

$$R_{new} = \frac{\rho l(1+\alpha\Delta T)}{A(1+2\alpha\Delta T)} = R(1-\alpha\Delta T)$$

Questions Based on

Electric Current Spreading in Volume



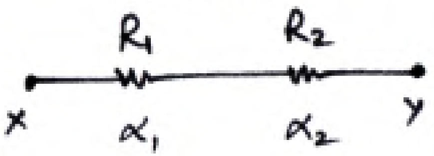
current density $J = \frac{I}{2\pi x^2}$

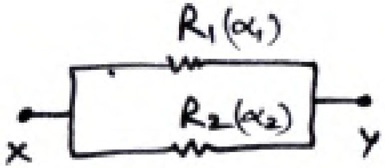
$$E_x = J \cdot \rho = \frac{\rho I}{2\pi x^2}$$

Questions Based on

Equivalent Temperature Coefficient of Resistance

Series





$\Delta T \uparrow$

$R_1 + R_2$ (α_s)

$$(R_1+R_2)_f = R_1(1+\alpha_1\Delta T) + R_2(1+\alpha_2\Delta T)$$

$$(R_1+R_2)(1+\alpha_s\Delta T) = R_1 + R_2 + R_1\alpha_1\Delta T + R_2\alpha_2\Delta T$$

$$\alpha_s = \underline{\qquad}$$

$\dfrac{R_1R_2}{R_1+R_2}$ (α_p)

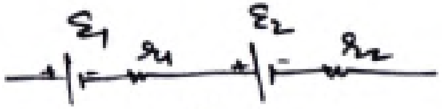
$$\left(\frac{R_1R_2}{R_1+R_2}\right)(1+\alpha_p\Delta T) = \underline{\qquad}$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1(1+\alpha_1\Delta T)} + \frac{1}{R_2(1+\alpha_2\Delta T)}$$

$$\alpha_p = \underline{\qquad}$$

Questions Based on

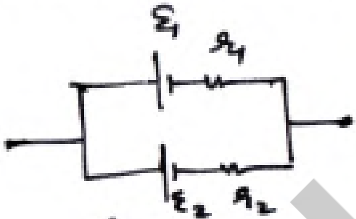
Circuit Solving Using Call Combinations



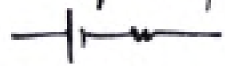
$\equiv$

$r_1 + r_2 = r_{eq}$

$\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2$



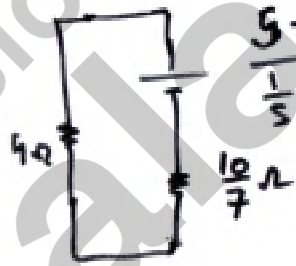
$=$



$r_{eq} = r_1 r_2 / r_1 + r_2$

$$\varepsilon_{eq} = \left(\frac{\varepsilon_1/r_1 + \varepsilon_2/r_2}{1/r_1 + 1/r_2}\right)$$

Ex: $I_{4\Omega} = ?$



$$\frac{5-4}{\frac{1}{5}+\frac{1}{2}} = \varepsilon_{eq} = \frac{10}{7}\text{ V}$$

$$I = \frac{10/7}{4 + 10/7}\text{ A Ans}$$

Questions Based on

Fusing of a Bulb in Circuit

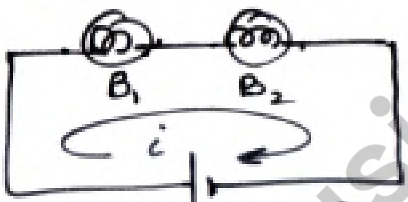
↓

200V, 100W

V_B P_B ⟶ $R_B = \frac{V^2}{P}$

Ex:

200V, 100W 100V, 20W



$V_{max} = ?$

$R_1 = \frac{(200)^2}{100} = 400\,\Omega$

$R_2 = \frac{(100)^2}{20} = 500\,\Omega$

$i = \frac{V_m}{900}$

$V_1 = \frac{V_m}{900} \times 400 \leq 200 \longrightarrow V_m = -$

$V_2 = \frac{V_m}{900} \times 500 \leq 100 \longrightarrow V_m = --$

Questions Based on

Heating Coils Combination

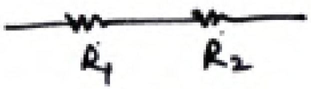
$t_1 \rightarrow$ water boil $\leftarrow t_2$

$i^2 R_1 t_1 = H = i^2 R_2 t_2$ —①

$\frac{V^2}{R_1} t_1 = \frac{V^2}{R_2} t_2 = H$

Case I → i Const

Case II → V Const



$\left(\frac{V^2}{R_1+R_2}\right) t = H$

$i^2 (R_1+R_2) t = H$

$\left(\frac{V^2}{\frac{V^2 t_1}{H} + \frac{V^2 t_2}{H}}\right) = \frac{H}{t}$

$\frac{H}{t_1} + \frac{H}{t_2} = \frac{H}{t}$

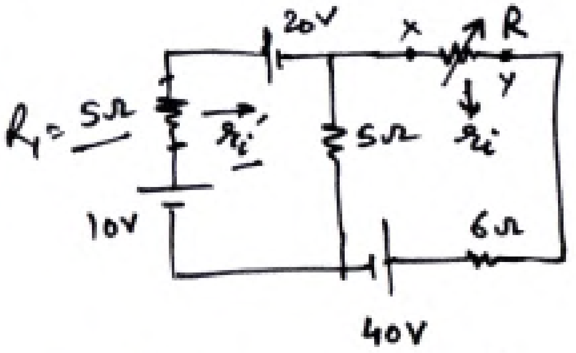
$\frac{H}{t_1+t_2} = \frac{H}{t}$

$t_s = \frac{t_1 t_2}{t_1+t_2}$

$t = t_1 + t_2$

Questions Based on

Maximum Power in a Circuit



for max power in a "variable resistance"

$$R_v = r_i$$

$$R_v = 6 + 2.5 = 8.5\,\Omega.$$

if Power in R_1 is to be maximised.

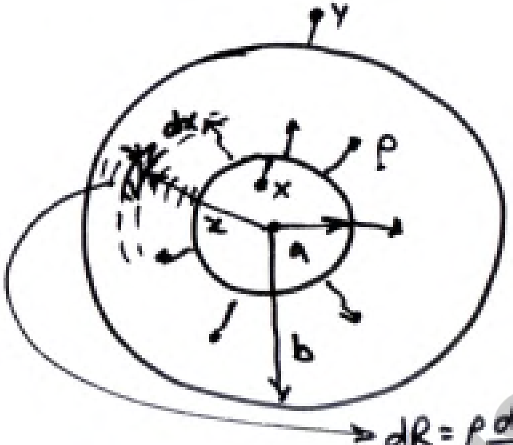
then r_i' is to be minimised.

$$r_i = \frac{5(6+R)}{5+(6+R)}$$

$$\left(\frac{1}{r_i}\right) = \frac{1}{5} + \frac{1}{6+R} \rightarrow \boxed{0} \text{ Ans}$$

QUESTIONS BASED ON

CURRENT DENSITY IN SPHERICAL OR CYLINDRICAL CONDUCTORS



$$dR = \frac{\rho\, dx}{4\pi x^2}$$

$V_x > V_y$

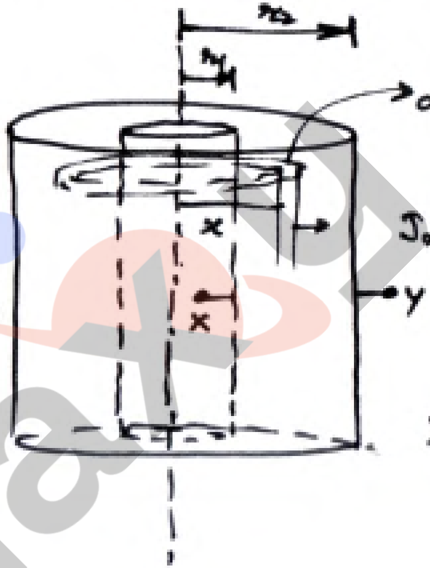
$$I = \frac{V_x - V_y}{R}$$

$$R = \int dR = \frac{\rho}{4\pi}\int_a^b \frac{dx}{x^2}$$

$$R = \frac{\rho}{4\pi}\left[\frac{1}{a} - \frac{1}{b}\right]$$

$$J_x = \frac{I}{4\pi x^2} \quad A/m^2$$

$$E_x = \rho J_x$$



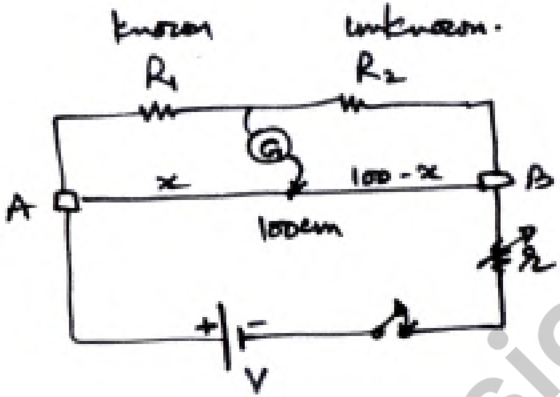
$$dR = \frac{\rho . dx}{2\pi x l}$$

$$J_x = \frac{I}{2\pi x l}$$

$$I = \frac{V_x - V_y}{R}$$

QUESTIONS BASED ON

METER BRIDGE FOR UNKNOWN RESISTANCES



for null pt $\frac{R_1}{x} = \frac{R_2}{100-x}$

$x = $ ——

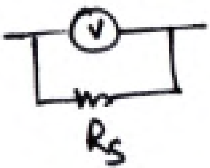
$\frac{R_1}{R_2} = $ ——

Questions Based on

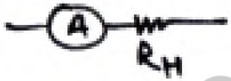
Ammeter Replacing a Voltmeter

$R \rightarrow low$

$R \rightarrow High$



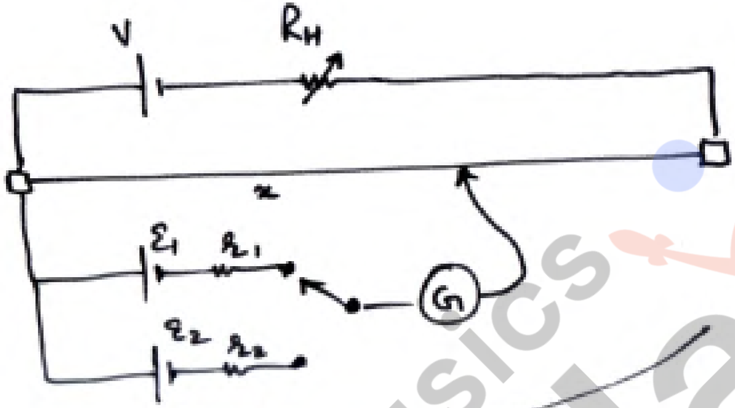
$$R_A = \frac{R_S R_V}{R_S + R_V}$$



$$R_V = R_A + R_H$$

Questions Based on

Cell Comparison in a Potentiometer



potential gradient = λ

$x = l_1$ for $\mathcal{E}_1$

$\Rightarrow \mathcal{E}_1 = \lambda l_1$ — (1)

$x = l_2$ for $\mathcal{E}_2$

$\mathcal{E}_2 = \lambda l_2$ — (2)

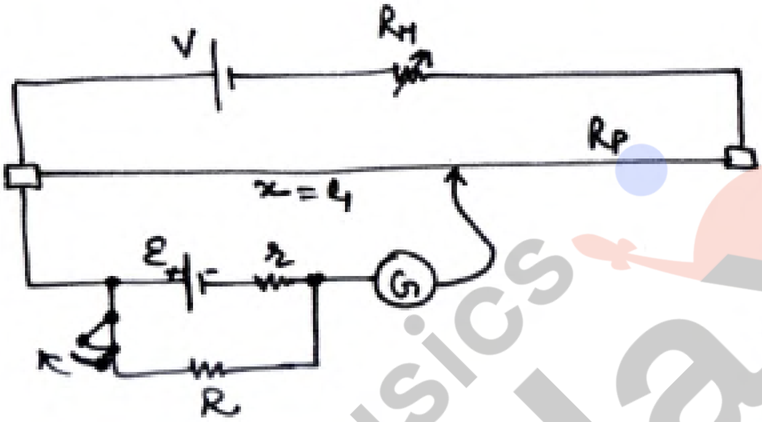
K ✓

$$\left[\frac{\mathcal{E}_1}{\mathcal{E}_2} = \frac{l_1}{l_2}\right]$$

UK

QUESTIONS BASED ON

INTERNAL RESISTANCE BY A POTENTIOMETER



p.g. = λ V/cm

$$\lambda = \frac{V}{R_H + R_P} \cdot \frac{R_P}{L}$$

at $x = l_1$ $\quad \mathcal{E} = \lambda l_1$ — (1)

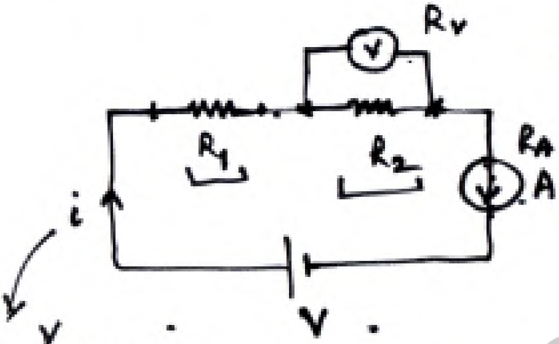
after R is connected

at $x = l_2$ $\quad \mathcal{E} - iR = \lambda l_2$

$$\frac{\mathcal{E}R}{r + R} = \lambda l_2 \quad \text{— (2)}$$

QUESTIONS BASED ON

ERROR IN VOLTMETER OR AMMETER



Error in reading of V = ?

$$i = \frac{V}{R_1 + R_2 + R_A}$$

$$V_{Reading} = i\left(\frac{R_V R_2}{R_V + R_2}\right)$$

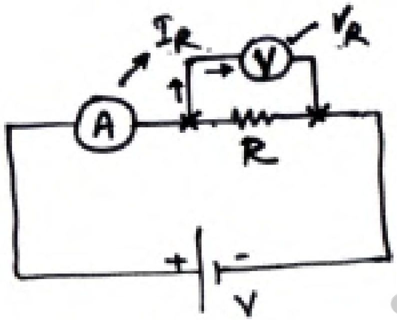
$$= \left(\frac{V}{R_1 + \frac{R_V R_2}{R_V + R_2}}\right)\left(\frac{R_V R_2}{R_V + R_2}\right)$$

In absence of voltmeter ⟵ $V_{actual} = \frac{V}{R_1 + R_2} \cdot R_2$

$$\% \text{ error} = \frac{|V_a - V_R|}{V_a} \times 100\%$$

Questions Based on

Effect on Measured Value of R due to V and A



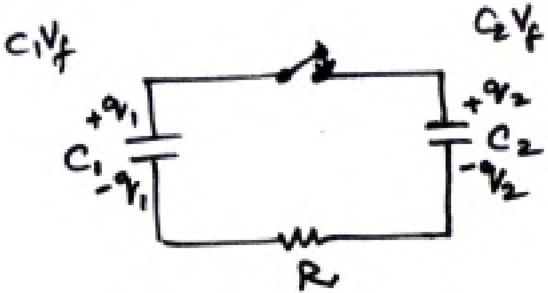
meas value of Resistance

$$\rightarrow R_m = \frac{V_R}{I_R}$$

here $I_R > I_{actual}\, R$ $\Rightarrow$ $R_{meas} < R_{actual}$

QUESTIONS BASED ON

HEAT PRODUCED IN CLOSING THE SWITCH



$$\left[V_f = \frac{q_1+q_2}{C_1+C_2}\right]$$

$$U_i = \frac{q_1^2}{2C_1} + \frac{q_2^2}{2C_2}$$

$$U_f = \frac{1}{2}(C_1+C_2)V_f^2$$

$$H = U_i - U_f$$

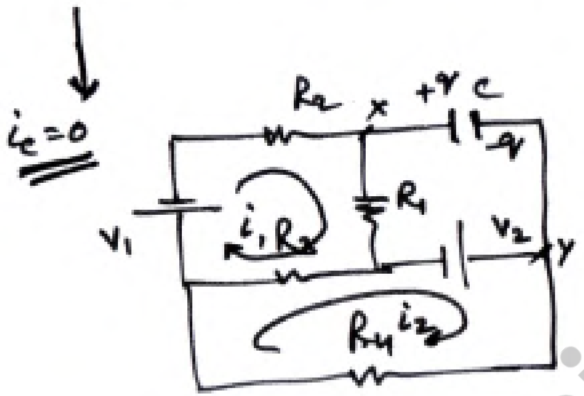
alternative

$$H = \frac{\Delta q_1^2}{2C_1} + \frac{\Delta q_2^2}{2C_2}$$

Questions Based on

Steady State of Capacitor in Electric Circuit

$i_c = 0$

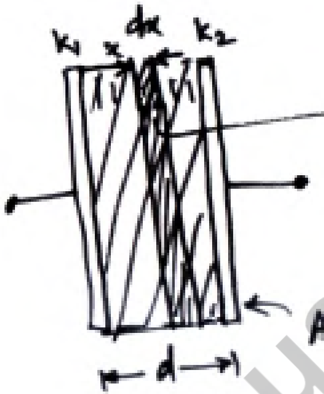


$q = C(V_x - V_y)$

in SS C →

Questions Based on

Dielectric Variation in Capacitors



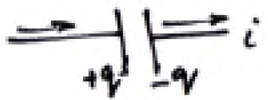
$$k = k_1 + \frac{k_2 - k_1}{d} \cdot x$$

$$dC = \frac{k\epsilon_0 A}{dx}$$

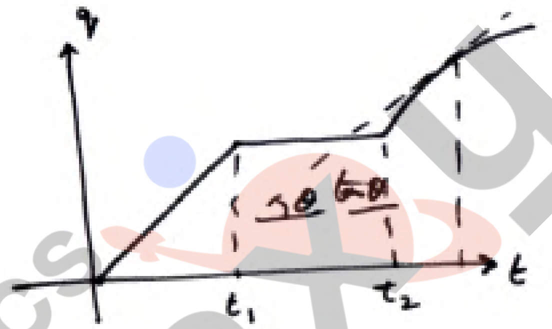
$$\frac{1}{C} = \int \frac{1}{dC} = \int_0^d \frac{dx}{k\epsilon_0 A} = \text{———}$$

Questions Based on

Charge Variation on Plates of a Capacitor



$q = f(t)$



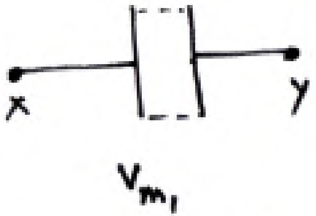
ckt current $i = \frac{dq}{dt}$

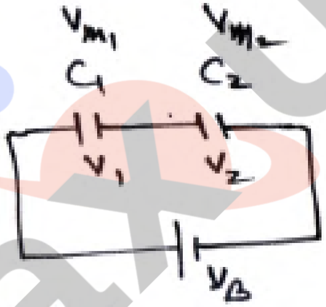
$i \leftarrow$ slope of q vs t curve

QUESTIONS BASED ON

VOLTAGE RATING OF A CAPACITOR

V_{max} ← causes dielectric breakdown.





Q: find V_B max for which both the capacitors will withstand

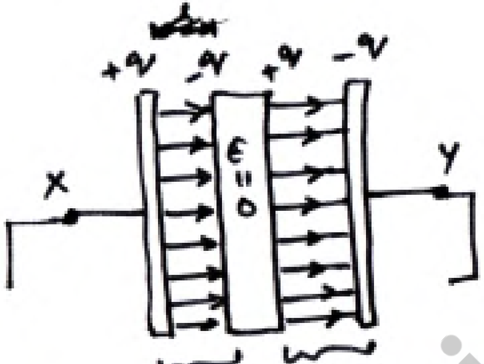
$$\underline{V_{m_1}} = V_1 = \frac{C_2 V_B}{C_1 + C_2} \quad ; \quad V_2 = \frac{C_1 V_B}{C_1 + C_2} = \underline{V_{m_2}}$$

$V_B = \_\_\_\_$ $\qquad$ $V_B = \_\_\_\_$

whichever is less is the max permissible value of $\underline{\underline{V_B}}$.

Questions Based on

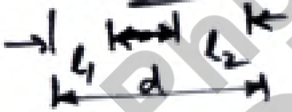
Metal Plate Inserted in a Capacitor



C_1 , $C_2 = \frac{\epsilon_0 A}{l_2}$

$\frac{\epsilon_0 A}{l_1}$ = (for C_1)

Series.

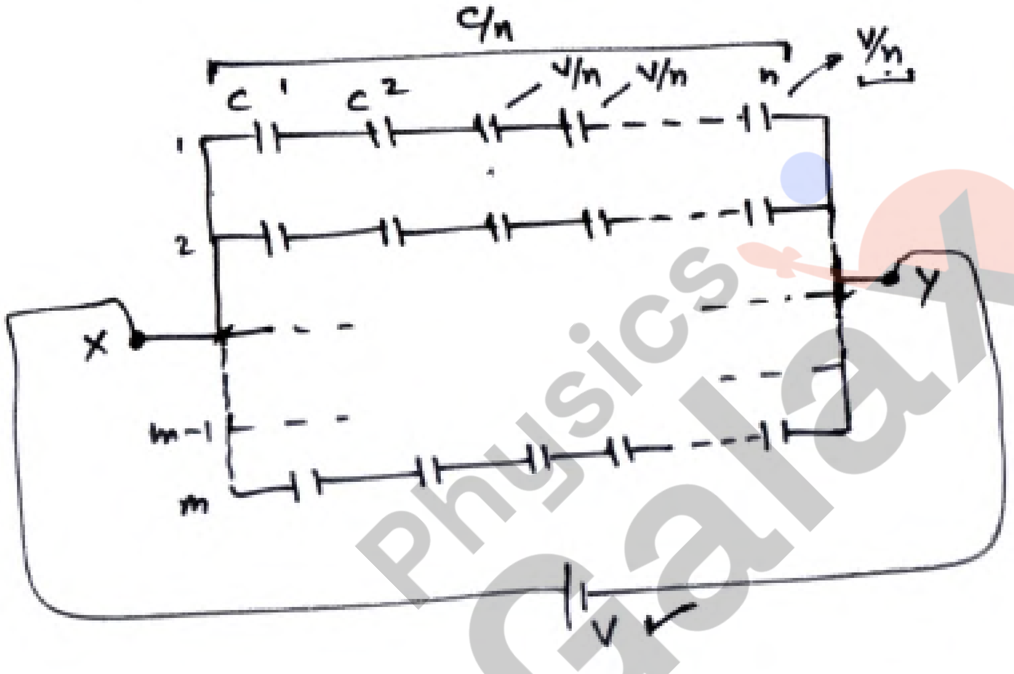


$$C_{xy} = \frac{C_1 C_2}{C_1 + C_2}$$

Original cap $C_i = \frac{\epsilon_0 A}{d}$

Questions Based on

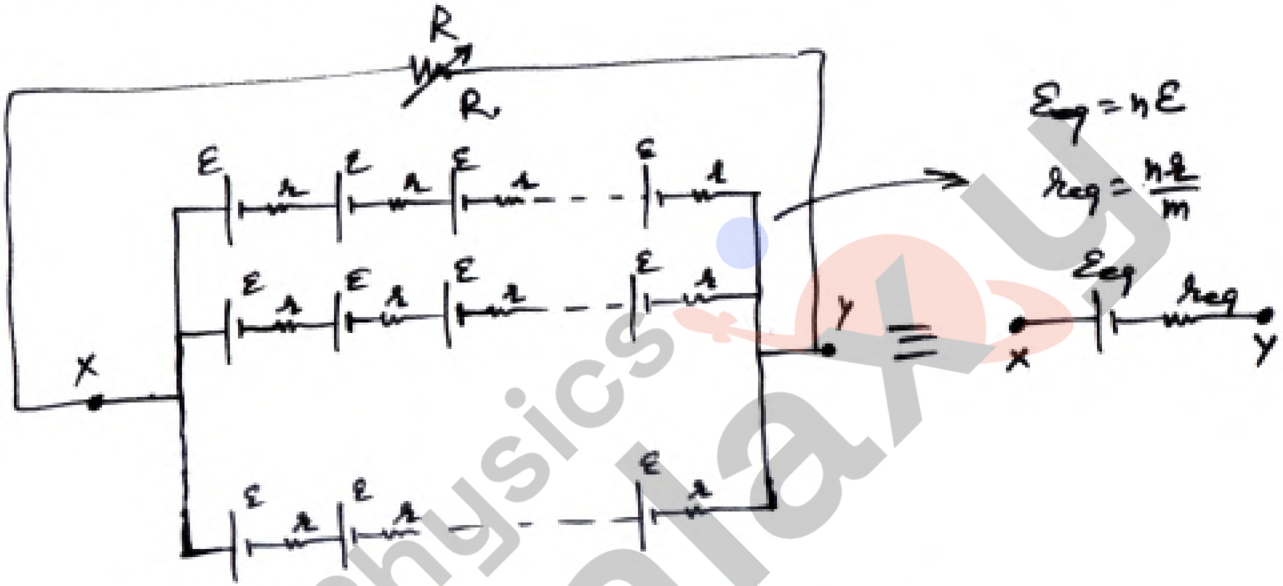
Capacitance Grid



$C_{xy} = \frac{mC}{n}$

Questions Based on

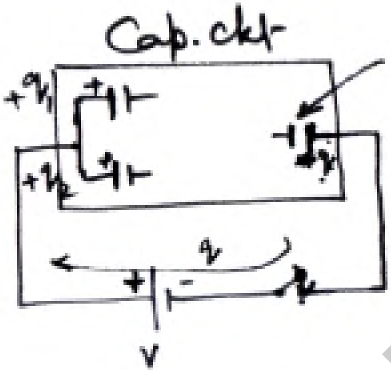
Battery Grid



for max power in R, we use $R = \frac{nr}{m}$.

QUESTIONS BASED ON

WORK DONE BY BATTERY IN CHARGING A CAPACITIVE CIRCUIT



$q = q_1 + q_2$

$|q_1|$ $|q_1 + q_2|$

W/D by battery $W = \Delta q_f \cdot V = \_\_\_$