Nishant Jindal

CURRENT ELECTRICITY

Potentiometer and Meter Bridge

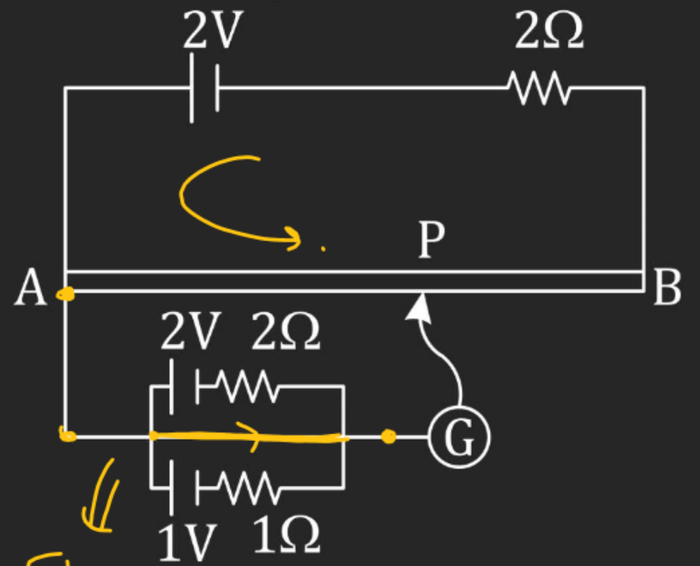
Q.6 A battery of emf $2\ \text{V}$ is connected across a long uniform wire AB of length $1\ \text{m}$ and resistance per unit length $2\Omega\text{m}^{-1}$. Two cells of emf $\varepsilon_1 = 1\ \text{V}$ and $\varepsilon_2 = 2\ \text{V}$ are connected as shown in the fig. If the galvanometer shows no deflection at point P, the distance of point P from point A is equal to :

(A) 0

(B) $50\ \text{cm}$

(C) $100\ \text{cm}$

(D) $25\ \text{cm}$



CURRENT ELECTRICITY

Potentiometer and Meter Bridge

Q.7 A battery of emf $\varepsilon_0 = 12\ \text{V}$ is connected across a $4\ \text{m}$ long uniform wire having resistance $4\Omega/\text{m}$. The cells of small emfs $\varepsilon_1 = 2\ \text{V}$ and $\varepsilon_2 = 4\ \text{V}$ having internal resistance 2Ω and 6Ω respectively, are connected as shown in the figure. If galvanometer shows no deflection at the point N, the distance of point N from the point A is equal to :

(A) $\frac{1}{6}$ m

(B) $\frac{1}{3}$ m3

(C) 25 cm

(D) 50 cm

$R_{AB} = (4\times4) = 16\Omega$

$i = \frac{12}{16+8} = \frac{12}{24}$

$i = \frac{1}{2}$ Amp.

$V_{AN} = \frac{1}{2}\times R_{AN}$

$= \frac{1}{2}\times 4\times l_{AN} = (2l_{AN})$

At the time of Null deflection $\Rightarrow V_{AN} = V_C - V_D$

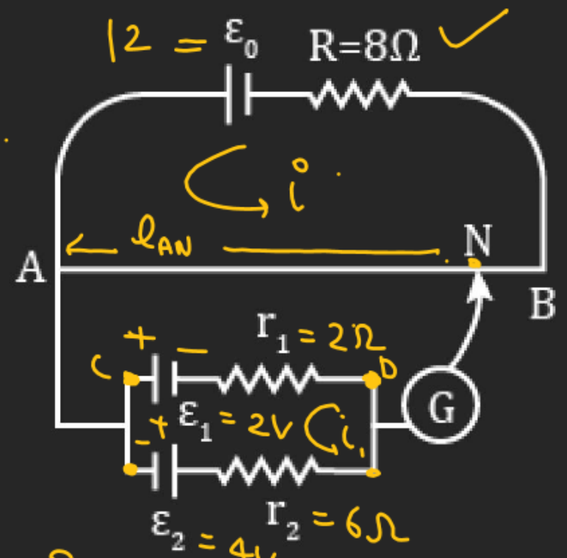
$\Rightarrow 2l_{AN} = \frac{1}{2}$

$\frac{R_{AB}}{L_{AB}} = 4\Omega/\text{m}$, $L_{AB} = 4\text{m}$.

$2 + 4 - 8i_1 = 0$

$\frac{6}{8} = i_1$

$i_1 = \frac{3}{4}$ Amp.



$l_{AN} = \frac{1}{4}\times 100\ \text{cm}$

$= 25\text{cm}$

$V_C - \varepsilon_1 + i_1 r_1 = V_D$

$V_C - V_D = \varepsilon_1 - i_1 r_1 = 2 - \frac{3}{4}\times 2$

$= \frac{1}{2}$ Volt.

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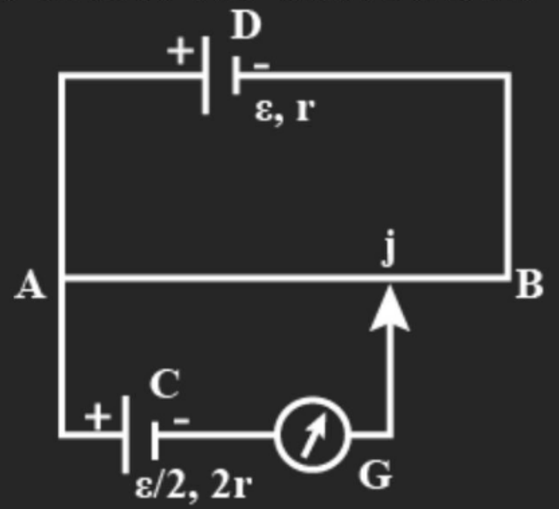
CURRENT ELECTRICITY

Potentiometer and Meter Bridge

Q.8 In the figure, the potentiometer wire AB of length L and resistance $9r$ is joined to the cell D of emf ε and internal resistance r. The cell C's emf is $\varepsilon/2$ and its internal resistance is $2r$. The galvanometer G will show no deflection when the length AJ is:



(A) $\frac{4L}{9}$

(B) $\frac{5L}{9}$

(C) $\frac{7L}{18}$

(D) $\frac{11L}{18}$

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CURRENT ELECTRICITY

Potentiometer and Meter Bridge

Q.9 In the arrangement shown in figure when the switch S_2 is open, the galvanometer shows no deflection for $l = L/2$. When the switch S_2 is closed, the galvanometer shows no deflection for $l = 5L/12$. The internal resistance (r) of 6 V cell, and the emf ε of the other battery are respectively:

H.W

(A) $3\Omega, 8$ V

(B) $2\Omega, 12$ V ✓

(C) $2\Omega, 24$ V

(D) $3\Omega, 12$ V

When S_2 open

$6 = \frac{\varepsilon}{L} \times \frac{L}{2} \Rightarrow \varepsilon = 12V$

Potential gradient $= \left(\frac{\varepsilon}{L}\right)$

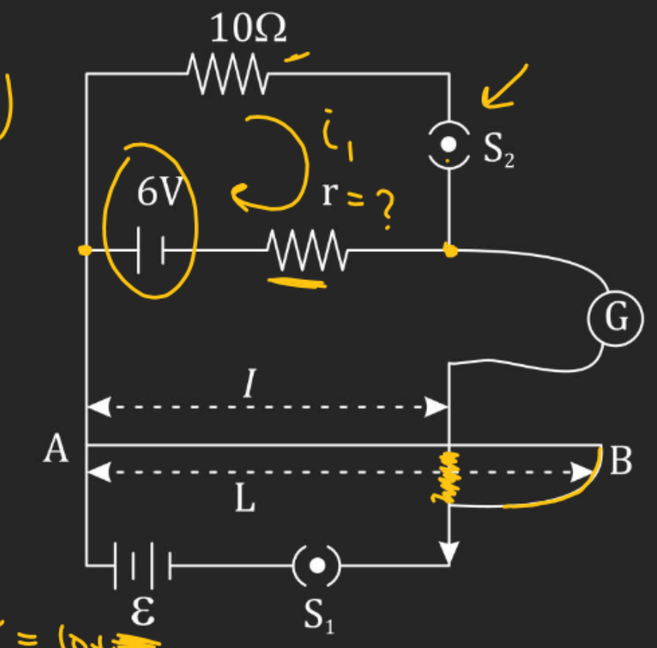
$i_1 = \left(\frac{6}{10+r}\right)$

When S_2 closed

$6 - i_1 r = \frac{\varepsilon}{L} \times \frac{5L}{12} = \frac{5\varepsilon}{12}$

$6 - \frac{6r}{10+r} = 5 \Rightarrow \frac{6r}{10+r} = 1 \Rightarrow 6r = 10+r$

$5r = 10 \Rightarrow r = 2\Omega$



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CURRENT ELECTRICITY

Potentiometer and Meter Bridge

Q.12 The wire AB of a meter bridge changes linearly from radius r to 2r from left end to right end. Where should the free end of the galvanometer be connected on AB so that the deflection in the galvanometer is zero?

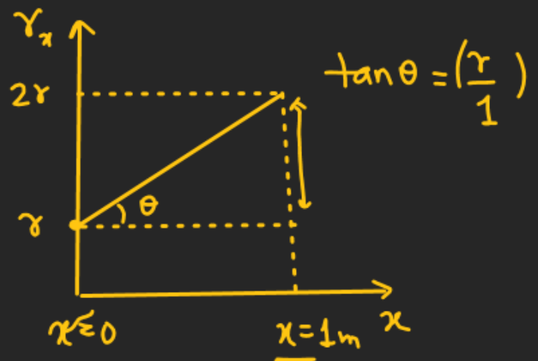
H.W

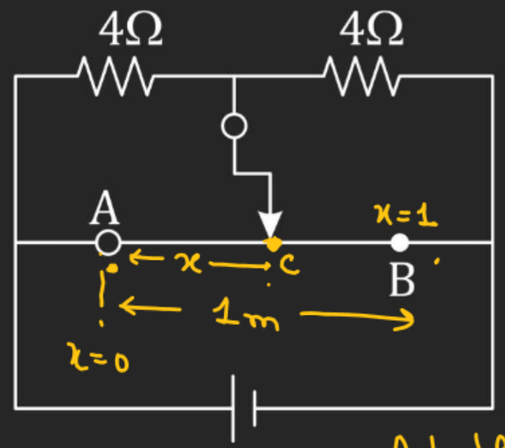
function of resistance with x

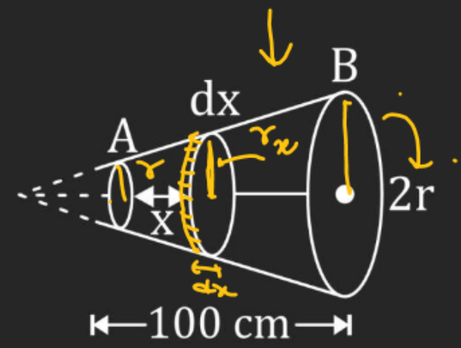
Radius at x. $\rightarrow r_x = \left(r + \frac{r}{1}x\right)$

$$\boxed{r_x = r(1+x)}$$ ✓

$$dR = \left(\frac{\rho dx}{\pi r_x^2}\right)$$







At the time of Null deflection

$$\frac{R_{AC}}{4} = \frac{R_{CB}}{4} \Rightarrow R_{AC} = R_{CB}$$

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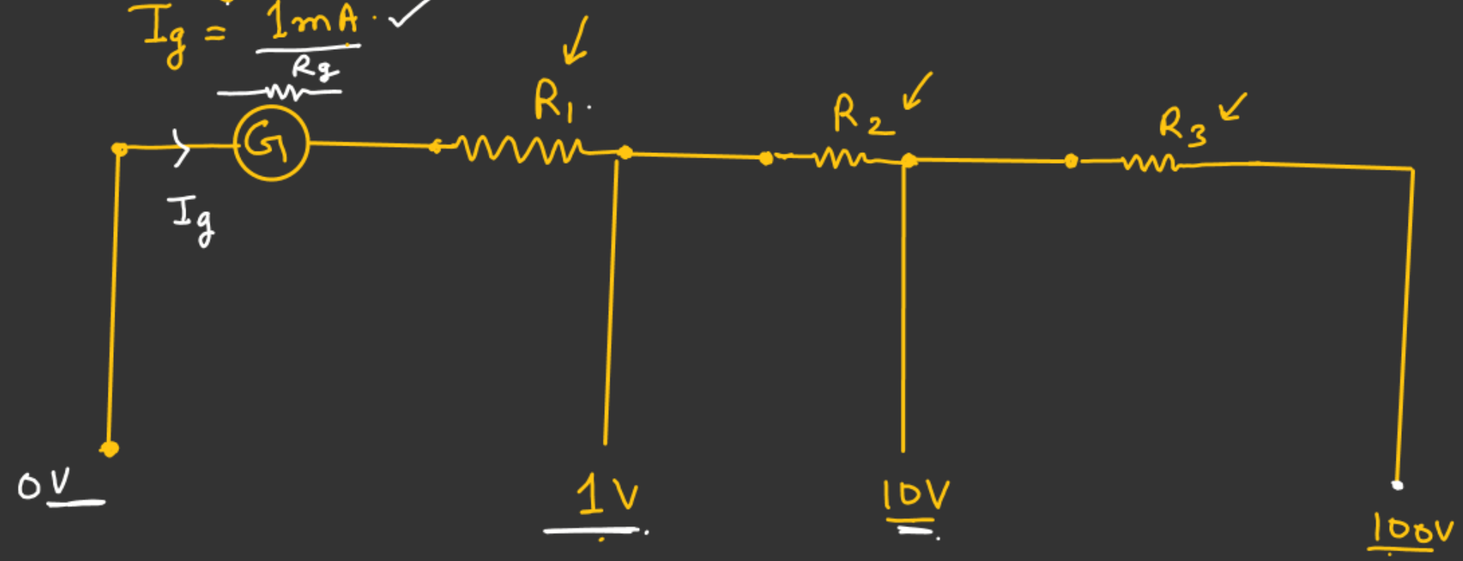
#

$R_g = 50\Omega$.

$I_g = 1mA$ ✓



To measure the voltage 1V, 10V, & 100V. find R_1, R_2 & R_3 to be added to the galvanometer

$I_g(R_g + R_1) = 1V$ ✓

$R_g + R_1 = \frac{1}{I_g} = \frac{1}{1\times10^{-3}}$

$R_1 = 1000 - R_g$

$R_1 = 1000 - 50$

$R_1 = 950\Omega$ ✓

For 10V

$I_g(R_g + R_1 + R_2) = 10$

$I_g(R_g + R_1) + I_g R_2 = 10$

$I_g R_2 = 10 - 1 = 9$.

$R_2 = \frac{9}{I_g} = 9000\Omega$

$= 9\times10^3\Omega$

For 100V

$I_g(R_g + R_1 + R_2 + R_3) = 100$

$I_g(R_g + R_1 + R_2) + I_g R_3 = 100$

$10 + I_g R_3 = 100$

$R_3 = \frac{90}{I_g} = \frac{90}{10^{-3}} = 9\times10^4\Omega$

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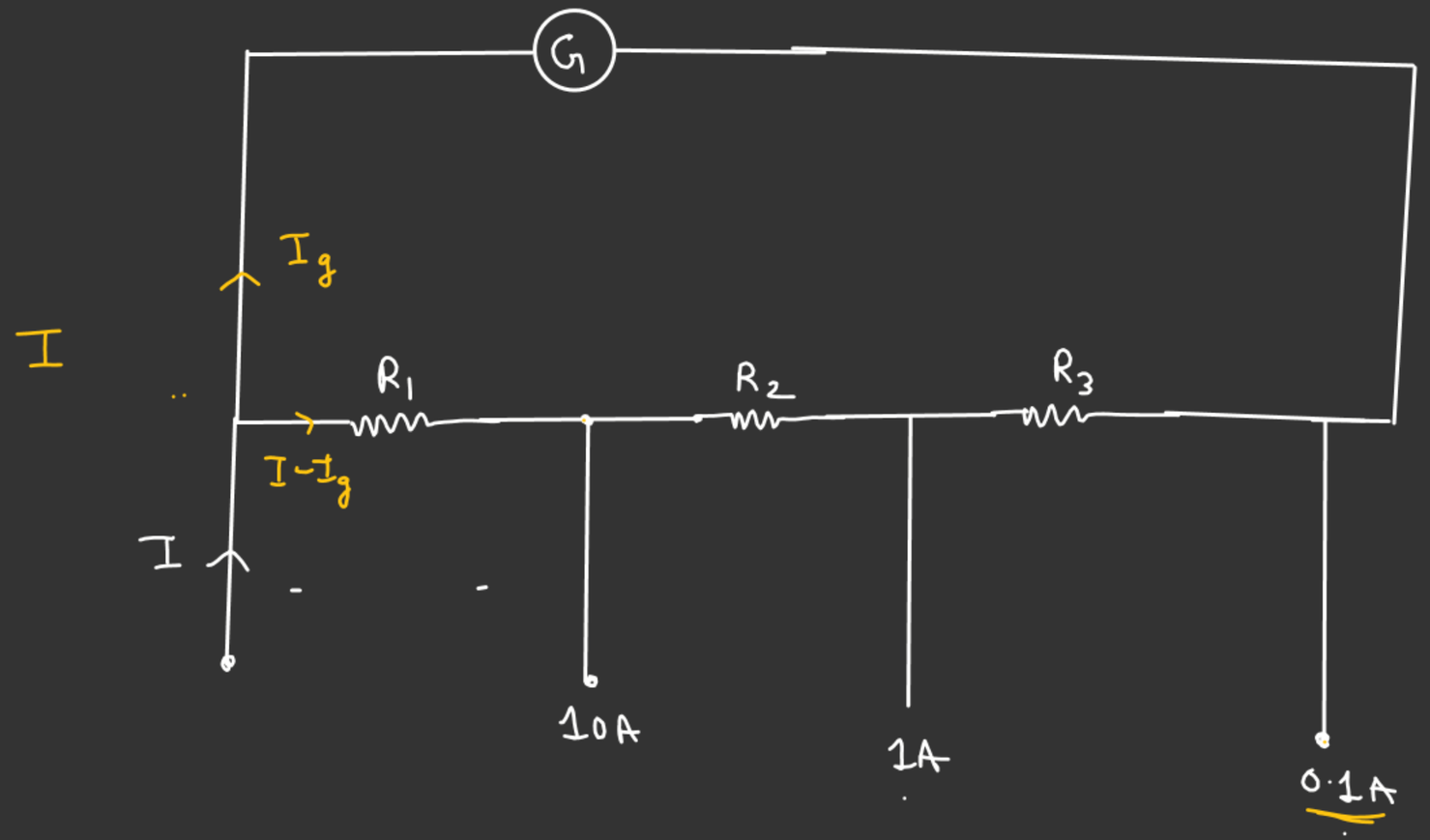
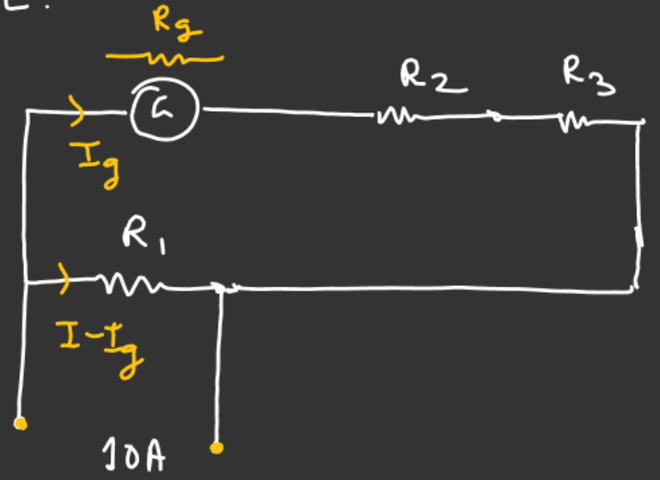
$R_g = 50\Omega$
$I_g = 1mA$



For this galvanometer to measure Current 0.1A, 1A & 10 Amp. find R_1, R_2 & R_3.



$$I_g (R_g + R_2 + R_3) = (I - I_g) R_1$$

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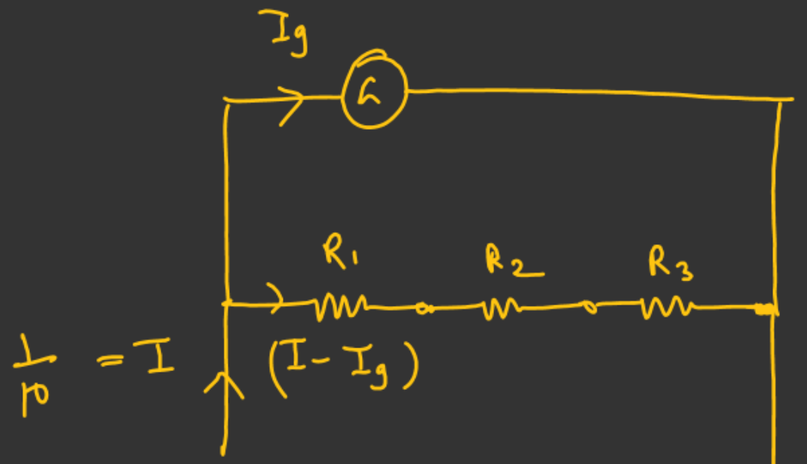
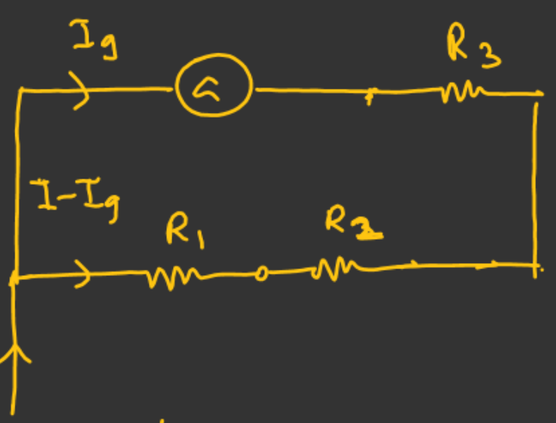


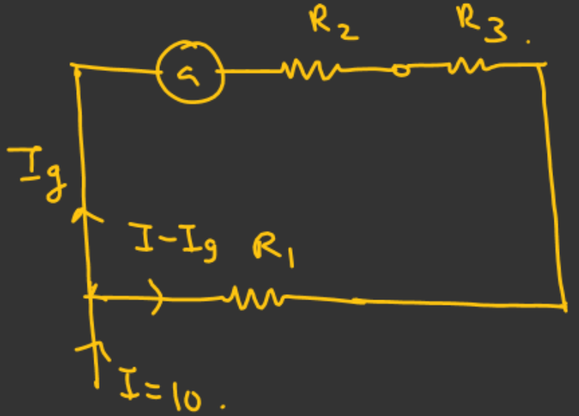
$$I_g R_g = (I - I_g)(R_1 + R_2 + R_3)$$

$$R_1 + R_2 + R_3 = \frac{I_g R_g}{I - I_g} = \frac{\frac{1}{1000} \times 5}{\left(\frac{1}{10} - \frac{1}{1000}\right)}$$

$$R_1 + R_2 + R_3 = \frac{\frac{5}{100}}{\frac{990}{1000}} = \frac{5}{99}\,\Omega.$$



$$I_g(R_3 + R_g) = (I - I_g)(R_1 + R_2) \quad -(2)$$



$$(I - I_g) R_1 = I_g (R_2 + R_3) \quad -(3)$$

R_1, R_2 & R_3 = ??

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$$r_x = r(1+x)$$

$$dR = \frac{\rho dx}{\pi r_x^2}$$

$$\int_0^{R_{AC}} dR = \frac{\rho}{\pi r^2}\int_0^{x} \frac{dx}{(1+x)^2}$$ ✓

$$R_{AC} = \frac{\rho}{\pi r^2}\left[\frac{-1}{(1+x)}\right]_0^{x}$$

$$R_{AC} = \frac{\rho}{\pi r^2}\left[\frac{-1}{1+x} + 1\right]$$

$$R_{AC} = \frac{\rho}{\pi r^2}\left[\frac{x}{1+x}\right]$$ ✓

$$\int_0^{R_{CB}} dR = \frac{\rho}{\pi r^2}\int_x^{1} \frac{dx}{(1+x)^2}$$

$$R_{CB} = \frac{\rho}{\pi r^2}\left[\frac{-1}{1+x}\right]_x^{1}$$

$$= \frac{\rho}{\pi r^2}\left[\frac{-1}{2} + \frac{1}{1+x}\right]$$

$$= \frac{\rho}{\pi r^2}\left[\frac{-1-x+2}{2(1+x)}\right]$$

$$= \frac{\rho}{\pi r^2}\frac{(1-x)}{2(1+x)}$$ ✓

For Null deflection

$$R_{AC} = R_{CB}$$

$$\frac{x}{1+x} = \frac{1-x}{2(1+x)}$$

$$2x = 1-x$$

$$3x = 1$$

$$x = \frac{1}{3}$$ ✓

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	Color	Color Code	Multiplier	Tolerance (%)
B ←	black	0	$\times 1$	↳ (error)
B ←	brown	1	$\times 10^1$	1
R ←	red	2	$\times 100 / 10^2$	2
O ←	orange	3	$\times 1\text{ K} / 10^3$	
Y ←	yellow	4	$\times 10\text{ K} / 10^4$	
G ←	green	5	$\times 100\text{ K} / 10^5$	0.5
B ←	blue	6	$\times 1\text{M} / 10^6$	0.25
V ←	violet	7	$\times 10\text{M} / 10^7$	0.1
G ←	grey	8	$\times 100\text{M} / 10^8$	0.05
W ←	white	9	$\times 1\text{G} / 10^9$	
	gold		$\times 0.1$	5
	silver		$\times 0.01$	10
	none			20

Colour Coding

Frist two Colour → (Colour code)

Next Colour → Multiplier

last Colour → Tolerance (error)

$x\ y \times 10^z \pm k$

(x y → Colour Code (xy); z → Multiplier; k → Tolerance)

BB ROY of Great Britain have Very Good Wife.

Bright Boys Race Over Young Girls But Voilet Generally Wins

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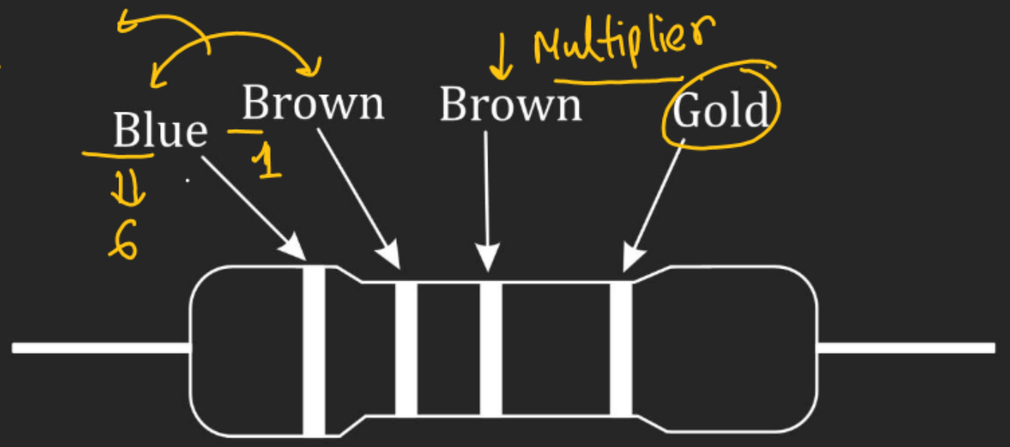
Colour Code.



R = 610Ω ± 5%

$R = (61) \times 10^{1} \times \pm 5\%$

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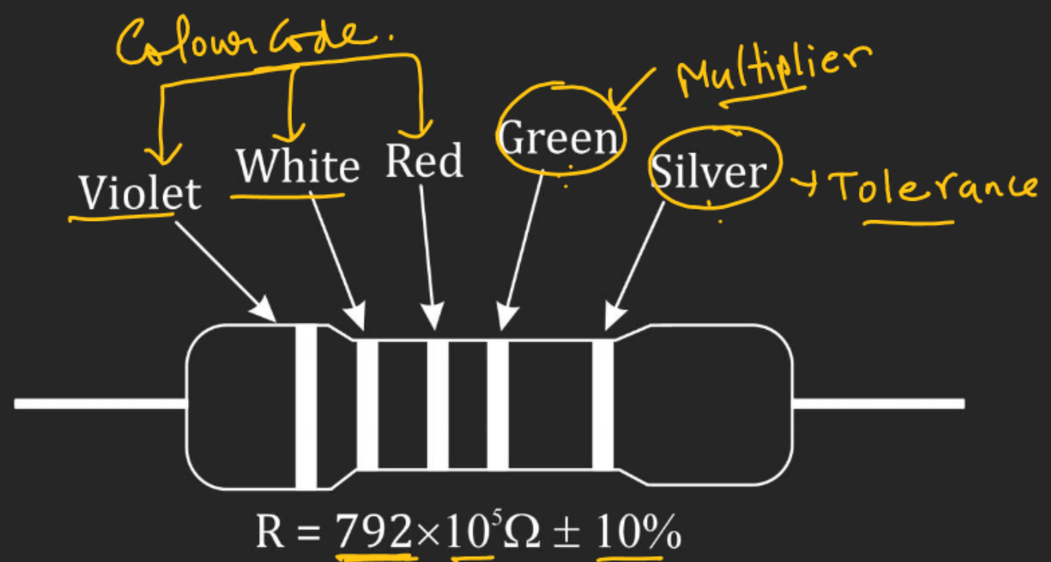
9th July (Jee Mains)

Test Syllabus:

60% ← [Capacitor

40% ← [Electrical Instrument
Current Electricity
Electrostatic



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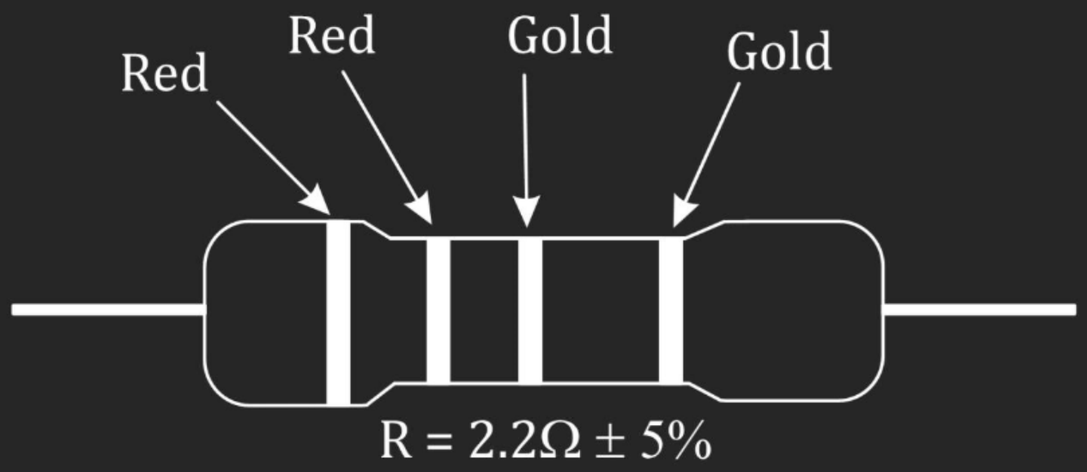

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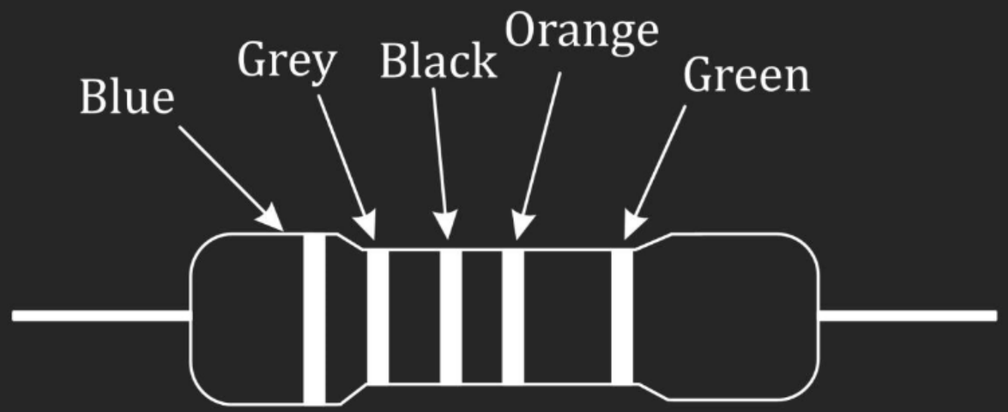

$$R = 651 \times 10^{3}\,\Omega \pm 0.5\%$$

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