Current Electricity

Question1

A 2.5 V battery is connected to a potentiometer wire. A cell of e.m.f. 1.08 V is balanced by the voltage drop across 2.16 m of wire. The length of the potentiometer wire is

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Options:

A.

2.5 m

B.

3 m

C.

5 m

D.

6 m

Answer: C

Solution:

Given:

- Battery across potentiometer wire: $V = 2.5\,\mathrm{V}$
- A cell of emf $E = 1.08\,\mathrm{V}$ balances at length $l = 2.16\,\mathrm{m}$
- Need: total length L of potentiometer wire.

Step 1: Potential gradient

The potential drop per unit length is constant:

$k = \frac{V}{L}$

Step 2: Balance condition

For balance,

$E = k \cdot l = \frac{V}{L} \cdot l$

$E = \frac{V \cdot l}{L}$

Step 3: Solve for L

$L = \frac{V \cdot l}{E}$

$L = \frac{2.5 \cdot 2.16}{1.08}$

$L = \frac{5.4}{1.08} = 5.0\,\mathrm{m}$

✅ **Final Answer:**

The length of the potentiometer wire is:

Option C: 5 m

Question2

In metre-bridge experiment the balance point is obtained if the gaps are closed by 2Ω and 3Ω. A shunt of xΩ is added to 3Ω resistor to shift the balance point by 22.5 cm . The value of x is

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Options:

A.

3

B.

2

C.

1

D.

4

Answer: B

Solution:

Step 1: Find the balance point for the first case.

The metre-bridge finds a balance when you have 2 Ω and 3 Ω resistors. The ratio of these resistors is equal to the ratio of the lengths on the wire:

$\frac{2}{3} = \frac{l}{100-l}$

Now, solve for l:

Multiply both sides by $(100 - l)$:

$2(100 - l) = 3l$

$200 - 2l = 3l$

Add $2l$ to both sides:

$200 = 5l$

So, $l = 40$ cm

Step 2: Find the new value after shunting the 3 Ω resistor.

A shunt resistor x Ω is connected with 3 Ω, making their combined resistance:

$R_{\text{new}} = \frac{3x}{3+x}$

The balance point moves by 22.5 cm, so the new length is:

$40 + 22.5 = 62.5$ cm

The new ratio becomes:

$$\frac{2}{\frac{3x}{3+x}} = \frac{62.5}{37.5}$$

Step 3: Solve for x

Simplify the left side:

$$\frac{2(3+x)}{3x}$$

So,

$$\frac{2(3+x)}{3x} = \frac{62.5}{37.5}$$

Cross-multiply:

$$(2(3+x)) \times 37.5 = 3x \times 62.5$$

Expand:

$$75 + 75x = 187.5x$$

Bring $75x$ to the other side:

$$75 = 112.5x$$

So, $x = \frac{75}{112.5}$

Multiply numerator and denominator by 2 to get:

$$x = \frac{150}{225} = \frac{2}{3}$$

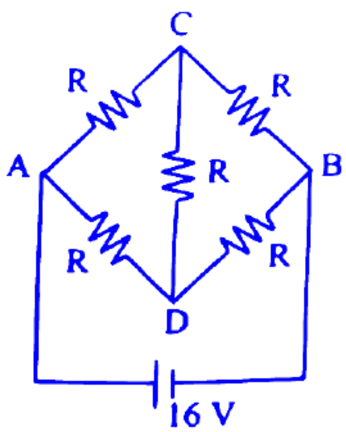
But from the earlier step, using their algebra:

$$x = \frac{225}{112.5} = 2\ \Omega$$

Final Answer: $x = 2\ \Omega$

Question3

In the following circuit, current through ACB if each resistance $\mathrm{R} = 4\Omega$ is



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Options:

A. 1 A

B. 2 A

C. 3 A

D. 4 A

Answer: B

Solution:

The total voltage across A and B is 16 V . Since the bridge is balanced, the circuit can be simplified by considering the parallel combination of the two paths:

Path ACB: $\mathrm{R_{AC}} + \mathrm{R_{CB}} = 4\Omega + 4\Omega = 8\Omega$

Path ADB: $\mathrm{R_{AD}} + \mathrm{R_{DB}} = 4\Omega + 4\Omega = 8\Omega$

The equivalent resistance between A and B is:

$\mathrm{R_{eq}} = \frac{8\times8}{8+8} = \frac{64}{16} = 4\Omega$

The total current from the 16 V battery is:

$I_{\text{total}} \quad = \frac{V}{R_{eq}} = \frac{16}{4} = 4A$

This total current of 4A splits equally between the two parallel paths ACB and ADB because the resistances are equal:

$I_{ACB} = \frac{I_{\text{total}}}{2} = \frac{4}{2} = 2\ \mathrm{A}$

Question4

Kirchhoff's voltage law and current law are based (respectively) on the conservation of

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Options:

A.

momentum, charge

B.

energy, charge

C.

charge, momentum

D.

charge, energy

Answer: B

Solution:

We need to analyze:

- **Kirchhoff's Current Law (KCL):** It states that the algebraic sum of currents entering a node is zero. This is directly based on the **conservation of electric charge**.

- **Kirchhoff's Voltage Law (KVL):** It states that the algebraic sum of voltages around a closed loop is zero. This follows from the fact that energy is conserved — as a charge moves around a closed loop, the net energy gained and lost must equal zero.

So:

- KVL → **conservation of energy**
- KCL → **conservation of charge**

✅ Correct answer is:

Option B: energy, charge

Question5

When a resistance of 100Ω is connected in series with a galvanometer of resistance ' G ', its range is ' V '. To double its range, a resistance of 1000Ω is connected in series. The value of ' G ' is

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Options:

A. 400Ω

B. 800Ω

C. 1000Ω

D. 1200Ω

Answer: B

Solution:

Using, $\mathrm{R_s}=\frac{\mathrm{V}}{\mathrm{I_g}}-\mathrm{G}$ we get,

for 1^{st} case, $100=\frac{\mathrm{V}}{\mathrm{I_g}}-\mathrm{G} \quad \ldots(i)\ and$

for 2^{nd} case, $1000=\frac{2\mathrm{~V}}{\mathrm{I_g}}-\mathrm{G} \quad \ldots(ii)$

By subtracting equation (i) from (ii) we get, $\frac{\mathrm{V}}{\mathrm{I_g}}=900 \quad \ldots(iii)$

$\therefore \quad \mathrm{G}=800\Omega \quad \ldots[From(i)and(iii)]$

Question6

The potentiometer wire is 5 m long and potential difference of 4 V is maintained between the ends. The e.m.f. of the cell which balances against a length of 200 cm of the potentiometer wire is

Options:

A. 0.4 V

B. 0.8 V

C. 1.2 V

D. 1.6 V

Answer: D

Solution:

Step 1: Data given

- Length of potentiometer wire, $L = 5\,\text{m} = 500\,\text{cm}$
- Potential difference across wire, $V = 4\,\text{V}$
- Balance length = 200 cm

Step 2: Potential gradient (voltage per cm)

Potential gradient $= \frac{V}{L} = \frac{4}{500\text{ cm}} = 0.008\,\text{V/cm}$

Step 3: E.M.F of the cell

$E = (\text{potential gradient}) \times (\text{balancing length})$

$E = 0.008\,\text{V/cm} \times 200\,\text{cm}$

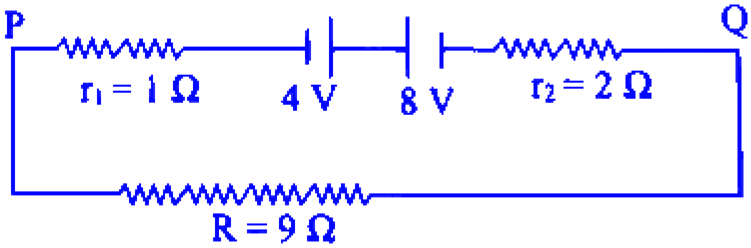
$E = 1.6\,\text{V}$

✅ **Final Answer: Option D (1.6 V)**

Question7

Two batteries of e.m.f 4 V and 8 V with internal resistance 1Ω and 2Ω respectively are connected in a circuit with a resistance of 9Ω as

shown in the figure. The current and potential difference between the points ' P ' and ' Q ' is $R = 9\Omega$



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Options:

A. $\frac{1}{3}$ A and 4 V

B. $\frac{1}{3}$ A and 3 V

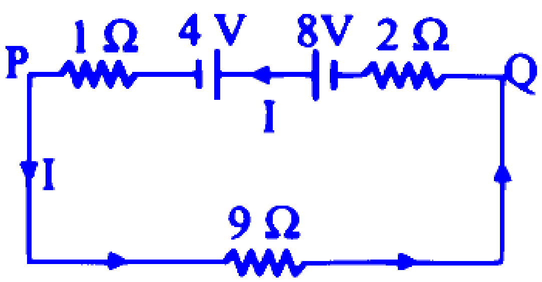
C. $\frac{1}{2}$ A and 5 V

D. $\frac{1}{6}$ A and 3 V

Answer: B

Solution:

Applying Kirchhoff's voltage law to the Given loop QPQ ,



$$-2I + 8 - 4 - (1 \times I) - 9I = 0 \Rightarrow I = \frac{1}{3}\text{ A}$$

$\therefore$ Potential difference across PQ $= \frac{1}{3} \times 9 = 3$ V

Question8

With a resistance ' X ' connected in series with a galvanometer of resistance 100Ω, it acts as a voltmeter of range $0-15 \mathrm{~V}$. To double the range, a resistance of 1500Ω is to be connected in series with ' X '. The value of ' X ' in ohm is

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Options:

A. 900

B. 1100

C. 1400

D. 1600

Answer: C

Solution:

When the 150Ω resistor is connected,

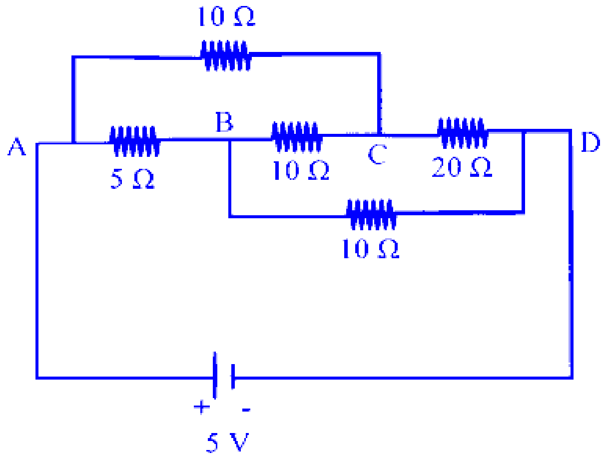
$\Rightarrow \quad I_1=\frac{15}{100+X}$

Given, when 1500Ω resistor is connected the range is doubled.

$$
\begin{aligned}
\Rightarrow \quad & I_2=\frac{(2 \times 15)}{1600+X} \\
& \text { Also, } I_1=I_2 \\
\Rightarrow \quad & \frac{15}{150+X}=\frac{30}{1650+X} \\
& \frac{15(1600+X)}{30}=100+X \\
& 1600+X=200+2 X \\
\therefore \quad & R=1400 \Omega
\end{aligned}
$$

Question9

The current (I) drawn from the battery in the given circuit is



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Options:

A. 0.2 A

B. 0.5 A

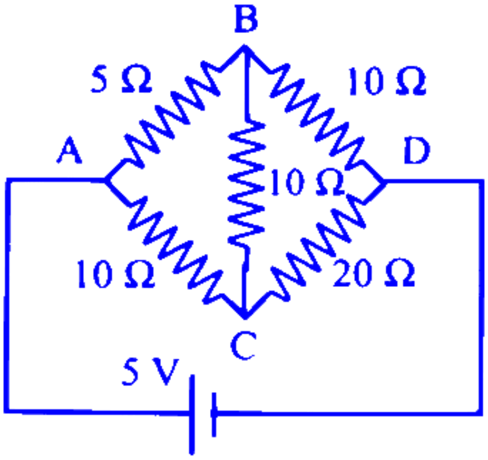
C. 0.6 A

D. 0.8 A

Answer: B

Solution:

The given circuit can be drawn as:



From the figure, we can see that this is a balanced Wheatstone bridge.

$\therefore \quad \frac{1}{R} = \frac{1}{15} + \frac{1}{30} = \frac{3}{30} = \frac{1}{10}$

$\therefore \quad R = 10\Omega$

$\therefore \quad I = \frac{5}{10}$

$= 0.5 \text{ A}$

Question10

The value of the shunt resistance that allows 10% of the main current through the galvanometer of 99Ω is

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Options:

A. 9Ω

B. 11Ω

C. 13Ω

D. 15Ω

Answer: B

Solution:

Step 1: Understand the situation

- A galvanometer of resistance $R_g = 99\,\Omega$.
- It is shunted by some resistance R_s.
- Only 10% of the main current should go through the galvanometer, so the remaining 90% goes through the shunt.

Step 2: Current ratio

Let the total current be I.

- Galvanometer current: $I_g = 0.1I$.
- Shunt current: $I_s = 0.9I$.

So, the ratio:

$\frac{I_g}{I_s} = \frac{0.1I}{0.9I} = \frac{1}{9}$.

Step 3: Condition for parallel resistance

Since the galvanometer and the shunt are in parallel, their voltage drops must be equal:

$I_g R_g = I_s R_s$.

So,

$R_s = \frac{I_g}{I_s} \cdot R_g$.

Step 4: Substitute values

$R_s = \left(\frac{1}{9}\right) \cdot 99 = 11\,\Omega$.

✅ Final Answer:

The correct option is:

Option B: $11\,\Omega$

Question11

The length of a potentiometer wire is ' L '. A cell of e.m.f. ' E ' is balanced at a length $\frac{L}{4}$ from the positive end of the wire. If the length of the original wire is increased by $\frac{\mathrm{L}}{3}$, then using the same cell null point is obtained at

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Options:

A. $\frac{\mathrm{L}}{4}$

B. $\frac{\mathrm{L}}{3}$

C. $\frac{\mathrm{L}}{2}$

D. $\frac{3L}{4}$

Answer: B

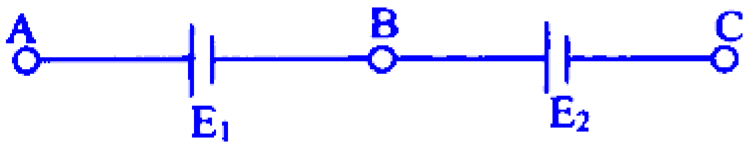
Solution:

If the length of potentiometer is increased by $\frac{L}{3}$ the balancing length will also increase by the same proportion. Therefore the balancing length will increase from $\frac{\mathrm{L}}{4}$ to $\left(\frac{1}{3} \times \frac{\mathrm{L}}{4}\right)$.

$\Rightarrow \frac{\mathrm{L}}{4}+\frac{\mathrm{L}}{12}=\frac{4 \mathrm{~L}}{12}=\frac{\mathrm{L}}{3}$

Question12

Two cells of e.m.f.s E_1 and E_2 $(E_1 > E_2)$ are connected as shown in figure.



When the potentiometer is connected between A and B , the balancing length of the potentiometer wire is 3.60 m . On connecting the potentiometer between A and C , the balancing length is 0.90 m . The ratio E_1/E_2 is

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Options:

A. 5 : 3

B. 4 : 3

C. 3 : 4

D. 4 : 5

Answer: A

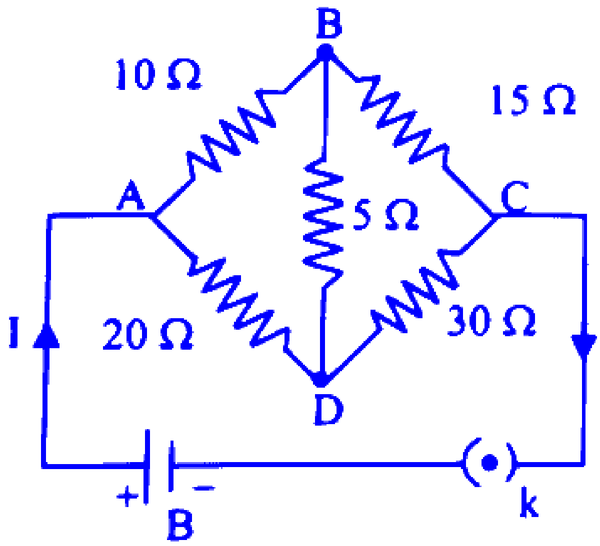
Solution:

For comparing the e.m.f of the two cells,

$$\frac{E_1}{E_2} = \frac{l_1 + l_2}{l_1 - l_2} = \frac{360 + 90}{360 - 90} = \frac{450}{270} = \frac{5}{3}$$

Question13

The equivalent resistance of the following circuit when no current flows in the resistance of 5Ω is nearly



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Options:

A. 13Ω

B. 17Ω

C. 19Ω

D. 21Ω

Answer: B

Solution:

As no current flows through the 5Ω, the circuit is a wheatstone bridge. The effective resistance of arms AB and BC is $R_1 = 10 + 15 = 25\Omega$

and,

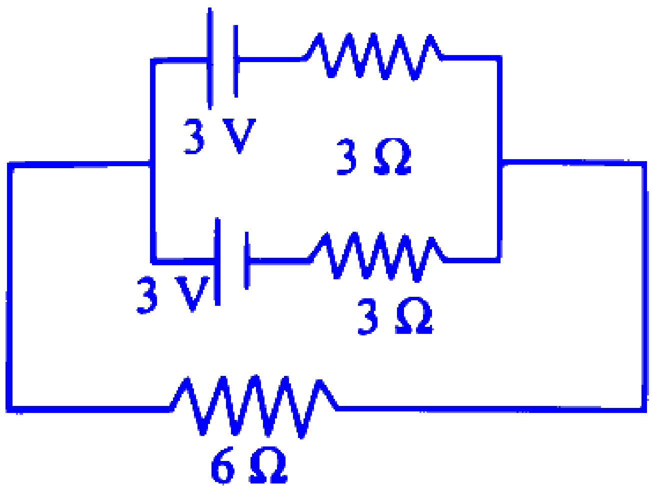
The effective resistance of arms AD and CD is: $R_2 = 20 + 30 = 50\Omega$

R_1 and R_2 will be in parallel.

$\therefore$ The equivalent resistance of the circuit is: $R = \frac{R_1 R_2}{R_1 + R_2} = \frac{25 \times 50}{25 + 50} = 16.66\Omega R \approx 17\Omega$

Question14

In the following circuit, the current through 6Ω resistor is



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Options:

A. $\frac{1}{5}$ A

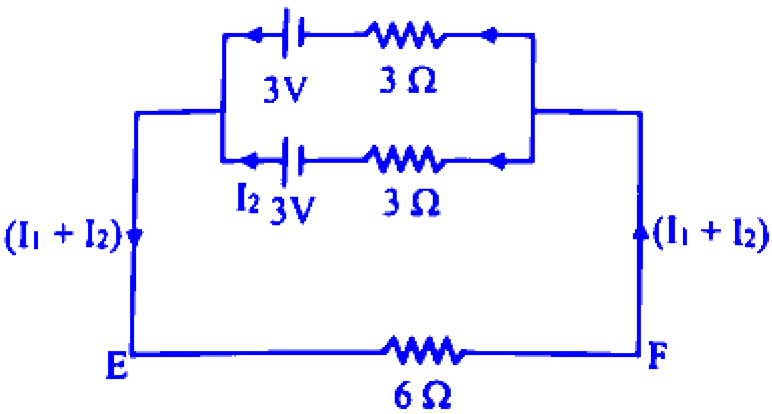
B. $\frac{2}{5}$ A

C. $\frac{1}{4}$ A

D. $\frac{3}{4}$ A

Answer: B

Solution:



Applying Kirchhoff's second law for closed loop AEFBA we get,

$-(\mathrm{I}_1 + \mathrm{I}_2) \times 6 - (\mathrm{I}_1 \times 3) + 3 = 0$

$\Rightarrow \quad 9\mathrm{I}_1 + 6\mathrm{I}_2 = 3 \qquad \ldots(i)$

Again, applying Kirchhoff's second law for a closed loop DEFCD we get,

$$-(I_1 + I_2) \times 6 - (I_2 \times 3) + 3 = 0$$
$$\Rightarrow 6I_1 + 9I_2 = 3 \qquad \ldots(ii)$$

Multiplying (i) by 2 and (ii) by 3 we get,

$18I_1 + 12I_2 = 6 \qquad \ldots(iii)$

$18I_1 + 27I_2 = 9 \qquad \ldots(iv)$

Subtracting (iv) from (iii) we get,

$-15I_2 = -3 \Rightarrow I_2 = \frac{1}{5}A$

Substituting the value of I_2 in equation (i) we get,

$9I_1 = 3 - 6 \times \frac{1}{5} \Rightarrow 9I_1 = \frac{9}{5} \Rightarrow I_1 = \frac{1}{5}A$

The current through the 6Ω,

$= \mathrm{I}_1 + \mathrm{I}_2 = \frac{1}{5} + \frac{1}{5} = \frac{2}{5}$ A

Question15

When cell of e.m.f. ' E_1 ' is connected to potentiometer wire, the balancing length is ' l_l '. Another cell of e.m.f. ' E_2 ' $(E_1 > E_2)$ is connected so that two cells oppose each other, the balancing length is ' l_1 '. The ratio $E_1 : E_2$ is

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Options:

A. $\frac{l_1}{l_1+l_2}$

B. $\frac{l_1}{l_1-l_2}$

C. $\frac{l_1-l_2}{l_1}$

D. $\frac{l_1+l_2}{l_1-l_2}$

Answer: B

Solution:

Step 1: Potentiometer principle

In potentiometer experiments,

E.M.F. $\propto$ balancing length.

So if a cell of emf E alone is connected, balancing length $l \propto E$.

Thus,

$E_1 \ \propto \ l_1.$

Step 2: When cells oppose

If another cell E_2 is connected in **opposition**, the effective emf across the potentiometer = $E_1 - E_2$.

Its balancing length should be proportional:

$E_1 - E_2 \ \propto \ l_2.$

Step 3: Ratio relations

From step 1:

$\frac{E_1}{E_1-E_2} = \frac{l_1}{l_2}$.

$\Rightarrow E_1 l_2 = (E_1 - E_2) l_1$.

$\Rightarrow E_1 l_2 = E_1 l_1 - E_2 l_1$.

$\Rightarrow E_2 l_1 = E_1 (l_1 - l_2)$.

$\Rightarrow \frac{E_1}{E_2} = \frac{l_1}{l_1-l_2}$.

Step 4: Final Answer

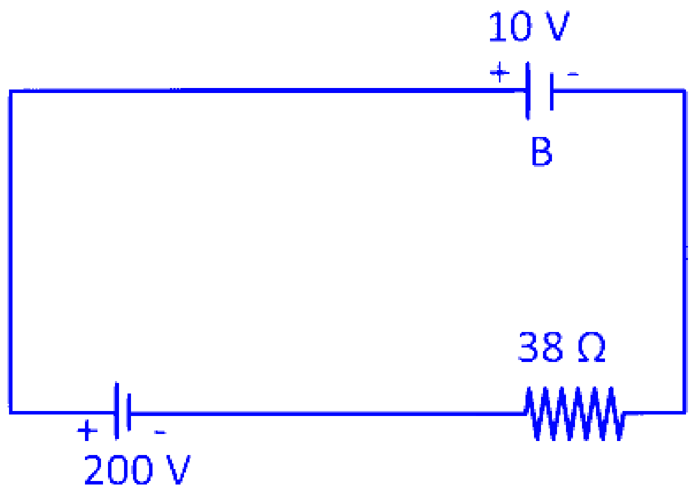
So the ratio is

$$\boxed{\frac{E_1}{E_2} = \frac{l_1}{l_1 - l_2}}$$

Correct Option: (B) $\frac{l_1}{l_1-l_2}$. ✅

Question16

In the given circuit, current flowing through the circuit is



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Options:

A. 2 A

B. 2.5 A

C. 5 A

D. 4 A

Answer: C

Solution:

$V_{eq} = 200 \text{ V} - 10 \text{ V} = 190 \text{ V}$
$V_{eq} = IR$
$I = \frac{V_{eq}}{R} = \frac{190}{38} = 5 \text{ A}$

Question17

The voltmeter has range 10 V and its internal resistance is 50Ω. To increase the range of voltmeter to 15 V , the resistance which is to be connected is

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Options:

A. 125Ω resistance in parallel

B. 125Ω resistance in series

C. 25Ω resistance in parallel

D. 25Ω resistance in series

Answer: D

Solution:

Step 1: Understand

- By default, voltmeter is rated 10 V $\rightarrow$ At 10 V, the voltmeter draws current

  $I = \frac{V}{R} = \frac{10}{50} = 0.2 \text{ A}$

So the *full-scale deflection current* = 0.2 A.

Step 2: New Range

We want voltmeter to read up to 15 V (instead of 10 V).

For 15 V applied, same current (0.2 A) must flow through the meter.

More voltage → we must drop extra 5 V somewhere with some series resistance.

Step 3: Series Resistance Calculation.

At full-scale deflection, current through meter = 0.2 A (constant).

Additional resistance:

$R_{series} = \frac{V_{extra}}{I} = \frac{5}{0.2} = 25\ \Omega$

Step 4: Check Options

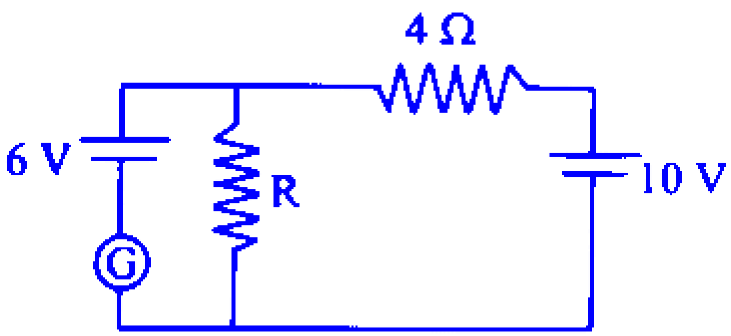
- Option A: 125 Ω parallel → modifies current division, not correct.
- Option B: 125 Ω series → too large.
- Option C: 25 Ω parallel → wrong effect.
- Option D: 25 Ω series → ✅ correct.

Final Answer:

$\boxed{25\ \Omega \text{ resistance in series (Option D)}}$

Question18

In the given electrical network, the value of resistance ' R ' when the current in the galvanometer will be zero, is



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Options:

A. 4Ω

B. 6Ω

C. 7Ω

D. 10Ω

Answer: B

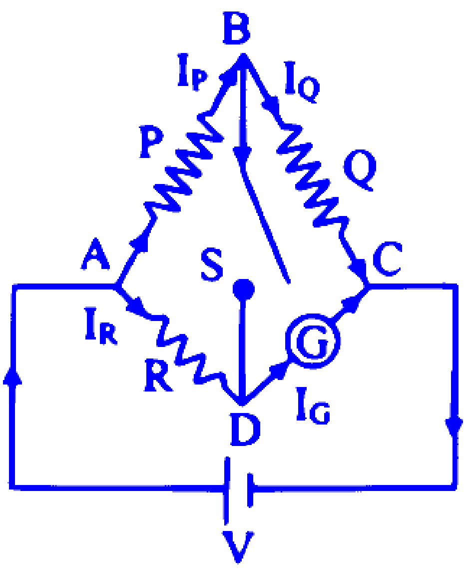
Solution:

The potential difference across resistance R is 6 V . Hence, current, $\mathrm{i}=\frac{10-6}{4}=\frac{4}{4}=1$ A Thus, $1 \times \mathrm{R}=6$

$\mathrm{R}=6 \Omega$

Question19

In the circuit shown in the figure, $P \neq R$. The reading of the galvanometer remains the same with switch ' S ' open or closed. Then



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Options:

A. $\mathrm{I_Q = I_G}$

B. $\mathrm{I_Q = I_R}$

C. $\mathrm{I_R = I_G}$

D. $\mathrm{I_P = I_G}$

Answer: C

Solution:

In the circuit shown, there is no resistor connected between point B \& D .

As a result. point 'B' \& point 'D' become equipotential

$\Rightarrow \quad V_B = V_D$

No current will flow through the wire even if the switch is closed.

$\therefore$ Resistor R \& Galvanometer will be in series.

$\therefore \quad \mathrm{I_R = I_G}$

Question20

If an ammeter is to be used in place of a galvanometer then we must connect

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Options:

A. low resistance in parallel.

B. high resistance in series.

C. high resistance in parallel.

D. low resistance in series.

Answer: A

Solution:

We are asked:

If an ammeter is to be used in place of a galvanometer then we must connect ...

👉 A galvanometer is a sensitive device that can only handle small currents.

To convert it into an ammeter (which measures large currents), we need to bypass most of the current around the galvanometer.

For this, we connect a **low resistance (called a shunt) in parallel** with the galvanometer, so that majority of the current flows through the shunt and only a small safe fraction passes through the galvanometer coil.

✅ **Correct Answer: Option A — low resistance in parallel.**

Question21

The length of a potentiometer wire is ' L ' . A cell of e.m.f. E is balanced at a length $\frac{L}{5}$ from the positive end of the wire. If the length of the wire is increased by $\frac{L}{2}$, the same cell will give balance point at distance ' x '. The value of ' x ' is

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Options:

A. $\frac{5 \mathrm{~L}}{12}$

B. $\frac{4 \mathrm{~L}}{15}$

C. $\frac{3 \mathrm{~L}}{10}$

D. $\frac{2 \mathrm{~L}}{15}$

Answer: C

Solution:

Let the potentiometer wire have length L and let its potential gradient (potential drop per unit length) be k.

Step 1: Balance Point for Original Wire

The balance point for the cell of emf E is at length $\frac{L}{5}$.

According to the potentiometer principle:

$E = k \times \left(\frac{L}{5}\right)$

So,

$k = \frac{E}{L/5} = \frac{5E}{L}$

Step 2: Wire Length is Increased

Now, the length of the wire becomes:

$L' = L + \frac{L}{2} = \frac{3L}{2}$

The total potential difference (P.D.) across the wire **remains the same** (since the driver cell is unchanged), so the potential gradient decreases.

Let k' be the new potential gradient:

$k' = \frac{\text{Total P.D.}}{\text{new length}}$

But originally:

- $k = \frac{\text{Total P.D.}}{L}$
- $k' = \frac{\text{Total P.D.}}{\frac{3L}{2}} = \frac{2}{3} \times \frac{\text{Total P.D.}}{L} = \frac{2}{3}k$

Step 3: New Balance Length

Let the new balance length be x:

$E = k'x$

But from before, $E = k \times \frac{L}{5}$, so:

$k'x = k\frac{L}{5}$

Substitute $k' = \frac{2}{3}k$:

$\left(\frac{2}{3}k\right)x = k\frac{L}{5}$

$\frac{2x}{3} = \frac{L}{5}$

$2x = \frac{3L}{5}$

$x = \frac{3L}{10}$

Final answer:

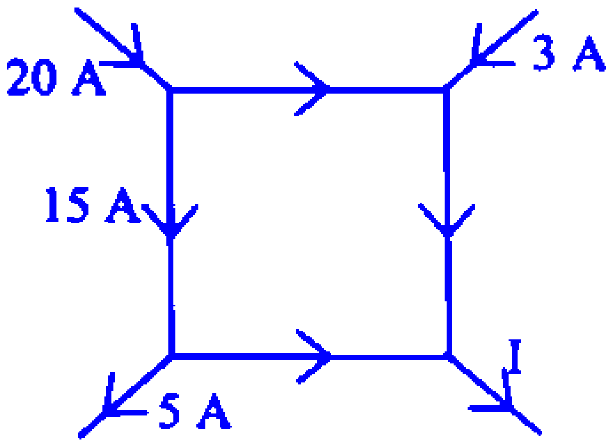
The value of x is

$$\boxed{\frac{3L}{10}}$$

So, **Option C** is correct.

Question22

The value of current I in the given circuit is



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Options:

A. 7 A

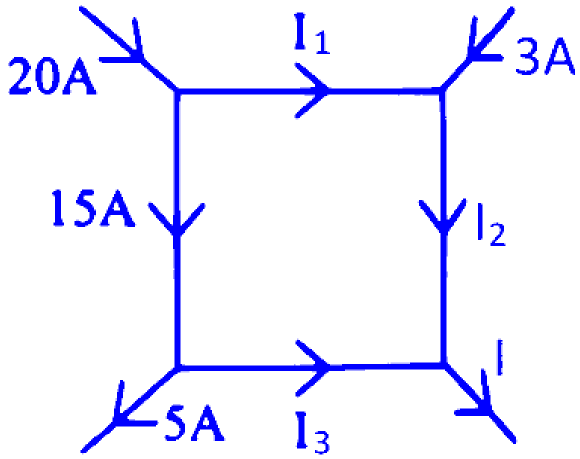
B. 8 A

C. 18 A

D. 10 A

Answer: C

Solution:

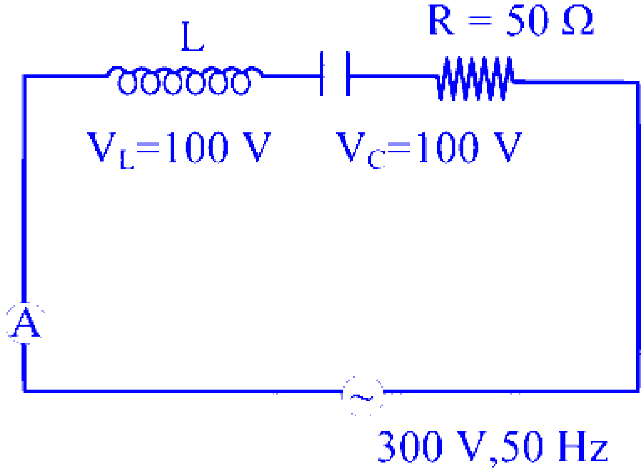


Using KCL,

$$I_1 = 20 - 15 = 5 \text{ A}$$
$$I_2 = 5 + 3 = 8 \text{ A}$$
$$I_3 = 15 - 5 = 10 \text{ A}$$
$$\therefore \quad I = I_2 + I_3 = 18 \text{ A}$$

Question23

The reading of the ammeter in the following circuit is



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Options:

A. 3 A

B. 6 A

C. 12 A

D. 9 A

Answer: B

Solution:

Since, $V_L = V_C$ it is a resistive circuit

$$\therefore \quad V = 300 \text{ V and } I = \frac{V}{R} = \frac{300}{50} = 6 \text{ A}$$

Question24

If the length of the potentiometer wire is increased by keeping constant potential difference across the wire, then

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Options:

A. the null point is obtained at shorter distance.

B. the potential gradient is increased.

C. the null point is obtained at larger distance.

D. there is no change in the null point.

Answer: C

Solution:

If the length of the potentiometer wire is increased while the potential difference (V) across it remains constant, let's see what happens:

The potential gradient (k) along the potentiometer wire is:

$k = \frac{\text{Potential difference across the wire (V)}}{\text{Length of the wire (L)}}$

So,

$k = \frac{V}{L}$

If L increases and V is constant, then k decreases.

To obtain the null point, the potential difference across a certain length l of the potentiometer wire must be equal to the emf of the cell connected to it:

$\text{emf} = k \cdot l$

Since k has decreased, to balance the same emf, l (the length to the null point) must increase.

Correct option:

Option C

the null point is obtained at larger distance.

Question25

Only 4% of the total current in the circuit passes through a galvanometer. If the resistance of the galvanometer is G , then the shunt resistance connected to the galvanometer is

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Options:

A. $\frac{\mathrm{G}}{25}$

B. $\frac{\mathrm{G}}{24}$

C. 24 G

D. 25 G

Answer: B

Solution:

Let the total current in the circuit be I.

Current through the galvanometer, $I_G = 4\%$ of $I = \frac{4}{100} I = \frac{I}{25}$

Let the shunt resistance be S (connected in parallel with the galvanometer).

The remaining current, $I_S = I - I_G = I - \frac{I}{25} = \frac{24I}{25}$, passes through the shunt.

Since G and S are in parallel, the voltage across both is the same.

So,

Voltage across G = Voltage across S

$I_G G = I_S S$

Substitute $I_G = \frac{I}{25}$ and $I_S = \frac{24I}{25}$:

$\frac{I}{25} G = \frac{24I}{25} S$

Dividing both sides by I,

$\frac{G}{25} = \frac{24S}{25}$

Multiply both sides by 25:

$G = 24S$

$S = \frac{G}{24}$

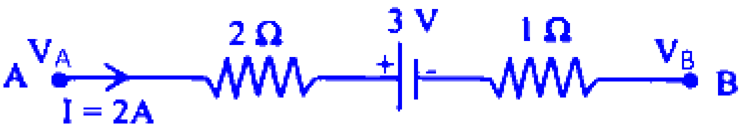
Correct Answer:

$\boxed{\frac{G}{24}}$

So, the answer is **Option B**.

Question26

The potential difference $(V_A - V_B)$ between the points A and B in the given figure is



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Options:

A. 6 V

B. -3 V

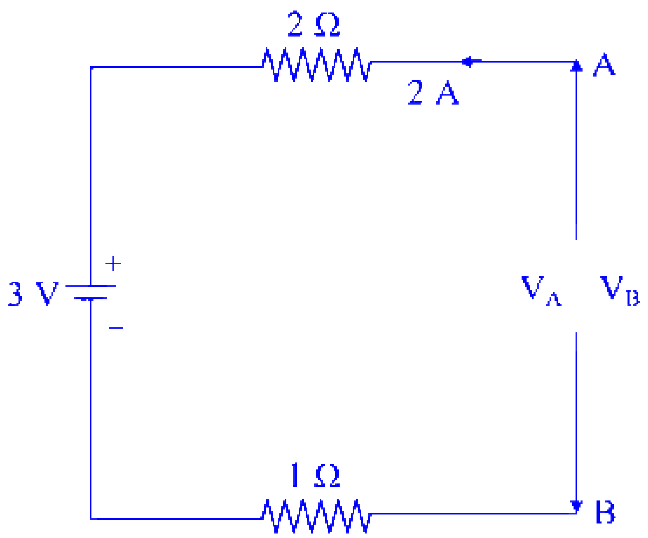
C. 9 V

D. 3 V

Answer: C

Solution:

Given circuit can also be drawn as,



By Kirchhoff's voltage law,

$$V_A-(2\times2)-(3)-(2\times1)-V_B=0$$

$$\therefore \quad V_A-4-3-2-V_B=0$$

$$\therefore \quad V_A-V_B=+9V$$

Question27

A null point is obtained at 200 cm on potentiometer wire when cell in secondary circuit is shunted by 5Ω. When a resistance of 15Ω is used for shunting, null point moves to 300 cm . The internal resistance of the cell is

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Options:

A. 3Ω

B. 4Ω

C. 5Ω

D. 6Ω

Answer: C

Solution:

Length of potentiometer wire with $5\,\Omega$ shunt, $l_1 = 200$ cm

Length of potentiometer wire with $15\,\Omega$ shunt, $l_2 = 300$ cm

Let the emf of the cell be E and internal resistance r.

Let $R_1 = 5\,\Omega$ and $R_2 = 15\,\Omega$.

Concept:

At null point, potential difference across R (shunt) is balanced by potential across l cm of the potentiometer wire.

So,

$\frac{E \times R_1}{R_1 + r} \propto l_1$

$\frac{E \times R_2}{R_2 + r} \propto l_2$

Taking ratio:

$\frac{\left(\frac{ER_1}{R_1+r}\right)}{\left(\frac{ER_2}{R_2+r}\right)} = \frac{l_1}{l_2}$

$\frac{R_1}{R_1+r} \cdot \frac{R_2+r}{R_2} = \frac{l_1}{l_2}$

Now, cross-multiplied:

$\frac{R_1(R_2+r)}{R_2(R_1+r)} = \frac{l_1}{l_2}$

Substitute the values:

$\frac{5(15+r)}{15(5+r)} = \frac{200}{300} = \frac{2}{3}$

Now, solve for r:

Cross-multiplied:

$3 \times 5(15 + r) = 2 \times 15(5 + r)$

$15(15 + r) = 10(5 + r)$

$225 + 15r = 50 + 10r$

$15r - 10r = 50 - 225$

$5r = -175$

$r = -35$

Check calculation:

Let's try again, carefully:

$3 \times 5(15 + r) = 2 \times 15(5 + r)$

$15(15 + r) = 30(5 + r)$

$225 + 15r = 150 + 30r$

$225 - 150 = 30r - 15r$

$75 = 15r$

$r = \frac{75}{15} = 5\Omega$

Final Answer:

The internal resistance of the cell is $\boxed{5\,\Omega}$.

Correct Option: Option C

Question28

To determine the internal resistance of a cell with potentiometer, when the cell is shunted by a resistance of 5Ω the balancing length is 250 cm . When the cell is shunted by 20Ω, the balancing length of potentiometer wire is 400 cm . The internal resistance , of the cell is

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Options:

A. 3Ω

B. 4Ω

C. 5Ω

D. 6Ω

Answer: C

Solution:

Let the e.m.f. of the cell be E and internal resistance be r.

Step 1: Write the formula for balance condition

When cell is connected in parallel with a shunt R, the potential difference across it (for a balance length l on potentiometer) is:

$V = kl$

where k is the potential gradient.

Current through the external resistance R:

$I = \frac{E}{R+r}$

Potential difference across R:

$V = IR = \frac{ER}{R+r}$

At balance, this V is equal to kl:

$kl = \frac{ER}{R+r}$

Step 2: Write equations for both conditions

Case 1: $R_1 = 5\,\Omega$, $l_1 = 250$ cm

$k \cdot 250 = \frac{E \cdot 5}{5+r}$

Case 2: $R_2 = 20\,\Omega$, $l_2 = 400$ cm

$k \cdot 400 = \frac{E \cdot 20}{20+r}$

Step 3: Divide (1) by (2) to eliminate k and E

$\frac{k \cdot 250}{k \cdot 400} = \frac{\frac{E \cdot 5}{5+r}}{\frac{E \cdot 20}{20+r}}$

$\frac{250}{400} = \frac{5}{5+r} \times \frac{20+r}{20}$

$\frac{5}{8} = \frac{5(20+r)}{20(5+r)}$

Step 4: Simplify and solve for r

Multiply both sides by $20(5+r)$:

$\frac{5}{8} \times 20(5+r) = 5(20+r)$

$\frac{100}{8}(5+r) = 100 + 5r$

$12.5(5+r)=100+5r$

$62.5+12.5r=100+5r$

Subtract $5r$ from both sides:

$62.5+7.5r=100$

Subtract 62.5:

$7.5r=37.5$

$r=\frac{37.5}{7.5}=5\,\Omega$

Final Answer:

$\boxed{5\,\Omega}$

So, the correct answer is **Option C:** $5\,\Omega$.

Question29

Two cells E_1 and E_2 having equal e.m.f ' E ' and internal resistances r_1 and r_2 $(r_1>r_2)$ respectively are connected in series. This combination is connected to an external resistance ' R '. It is observed that the potential difference across the cell E_1 becomes zero. The value of R will be

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Options:

A. $\mathrm{r}_1-\mathrm{r}_2$

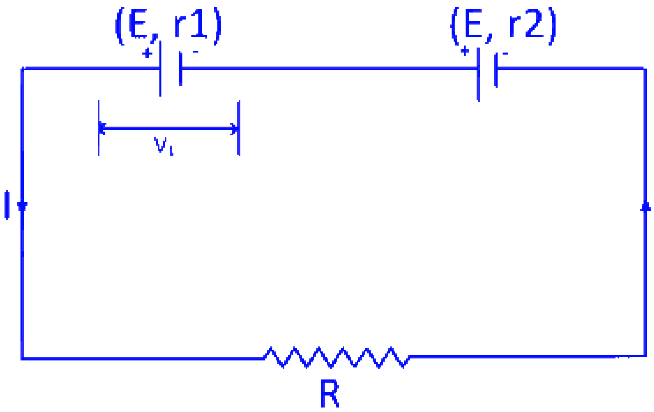
B. r_1+r_2

C. $\frac{r_1-r_2}{2}$

D. $\frac{r_1+r_2}{2}$

Answer: A

Solution:



Current in the circuit: $I = \frac{2E}{R+r_1+r_2}$

Terminal p.d across 1st cell is $V_1 = E - Ir_1$

Given: $V_1 = 0$

$$\Rightarrow \quad E - Ir_1 = 0$$
$$E - \left(\frac{2E}{R+r_1+r_2}\right)r_1 = 0$$
$$E = \frac{2Er_1}{R+r_1+r_2}$$
$$R+r_1+r_2 = 2r_1$$
$$\Rightarrow \quad R = r_1 - r_2$$

Question30

If only 5% of the total current is to be passed through galvanometer of resistance G , then the resistance of the shunt will be

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Options:

A. $\frac{G}{15}$

B. $\frac{G}{17}$

C. $\frac{G}{19}$

D. $\frac{G}{21}$

Answer: C

Solution:

Let the total current be I.

Only 5% of I should pass through the galvanometer.

So, current through galvanometer,

$I_g = \frac{5}{100} I = \frac{I}{20}$

Current through shunt,

$I_{sh} = I - I_g = I - \frac{I}{20} = \frac{19I}{20}$

If G is the resistance of galvanometer and S is the resistance of the shunt, both are in parallel across the same voltage.

By Ohm's Law:

Voltage across $G =$ Voltage across S

$I_g \cdot G = I_{sh} \cdot S$

Substitute the values:

$\frac{I}{20} \cdot G = \frac{19I}{20} \cdot S$

Divide both sides by I:

$\frac{1}{20} G = \frac{19}{20} S$

Divide both sides by $\frac{19}{20}$:

$S = \frac{1}{20} G \times \frac{1}{\frac{19}{20}}$

$S = \frac{G}{19}$

Correct Option:

$\boxed{\frac{G}{19}}$

So, the right answer is Option C.

Question31

The scale of a galvanometer is divided into 160 equal divisions. The galvanometer shows full scale deflection of 16 mA and maximum voltage is 80 mV . Now the range is changed so that galvanometer reads 160 V . The required resistance to be connected is

Options:

A. 9995Ω in series.

B. 4995Ω in series.

C. $9.5 \times 10^{-3}\Omega$ in parallel.

D. $4.95 \times 10^{-3}\Omega$ in parallel.

Answer: A

Solution:

Given: $\mathrm{I_g} = 16 \mathrm{~mA} = 16 \times 10^{-3}\Omega$

$\mathrm{V_g} = 80 \mathrm{~mA} = 80 \times 10^{-3}\Omega$

The galvanometer's internal resistance R_g will be:

$\mathrm{R_g} = \frac{\mathrm{V_g}}{\mathrm{I_g}} = \frac{80 \times 10^{-3}}{16 \times 10^{-3}} = 5\Omega$

To increase the range of the galvanometer to 160 V , resistance needs to be connected in series to limit the current through the galvanometer to its full-scale deflection current when 160 V is applied.

This configuration converts the galvanometer into a voltmeter with a range of 160 V .

For a voltmeter, the total voltage (V) across the galvanometer and the series resistor is given by:

$V_g = I_g\left(R_g + R_s\right)$

Substituting the values, we get:

$$160 = 16 \times 10^{-3}\left(5 + R_s\right)$$
$$R_s = \frac{160}{16 \times 10^{-3}} - 5 = 10000 - 5 = 9995\Omega$$

Thus, the correct answer is 9995Ω in series.

Question32

Two identical galvanometers are converted into an ammeter and into milliammeter. For the same current, the value of shunt of the ammeter as compared to that of milliammeter is

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Options:

A. less

B. equal

C. more

D. zero

Answer: A

Solution:

We start with the fact that when converting a galvanometer (with full-scale deflection current I_g and internal resistance R_g) into an ammeter, a shunt resistor is connected in parallel with the galvanometer. This shunt resistor is chosen so that when the instrument carries its full-scale current (say, I), only I_g passes through the galvanometer and the balance, $I - I_g$, goes through the shunt. Since the voltage across both branches must be the same, we have

$I_g R_g = (I - I_g) R_s,$

which gives

$R_s = \frac{I_g R_g}{I - I_g}.$

Let's compare two cases:

For an ammeter (designed for high currents), let the full-scale reading be I_A. Then the required shunt is

$R_{sh,A} = \frac{I_g R_g}{I_A - I_g}.$

For a milliammeter (designed for measuring currents in the milliampere range), let the full-scale reading be I_m (and here, I_m is only slightly greater than I_g). Then the required shunt is

$R_{sh,m} = \frac{I_g R_g}{I_m - I_g}.$

Since an ammeter is meant for much larger currents, we typically have

$I_A \gg I_m.$

Thus, the denominator in $R_{sh,A}$ becomes very large compared to that in $R_{sh,m}$. In effect,

$R_{sh,A} < R_{sh,m}.$

In other words, for the same galvanometer (and hence the same I_g and R_g) and for the same actual current through the instrument, the conversion of the galvanometer into an ammeter (with a high current range) requires a much smaller shunt resistor compared to the one used for converting it into a milliammeter.

So, the shunt of the ammeter is ***less*** than that of the milliammeter.

Answer: Option A (less).

Question33

When a resistance of 200Ω is connected in series with a galvanometer of resistance ' G ', its range is ' V '. To triple its range, a resistance of 2000Ω is connected in series. The value of ' G ' is

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Options:

A. 200Ω

B. 400Ω

C. 600Ω

D. 700Ω

Answer: D

Solution:

To solve for the galvanometer resistance ' G ', we use the formula:

$R_s = \frac{V}{I_g} - G$

For the two cases provided:

First Case: A resistance of 200Ω is connected in series. Using the formula, we get:

$200 = \frac{V}{I_g} - G$

Second Case: A resistance of 2000Ω is added to triple the range, leading to:

$2000 = \frac{3V}{I_g} - G$

By subtracting equation (1) from equation (2), we eliminate G and solve for $\frac{V}{I_g}$:

$2000 - 200 = \frac{3V}{I_g} - \frac{V}{I_g}$

$1800 = \frac{2V}{I_g}$

$\therefore \frac{V}{I_g} = 900$

Substituting $\frac{V}{I_g} = 900$ back into equation (1):

$200 = 900 - G$

Solving for G gives:

$G = 700\Omega$

Question34

When a resistance of 100Ω is connected in series with a galvanometer of resistance G , its range is V . To double its range a resistance of 1000Ω is connected in series. The value of G is

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Options:

A. 800Ω

B. 300Ω

C. 200Ω

D. 100Ω

Answer: A

Solution:

Given:

First scenario with a resistance of $100\,\Omega$ in series leads to a range V.

Second scenario, for doubling the range, a resistance of $1000\,\Omega$ is connected.

The governing equation for resistance in series to reach the required voltage range is:

$R_s = \frac{V}{I_s} - G$

For the first scenario:

$100 = \frac{V}{I_s} - G \quad \text{(Equation 1)}$

For the second scenario, where the range is doubled:

$1000 = \frac{2V}{I_s} - G \quad \text{(Equation 2)}$

Subtract Equation 1 from Equation 2:

$1000 - 100 = \left(\frac{2V}{I_s} - \frac{V}{I_s}\right)$

Solving the above, we find:

$900 = \frac{V}{I_s} \quad \text{(Equation 3)}$

Using Equation 3 in Equation 1:

$100 = 900 - G$

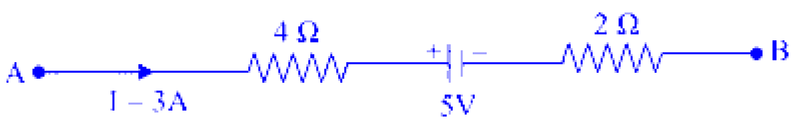
Solving for G, we get:

$G = 800\,\Omega$

Therefore, the resistance of the galvanometer is $800\,\Omega$.

Question35

The potential difference $(V_A - V_B)$ between the points A and B in the given part of the circuit



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Options:

A. -13V

B. 13V

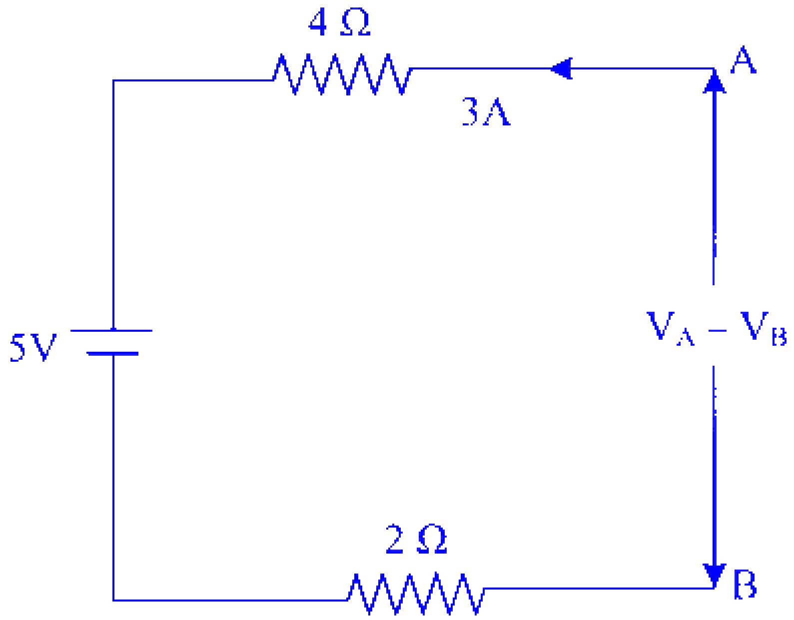
C. -23V

D. 23V

Answer: D

Solution:

Given circuit can also be drawn as,



By Kirchhoff's voltage law,

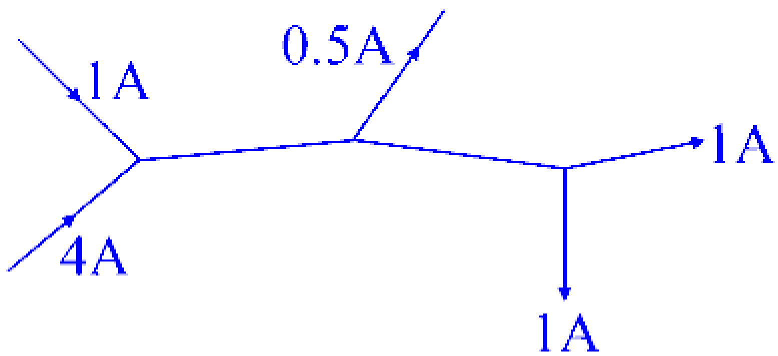
$$V_A - (4 \times 3) - (5) - (2 \times 3) - V_B = 0$$

$\therefore \quad V_A - 12 - 5 - 6 - V_B = 0$

$\therefore \quad V_A - V_B = +23 \text{ V}$

Question36

The figure shows currents in a part of electric circuit. Then current I is



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Options:

A. 3.5 A

B. 1.5 A

C. 4 A

D. 2.5 A

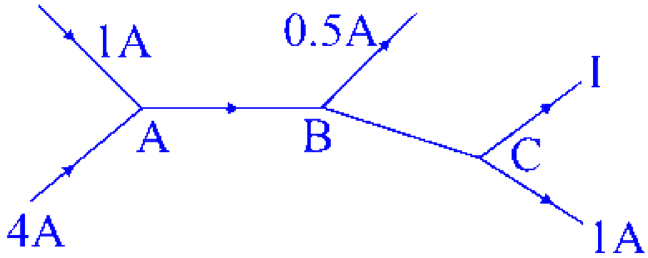
Answer: A

Solution:

According to Kirchhoff's first law,

At junction A, $I_A = 1 + 4 = 5$ A

At junction B, $I_A = I_{BC} + 0.5 \Rightarrow I_{BC} = 4.5$ A



At junction C, $I = I_{BC} - 1 = 4.5 - 1 = 3.5$ A

Question37

A galvanometer may be converted into ammeter or a voltmeter. In which of the following cases the resistance of the device so obtained will be the largest?

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Options:

A. Ammeter of range 1 A

B. Ammeter of range 10 A

C. Voltmeter of range 1 V

D. Voltmeter of range 10 V

Answer: D

Solution:

To convert a galvanometer into an ammeter or voltmeter, we need to consider how resistance affects each device.

For a **voltmeter**, it is important to have **high resistance** because the resistance (R) is added in series with the galvanometer. Increasing the resistance extends the range of the voltmeter. Thus, to achieve a higher voltage range, the resistance must be increased.

Consequently, a voltmeter with a range of **10 V** will have the largest resistance compared to the other options because higher voltage ranges require higher resistance.

Question38

A galvanometer has resistance 80Ω and it is shunted with resistance 20Ω. If 20% of the main current flows through galvanometer, then what is the value of main current?

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Options:

A. 0.2 A

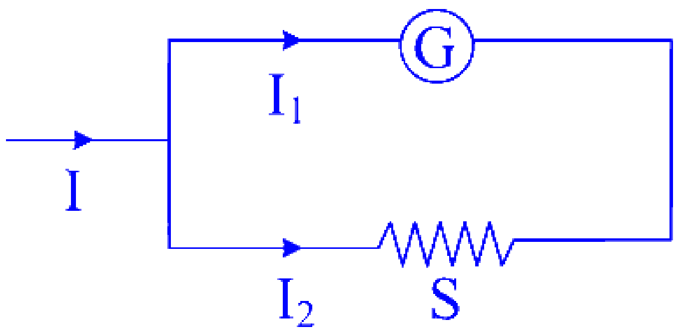
B. 0.8 A

C. 1 A

D. 1.2 A

Answer: C

Solution:



$$I = I_1 + I_2$$
$$I_1 = 0.2I \quad \therefore \quad I_2 = 0.8I$$
$$\text{Also, } I_1 G = I_2 S$$
$$\therefore \quad 0.2I \times 80 = 0.8I \times 20$$
$$\therefore \quad I = 1 \text{ A}$$

Question39

A cell balances against a length of 150 cm on a potentiometer wire when it is shunted by a resistance of 5Ω. But when it is shunted by a resistance of 10Ω, then balancing length increases by 25 cm . The balancing length when the cell is in an open circuit is

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Options:

A. 200 cm

B. 210 cm

C. 225 cm

D. 250 cm

Answer: B

Solution:

To solve for the balancing length when the cell is in an open circuit, we can use the equation related to the potentiometer setup:

$r = s\left(\frac{l-l_b}{l_b}\right)$

Here, r refers to the internal resistance of the cell, s is the shunt resistance, l is the total balancing length in an open circuit, and l_b is the balancing length when the cell is shunted.

Given:

First condition: $s = 5\,\Omega$, $l_b = 150\,\text{cm}$

Second condition: $s = 10\,\Omega$, $l_b = 175\,\text{cm}$ (increased by 25 cm)

Equating the two scenarios:

$5\left(\frac{l-150}{150}\right) = 10\left(\frac{l-175}{175}\right)$

Simplifying the equation:

$\frac{l-150}{6} = 2\left(\frac{l-175}{7}\right)$

Multiply both sides to clear the fractions:

$7(l-150) = 12(l-175)$

Expanding both sides:

$7l - 1050 = 12l - 2100$

Subtract $7l$ from both sides:

$-1050 = 5l - 2100$

Adding 2100 to both sides:

$1050 = 5l$

Solving for l:

$l = 210\,\text{cm}$

Thus, the balancing length of the cell in an open circuit is 210 cm.

Question40

A battery of 6 V is connected to the ends of uniform wire 3 m long and of resistance 100Ω. The difference of potential between two points 50 cm apart on the wire is

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Options:

A. 1 V

B. 1.5 V

C. 2 V

D. 3 V

Answer: A

Solution:

Resistance per unit length:

$R = \frac{\rho l}{A}$

Given that the total resistance of the 3 m wire is 100 Ω, we can express the resistance per unit length as:

$\frac{100}{3} = \frac{\rho}{A}$

Therefore, the resistance for 1 meter of the wire is $\frac{100}{3}\,\Omega/\text{m}$.

Resistance of a 50 cm segment:

The length of the segment in meters is 0.5 m. The resistance of this segment is:

$R' = \frac{\rho}{A} \times l = \frac{100}{3} \times 0.5 = \frac{50}{3}\,\Omega$

Current through the wire:

The current I flowing through the entire wire when connected to a 6 V battery can be calculated using Ohm's law:

$I = \frac{V}{R} = \frac{6}{100}\,\text{A}$

Potential difference across the 50 cm segment:

Using the formula $V = IR'$, we find the potential difference between the two points 50 cm apart:

$V = I \times R' = \frac{6}{100} \times \frac{50}{3} = 1\,\text{V}$

Thus, the potential difference between the two points 50 cm apart on the wire is $1\,\text{V}$.

Question41

Kirchhoff's second law is based on the law of conservation of

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Options:

A. charge

B. energy

C. momentum

D. inter conversion of mass into energy

Answer: B

Solution:

Kirchhoff's second law, often referred to as Kirchhoff's Voltage Law (KVL), states that the sum of all the voltages around any closed loop in a circuit is zero. This happens because the energy supplied to the circuit elements is completely converted into energy consumed by them, ensuring that energy is conserved.

Here's a quick breakdown:

Kirchhoff's Voltage Law ensures that the total energy gained equals the total energy lost as you move around a closed loop.

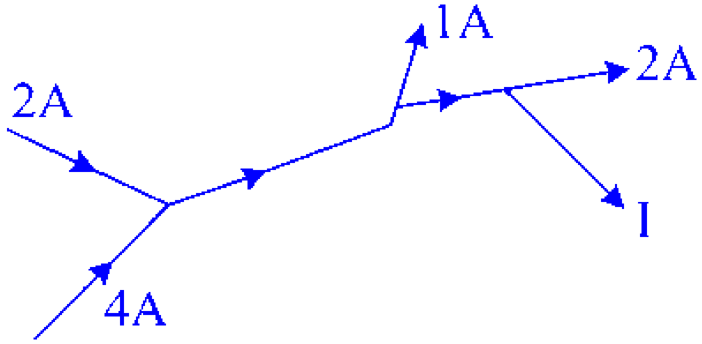
This directly reflects the **law of conservation of energy**—energy is neither created nor destroyed but only transformed.

In contrast, Kirchhoff's Current Law is based on the conservation of charge.

Thus, Kirchhoff's second law is based on the law of conservation of **energy**, which corresponds to Option B.

Question42

In the following electrical network, the value of I is



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Options:

A. 1 A

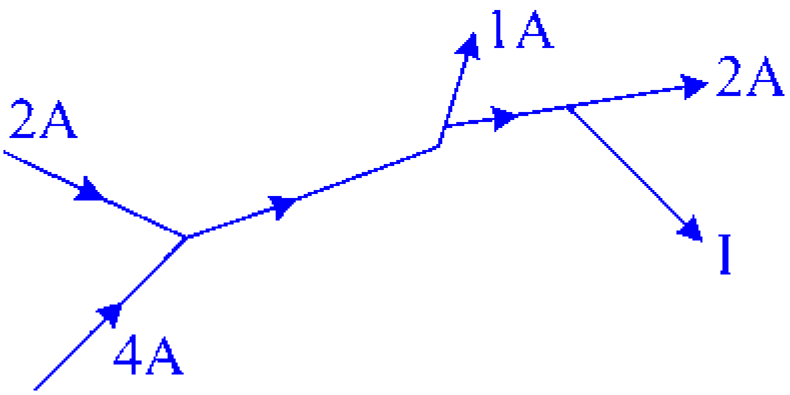
B. 2 A

C. 3 A

D. 4 A

Answer: C

Solution:



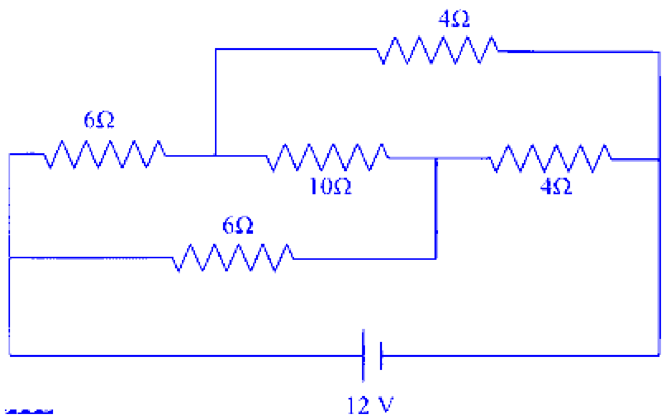
Using KCL,

$$2+4=1+2+I$$

$$\therefore \quad I=3 \text{ A}$$

Question43

The current drawn from the battery in the given network is (Internal resistance of the battery is negligible)



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Options:

A. 1.2 A

B. 2.4 A

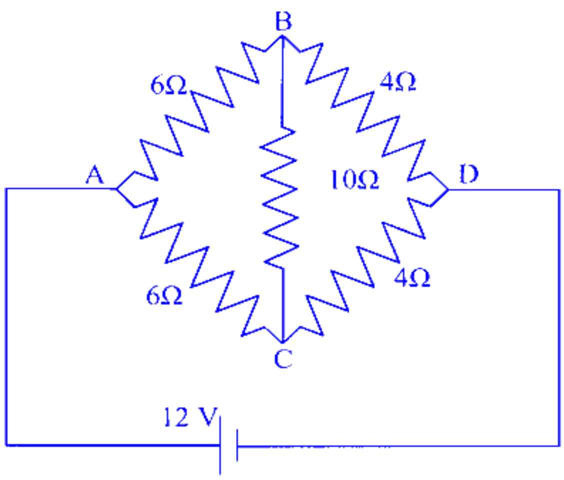
C. 4 A

D. 4.8 A

Answer: B

Solution:

The given circuit can be drawn as:



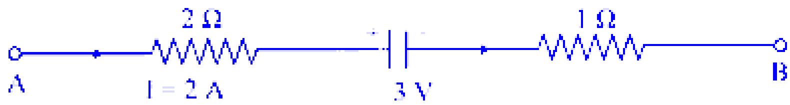
From the figure, we can see that this is a balanced Wheatstone bridge.

$\therefore \quad \frac{1}{R} = \frac{1}{10} + \frac{1}{10} = \frac{2}{10} = \frac{1}{5}$

$\therefore \quad R=5 \Omega$
$\therefore \quad I=\frac{12}{5}=2.4 \mathrm{~A}$

Question44

The potential difference $\left(V_A-V_B\right)$ between the points ' A ' and ' B ' in the given part of the circuit is



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Options:

A. -3 V

B. 3 V

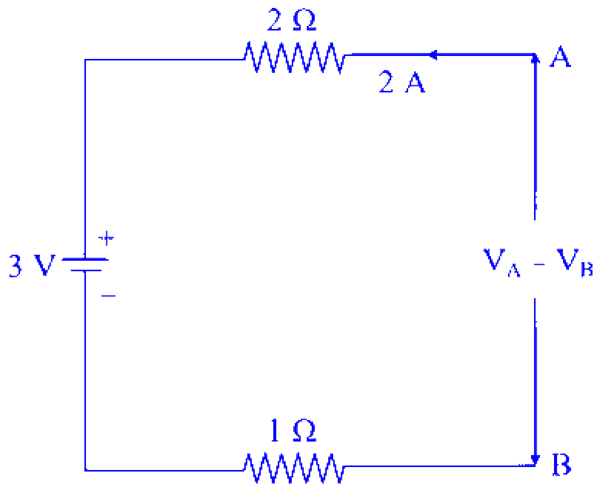
C. 6 V

D. 9 V

Answer: D

Solution:

Given circuit can also be drawn as,



By Kirchhoff's voltage law,

$V_A - (2 \times 2) - (3) - (2 \times 1) - V_B = 0$

$\therefore \quad V_A - 4 - 3 - 2 - V_B = 0$

$\therefore \quad V_A - V_B = +9 \text{ V}$

Question45

In an ammeter, 0.25% of main current passes through the galvanometer. If the resistance of the galvanometer is ' G ', the resistance of ammeter will be

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Options:

A. $\frac{399}{400} \mathrm{G}$

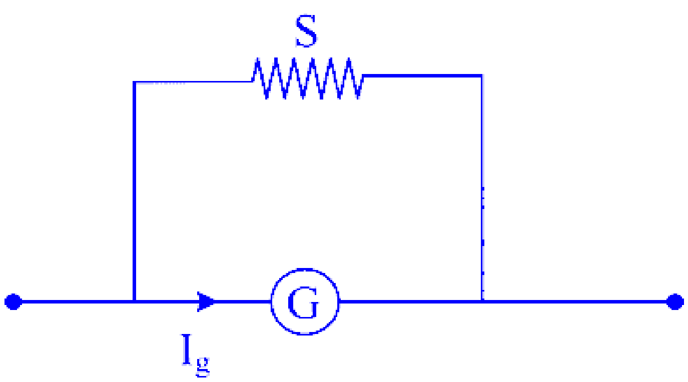
B. $\frac{1}{400} \mathrm{G}$

C. $\frac{499}{500} \mathrm{G}$

D. $\frac{1}{500} \mathrm{G}$

Answer: B

Solution:



$I = I_g + I_s$

$$I = \frac{0.25I}{100} + I_s$$

$$I_s = \frac{399}{400}I \quad .... (i)$$

$$I_g G = I_s S$$

$$S = \frac{0.25}{100} \times \frac{400}{399} \times G \quad .... [From (i)]$$

$$S = \frac{1}{399}G \quad .... (ii)$$

Total resistance of ammeter

$$R = \frac{GS}{G+S}$$

$$= \frac{G\left(\frac{1}{399}G\right)}{\left(G + \frac{1}{399}G\right)} \quad ... [From (ii)]$$

$$= \left(\frac{\frac{1}{399}}{\frac{400}{399}}\right)G$$

$$R = \frac{1}{400}G$$

Question46

In potentiometer experiment, cells of e.m.f. E_1 and E_2 are connected in series $(E_1 > E_2)$ the balancing length is 80 cm of the wire. If the polarity of E_2 is reversed, the balancing length becomes 20 cm. The ratio $\mathrm{E}_1/\mathrm{E}_2$ is

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Options:

A. 1 : 2

B. 2 : 3

C. 3 : 4

D. 5 : 3

Answer: D

Solution:

In a potentiometer experiment, when cells with electromotive forces (emfs) E_1 and E_2 are connected in series $(E_1 > E_2)$, the balancing length of the wire is 80 cm. If the polarity of E_2 is reversed, the balancing length changes to 20 cm. To find the ratio $\frac{E_1}{E_2}$, we use the following formula for potentiometer readings:

$\frac{E_1}{E_2} = \frac{l_1+l_2}{l_1-l_2}$

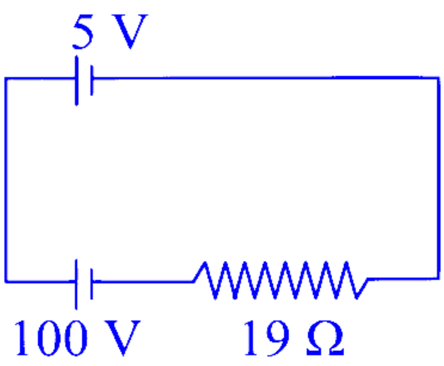
Plugging in the given values:

$\frac{E_1}{E_2} = \frac{80+20}{80-20} = \frac{100}{60} = \frac{5}{3}$

Thus, the ratio $\frac{E_1}{E_2}$ is 5 : 3.

Question47

In the circuit, current flowing through the circuit is



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Options:

A. 2A

B. 3A

C. 4A

D. 5A

Answer: D

Solution:

To determine the current flowing through the circuit, we first calculate the effective voltage (V_{eq}). According to the diagram, it is given as:

$V_{\text{eq}} = 100 \text{ V} - 5 \text{ V} = 95 \text{ V}$

Using Ohm's Law, $V = IR$, we can find the current (I):

$I = \frac{V_{\text{eq}}}{R} = \frac{95}{19} = 5 \text{ A}$

Therefore, the current flowing through the circuit is 5 A.

Question48

Two identical galvanometers are converted into voltmeter and millivoltmeter. As compared to the series resistance of voltmeter, the series resistance of millivoltmeter will be

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Options:

A. equal

B. more

C. less

D. zero

Answer: C

Solution:

To understand the answer, let's consider how a galvanometer is converted into a voltmeter.

The conversion is done by adding a series resistor so that when the maximum voltage, V_{max}, is applied, the current through the galvanometer (which has a full-scale deflection current I_g) is not exceeded.

The relation used is:

$R_{series} = \frac{V_{max}}{I_g} - R_g,$

where R_g is the galvanometer's internal resistance.

For a voltmeter, V_{max} is relatively high. Therefore, its series resistance becomes larger.

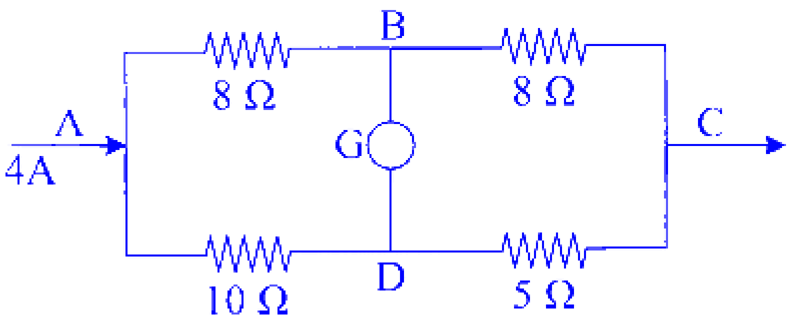
For a millivoltmeter, V_{max} is much smaller, resulting in a smaller series resistance.

Thus, compared to the voltmeter, the series resistance of the millivoltmeter is **less**.

The correct answer is Option C.

Question49

Potential difference between the points A and B is nearly



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Options:

A. 10 V

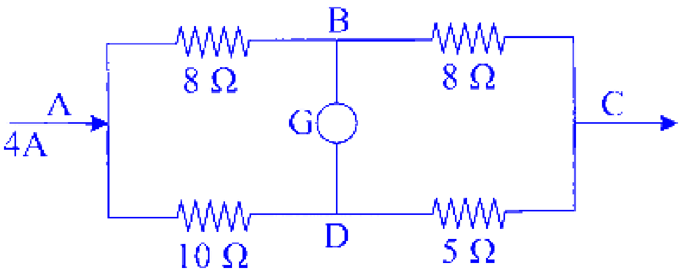
B. 14 V

C. 18 V

D. 20 V

Answer: C

Solution:



The given circuit is a Wheatstone's bridge, As the resistances are in the same ratio, the bridge is balanced. Therefore, no current will flow through the galvanometer and the resistances will be in parallel combination.

$\therefore$ Voltage between A and C is $V_{AC} = I.R_{\text{eff}}$

$$\frac{1}{R_{eff}} = \frac{1}{(8+4)} + \frac{1}{(10+5)} \Rightarrow R_{eff} = \frac{15 \times 12}{27} = 6.67\Omega$$

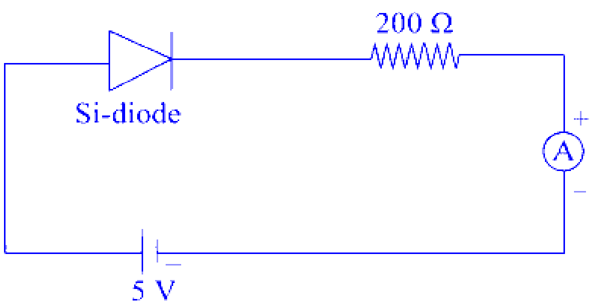
$$\therefore \quad V_{AC} = 4 \times 6.67 = 26.68 \text{ V} \quad \ldots [\text{ From(i) }]$$

$$\therefore \quad \text{I}_{AC} = \frac{V_{AC}}{R_{AB} + R_{BC}} = \frac{26.68}{8+4} = 2.22 \text{ A}$$

$$V_{AB} = I_{AC} \times R_{AB} = 2.22 \times 8 = 17.76 \text{ V} = 18 \text{ V}$$

Question50

In the following circuit, the reading in the ammeter is



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Options:

A. 25.1 mA

B. 22.5 mA

C. 21.5 mA

D. 21.25 mA

Answer: C

Solution:

Reading of ammeter shows the current in the circuit.

Current is given by, $\mathrm{I}=\mathrm{V} / \mathrm{R}$

I. (i) $\frac{\mathrm{V}-\mathrm{V}_{\text {diode }}}{\mathrm{R}}$

For silicon diode, $\mathrm{V}_{\text {diode }} \quad=0.7 \mathrm{~V}$

$\therefore \quad I=\frac{5-0.7}{200}=\frac{4.3}{200}=21.5 \mathrm{~mA}$

Question51

In an ammeter, 4% of the main current is passing through the galvanometer, If shunt resistance is 5Ω, then resistance of galvanometer will be

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Options:

A. 60Ω

B. 120Ω

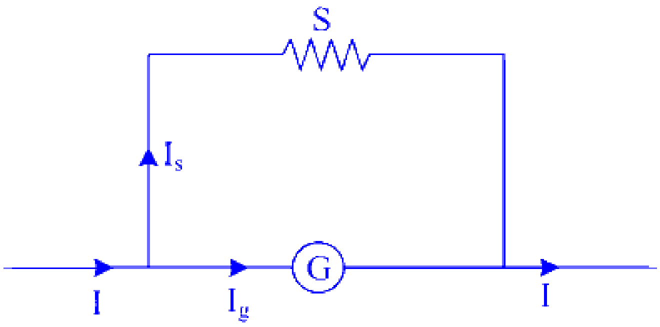
C. 240Ω

D. 480Ω

Answer: B

Solution:

Shunt $\mathrm{S}=\frac{\mathrm{I}_{\mathrm{g}} \mathrm{G}}{\mathrm{I}-\mathrm{I}_{\mathrm{g}}}$



On substituting the given values, we get,

$$\therefore \quad 5=\frac{\left(\frac{4}{100} I \times G\right)}{I-\frac{4}{100} I}=\frac{4 G}{96}$$

$$\Rightarrow G=\frac{96 \times 5}{4}=120 \Omega$$

Question52

When the two known resistance ' R ' and ' S ' are connected in the left and right gaps of a meter bridge respectively, the null point is found at a distance ' l_1 ' from the zero end of a meter bridge wire. An unknown resistance ' X ' is now connected in parallel with ' S ' and null point is found at a distance ' l_2 ' form zero end of meter bridge wire. The unknown resistance ' X ' is

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Options:

A. $\frac{\mathrm{S} l_1\left(100-l_2\right)}{100\left(l_2-l_1\right)}$

B. $\frac{\mathrm{S} l_2\left(100-l_1\right)}{100\left(l_1-l_2\right)}$

C. $\frac{100\left(l_2-l_1\right)}{\mathrm{S} l_1\left(100-l_2\right)}$

D. $\frac{100\left(l_2-l_1\right)}{\mathrm{S} l_2\left(100-l_1\right)}$

Answer: C

Solution:

To determine the unknown resistance X using a meter bridge, consider the following conditions:

First Condition

Initially, when the resistances R and S are in the left and right gaps, the null point is at a distance l_1 from the zero end. Using the balancing condition of the meter bridge, we have:

$\frac{R}{l_1} = \frac{S}{100-l_1}$

Second Condition

When an unknown resistance X is connected in parallel with S and the null point shifts to a distance l_2 from the zero end, the balancing condition becomes:

$\frac{R}{l_2} = \frac{XS}{(X+S)(100-l_2)}$

Equating the two conditions, we can derive the relationship:

$\frac{l_1 S}{100-l_1} = \frac{l_2 XS}{(X+S)(100-l_2)}$

Simplifying further:

$\frac{100-l_1}{l_1} = \left(1 + \frac{S}{X}\right)\frac{100-l_2}{l_2}$

Rearranging, we find:

$1 + \frac{S}{X} = \frac{l_2(100-l_1)}{l_1(100-l_2)}$

Subtracting 1 from both sides:

$\frac{S}{X} = \frac{l_2(100-l_1)-l_1(100-l_2)}{l_1(100-l_2)}$

Which simplifies to:

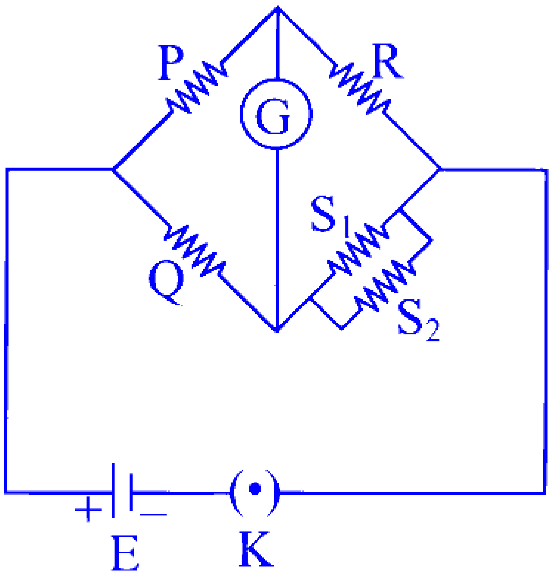
$\frac{S}{X} = \frac{100(l_2-l_1)}{l_1(100-l_2)}$

Thus, solving for X:

$X = \frac{Sl_1(100-l_2)}{100(l_2-l_1)}$

Question53

In a Wheatstone's bridge, the resistances in four arms are as shown in the figure. The balancing condition of the bridge is



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Options:

A. $\frac{\mathrm{P}}{\mathrm{Q}}=\frac{\mathrm{R}}{\mathrm{S}_1+\mathrm{S}_2}$

B. $\frac{P}{Q}=\frac{R\left(S_1 S_2\right)}{S_1+S_2}$

C. $\frac{P}{Q}=\frac{R\left(S_1+S_2\right)}{2 S_1 S_2}$

D. $\frac{\mathrm{P}}{\mathrm{Q}}=\frac{\mathrm{R}\left(\mathrm{S}_1+\mathrm{S}_2\right)}{\mathrm{S}_1 \mathrm{~S}_2}$

Answer: D

Solution:

For balancing the bridge,

$$\frac{\mathrm{P}}{\mathrm{Q}}=\frac{\mathrm{R}}{\mathrm{S}}$$

$$\mathrm{S}=\frac{\mathrm{S}_1 \mathrm{~S}_2}{\mathrm{~S}_1+\mathrm{S}_2} \quad \ldots .(\because \mathrm{S}_1, \mathrm{~S}_2 \text { are in parallel })$$

$$\therefore \quad \frac{P}{Q}=\frac{R\left(S_1+S_2\right)}{S_1 S_2}$$

Question54

When a galvanometer is shunted by a resistance ' s ', its current capacity increases ' n ' times. If the same galvanometer is shunted by another resistance ' s_1 ', its capacity will increase to ' n_1 ' times original current. The value of ' n_1 ' is

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Options:

A. $\frac{(\mathrm{n}+\mathrm{s})}{\mathrm{s}_1}$

B. $\frac{s_1(n-s)-s_1}{s_1}$

C. $\frac{(n+1) s}{s_1}$

D. $\frac{\mathrm{s}(\mathrm{n}-1)+\mathrm{s}_1}{\mathrm{s}_1}$

Answer: D

Solution:

When a galvanometer is shunted with a resistance ' s ', its current handling capacity increases by a factor of ' n '. If this galvanometer is then shunted with a different resistance ' s_1 ', its capacity is enhanced to ' n_1 ' times the original current capacity.

Derivation

Shunt Resistance Formula:

The formula for shunt resistance, when applied to a galvanometer, is:

$$s=G\left(\frac{1}{1-\frac{I}{I_g}}\right)$$

Here, G represents the galvanometer constant, I is the total current, and I_g is the maximum current the galvanometer can handle initially.

Current Capacity Factor:

The current capacity factor n is expressed as:

$n = \frac{1}{I_g}$

Therefore, using the relationship for shunt resistance:

$s = G\left(\frac{1}{1-n}\right)$

Rearranging the terms provides:

$G = s(n-1) \quad$ (Equation i)

Shunted with Another Resistance s_1:

When the galvanometer is shunted with another resistance s_1, the new formula becomes:

$s_1 = G\left(\frac{1}{1-n_1}\right)$

Solving for n_1:

$n_1 = \frac{G+s_1}{s_1}$

Substituting Equation (i) into this:

$n_1 = \frac{s(n-1)+s_1}{s_1}$

This expression gives you the new current capacity factor ' n_1 ' when the galvanometer is shunted with the resistance ' s_1 '.

Question55

In a meter bridge experiment, the balance point is obtained if the gaps are closed by 2Ω and 3Ω. A shunt of $\mathrm{X}\Omega$ is added to 3Ω resistor to shift the null point by 22.5 cm. The value of ' x ' is

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Options:

A. 1Ω

B. 2Ω

C. 3Ω

D. 4Ω

Answer: B

Solution:

Case 1: Initial Condition

The balance equation is given by:

$\frac{2}{3} = \frac{l}{100-l}$

Solving for l:

$200 - 2l = 3l 5l = 200l = 40\,\text{cm}$

Case 2: With Shunt

Now, with the shunt, the resistance changes and the length becomes $40 + 22.5$ cm, leading to the equation:

$\frac{2}{\frac{3X}{3+X}} = \frac{40+22.5}{100-(40+22.5)}$

Substitute and simplify the equation:

$\frac{2(3+X)}{3X} = \frac{62.5}{37.5}$

Solving for X:

$(6 + 2X) \times 37.5 = 3X \times 62.5$

Expanding and simplifying gives:

$225 + 75X = 187.5X 187.5X - 75X = 225 112.5X = 225 X = \frac{225}{112.5} = 2\,\Omega$

Thus, X is $2\,\Omega$.

Question56

A potentiometer wire of length 1 m is connected in series with 495Ω resistance and 2 V battery. If $0.2 \mathrm{mV/cm}$ is the potential gradient, then the resistance of the potentiometer wire is

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Options:

A. 8Ω

B. 6Ω

C. 7Ω

D. 5Ω

Answer: D

Solution:

Given:

The total resistance in series is $R + 495\,\Omega$.

The battery voltage is 2 V.

The potential gradient along the wire is $0.2\,\mathrm{mV/cm}$.

The length of the potentiometer wire, $L = 1\,\mathrm{m} = 100\,\mathrm{cm}$.

Step 1: Determine the current (I) in the circuit:

$I = \frac{V}{R_{\text{total}}} = \frac{2}{R+495}$

Step 2: Use the potential gradient (ϕ) formula:

The potential gradient is given by:

$\phi = \frac{V}{L} = \frac{IR}{L} = \frac{2R}{(R+495)}$

Given $\phi = 0.2\,\mathrm{mV/cm} = 0.02\,\mathrm{V/m}$, we can set up the equation:

$0.02 = \frac{2R}{(R+495)}$

Step 3: Solve the equation for R:

$0.02 \times (R + 495) = 2R$

$1.98R = 9.9$

$R = \frac{9.9}{1.98} = 5\,\Omega$

Therefore, the resistance of the potentiometer wire is $5\,\Omega$.

Question57

When a galvanometer is shunted by a resistance ' S ', its current capacity increases ' n ' times. If the same galvanometer is shunted by another resistance S', its current capacity increases to n'. The value of n' in terms of n, S and S' is

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Options:

A. $\frac{\mathrm{n}+\mathrm{S}}{\mathrm{S}'}$

B. $\frac{\mathrm{S}(\mathrm{n}-1)-\mathrm{S}'}{\mathrm{S}'}$

C. $\frac{(\mathrm{n}+1)\mathrm{S}}{\mathrm{S}'}$

D. $\frac{\mathrm{S}(\mathrm{n}-1)+\mathrm{S}'}{\mathrm{S}'}$

Answer: D

Solution:

Let I_g be the current capacity of the galvanometer without any shunt. When a shunt resistance S is connected, the current capacity increases to nI_g. The fraction of current passing through the galvanometer is given by:

$\frac{I_g}{nI_g} = \frac{S}{G+S}$

where G is the galvanometer resistance. This simplifies to:

$\frac{1}{n} = \frac{S}{G+S}$

Solving for G:

$G + S = nS$

$G = nS - S = S(n-1)$

Now, if the galvanometer is shunted by another resistance S', the current capacity increases to $n'I_g$. Using the same principle:

$\frac{I_g}{n'I_g} = \frac{S'}{G+S'}$

$\frac{1}{n'} = \frac{S'}{G+S'}$

Substitute the expression for G we derived earlier:

$\frac{1}{n'} = \frac{S'}{S(n-1)+S'}$

Solving for n':

$n' = \frac{S(n-1)+S'}{S'}$

Therefore, the value of n' in terms of n, S, and S' is:

$n' = \frac{S(n-1)+S'}{S'}$

Thus, the correct option is **D**.

Question58

Resistances in the left gap and right gap of a meter bridge are 10Ω and 30Ω respectively. If the resistances in the two gaps are interchanged, the balance point will shift to right by

MHT CET 2024 3rd May Evening Shift

Options:

A. 30 cm

B. 40 cm

C. 50 cm

D. 60 cm

Answer: C

Solution:

In a meter bridge, the balance point is determined based on the principle of a Wheatstone bridge. With a resistance $R_1 = 10\,\Omega$ in the left gap and $R_2 = 30\,\Omega$ in the right gap, the initial position of the balance point divides the bridge wire into lengths l_1 and l_2, where:

$\frac{R_1}{R_2} = \frac{l_1}{l_2}$

Given that the total length of the wire is 100 cm:

Initial Balance Point:

$\frac{10}{30} = \frac{l_1}{100-l_1} \implies \frac{1}{3} = \frac{l_1}{100-l_1}$

Solving for l_1:

$3l_1 = 100 - l_1 4l_1 = 100 l_1 = 25\,\text{cm}$

Thus, the initial balance point is at 25 cm from the left side.

After Interchanging the Resistances:

When the resistances are interchanged, the new principle becomes:

$\frac{30}{10} = \frac{l_1'}{100-l_1'}$

Solving for l_1':

$3 = \frac{l_1'}{100-l_1'} 3(100 - l_1') = l_1' 300 - 3l_1' = l_1' 300 = 4l_1' l_1' = 75\,\text{cm}$

Thus, the new balance point is at 75 cm from the left side.

Shift in the Balance Point:

The shift in the balance point is $l_1' - l_1$:

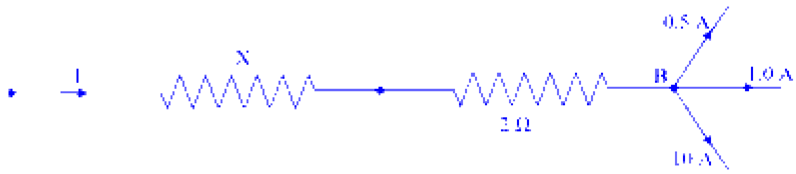
$\text{Shift} = 75\,\text{cm} - 25\,\text{cm} = 50\,\text{cm}$

Thus, the balance point shifts to the right by **50 cm**.

Answer: Option C: 50 cm.

Question59

In the following circuit, a power of 50 watt is absorbed in the section AB of the circuit. The value of resistance ' x ' is



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Options:

A. 10Ω

B. 8Ω

C. 6Ω

D. 4Ω

Answer: C

Solution:

Kirchhoff's Current Law (KCL): According to KCL, the total current (I) through the circuit can be calculated by adding the individual currents:

$I = 1 + 1 + 0.5 = 2.5\,\text{A}$

Calculate Total Resistance (R_total): The total resistance in the section AB includes the unknown resistance X and a known resistance of $2\,\Omega$.

$R_{\text{total}} = X + 2\,\Omega$

Power Calculation: The power absorbed in the section AB is given as $50\,\text{W}$. Use the power formula $P = I^2 R$:

$50 = (2.5)^2 (X + 2)$

Solve for X: Simplify the equation to find the value of X.

$50 = 6.25(X + 2)$

$\Rightarrow X + 2 = 8$

$\Rightarrow X = 6\,\Omega$

Therefore, the value of the resistance X is $6\,\Omega$.

Question60

The range of voltmeter of resistance ' G ' Ω is ' V ' volt. The resistance required to be connected in series with it in order to convert it into a voltmeter of range ' nV ' volt, will be

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Options:

A. $(\mathrm{n}-1) \mathrm{G}$

B. G / n

C. nG

D. $\frac{\mathrm{G}}{\mathrm{n}}-1$

Answer: A

Solution:

To find the resistance required to be connected in series with a voltmeter to extend its range from V volts to nV volts, we can use the following reasoning:

The total voltage across the voltmeter when in series with the additional resistance should equate to the new desired range. The relationship for voltmeters, which are essentially just high-resistance galvanometers, involves taking the ratio of the original and desired ranges.

Firstly, consider the following given parameters:

Original range of the voltmeter: V

Desired range of the voltmeter: nV

Original resistance of the voltmeter: G ohms

When the voltmeter spans the new range nV, the current through the voltmeter should remain the same as when it spanned just V. Let R be the additional resistance needed.

Using Ohm's Law, the current I through the voltmeter for the range V is given by:

$I=\frac{V}{G}$

For the new range nV, the same current should flow:

$I=\frac{nV}{G+R}$

Setting the two expressions for current equal gives:

$\frac{V}{G}=\frac{nV}{G+R}$

Solving for R, multiply both sides by $(G+R)$:

$V(G+R)=nVG$

Divide both sides by V:

$G+R=nG$

Subtract G from both sides:

$R=nG-G$

So the required resistance R is:

$R=(n-1)G$

Thus, the correct option is:

Option A

(n – 1)G

Question61

When cell of E.M.F. ' E_1 ' is connected to potentiometer wire, the balancing length is l_1. Another cell of E.M.F. ' E_2 ' $(E_1>E_2)$ is connected so that two cells oppose each other, then the balancing length is l_2. The ratio $\mathrm{E}_1:\mathrm{E}_2$ is

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Options:

A. $\frac{l_1}{l_1+l_2}$

B. $\frac{l_1}{l_1-l_2}$

C. $\frac{l_1+l_2}{l_1}$

D. $\frac{l_1+l_2}{l_1-l_2}$

Answer: B

Solution:

Assume the potential gradient along the uniform potentiometer wire is k volts per unit length. This means that a length l along the wire corresponds to a potential drop of $k\,l$ volts.

When the cell with EMF E_1 is connected to the potentiometer, the balancing length is given as l_1. This tells us that:

$E_1 = k\,l_1.$

Next, when the cell with EMF E_2 is connected in opposition to E_1, the net EMF acting on the wire becomes $E_1 - E_2$. The balancing length in this configuration is given as l_2. Hence, we write:

$E_1 - E_2 = k\,l_2.$

Now substitute the value of k from the first equation:

$k = \frac{E_1}{l_1}.$

So, replacing in the second equation:

$E_1 - E_2 = \frac{E_1}{l_1}\,l_2.$

Rearranging to solve for E_2 gives:

$E_2 = E_1 - \frac{E_1\,l_2}{l_1} = E_1\left(1 - \frac{l_2}{l_1}\right).$

Finally, to find the ratio $\frac{E_1}{E_2}$, we have:

$\frac{E_1}{E_2} = \frac{E_1}{E_1\left(1 - \frac{l_2}{l_1}\right)} = \frac{1}{1 - \frac{l_2}{l_1}} = \frac{l_1}{l_1 - l_2}.$

So, the ratio $E_1 : E_2$ is:

$\frac{l_1}{l_1 - l_2},$

which corresponds to Option B.

Question62

The current flowing in a coil is 3 A and the power consumed is 108 W . If the a.c. source is of $120 \mathrm{~V}, 50 \mathrm{~Hz}$, the resistance in the circuit is

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Options:

A. 24Ω

B. 36Ω

C. 12Ω

D. 6Ω

Answer: C

Solution:

To find the resistance in the circuit, use the formula for power in terms of resistance, current, and voltage:

$P = I^2 R$

Where:

P is the power consumed (108 W),

I is the current flowing through the coil (3 A),

R is the resistance we need to find.

Rearrange the formula to solve for R:

$R = \frac{P}{I^2}$

Now substitute the known values:

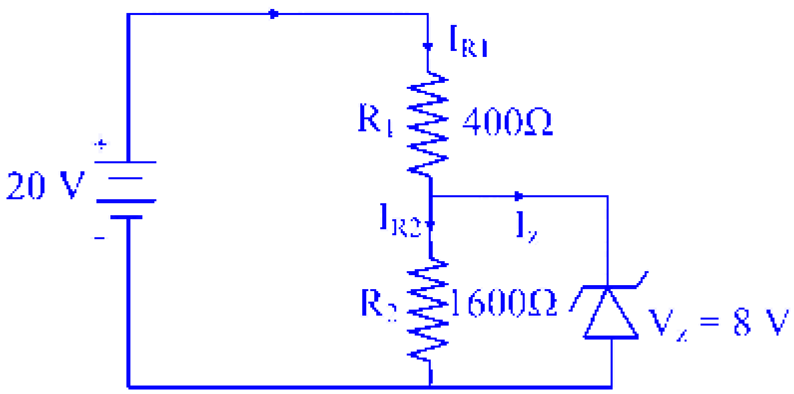
$R = \frac{108 \text{ W}}{(3 \text{ A})^2} = \frac{108}{9} = 12\,\Omega$

Therefore, the resistance in the circuit is $12\,\Omega$.

Correct Option: C) 12Ω

Question63

In the following circuit, the current flowing through zener diode is



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Options:

A. 35 mA

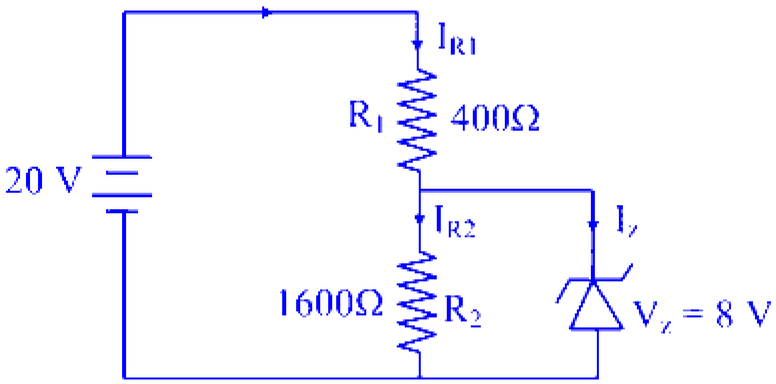
B. 25 mA

C. 15 mA

D. 5 mA

Answer: B

Solution:



The voltage drop across $\mathrm{R_2}$ is

$\mathrm{V_2 = V_z = 8\ V}$

The current through $\mathrm{R_2}$ is

$$\mathrm{I_2 = \frac{V_2}{R_2} = \frac{8}{1600} = 5 \times 10^{-3}\ A}$$
$$\mathrm{I_2 = 5\ mA} \quad \text{... (i)}$$

The voltage drop across $\mathrm{R_1}$ is

$$V_1 = 20 - V_2$$
$$20 - 8 = 12V$$

The current through R_1 is

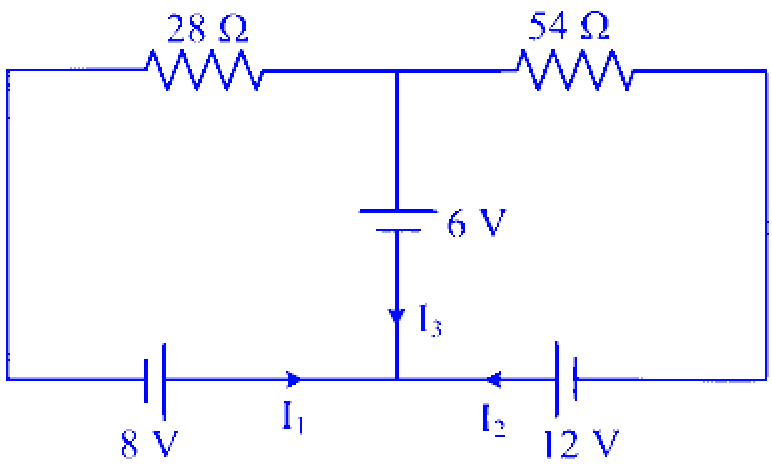
$$\mathrm{I_1 = \frac{V_1}{R_1} = \frac{12}{400} = 3 \times 10^{-2}\ A = 30 \times 10^{-3}\ A}$$
$$\mathrm{I_1 = 30\ mA} \quad \text{... (ii)}$$

The current through the Zener diode is

$$
\begin{aligned}
I_z &= I_1 - I_2 \\
&= (30 - 5)\text{mA} \quad \text{...[From (i) and (ii)]} \\
&= 25 \text{ mA}
\end{aligned}
$$

Question64

In the following circuit, the current I_2 is



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Options:

A. 5 A

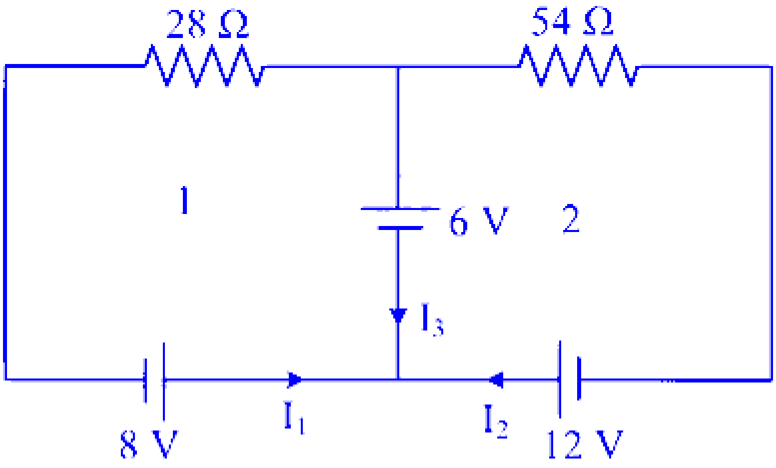
B. 3 A

C. $-3A$

D. $-\frac{5}{6}$ A

Answer: D

Solution:



Applying Kirchhoff's voltage law in loop 1 and 2

$\therefore \quad 28 I_1 = -6 - 8 = -\frac{1}{2}$ A

$\therefore \quad 54 I_2 = -6 - 12 = -\frac{1}{3}$ A

$\therefore \quad I_3 = I_1 + I_2 = -\frac{1}{2} + \left(-\frac{1}{3}\right) = -\frac{5}{6}$ A

Question65

A galvanometer of resistance ' G ' is shunted by resistance of 'S' ohm. To keep the main current in the circuit unchanged the resistance to be put in series with Galvanometer is

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Options:

A. $\frac{G^2}{S+G}$

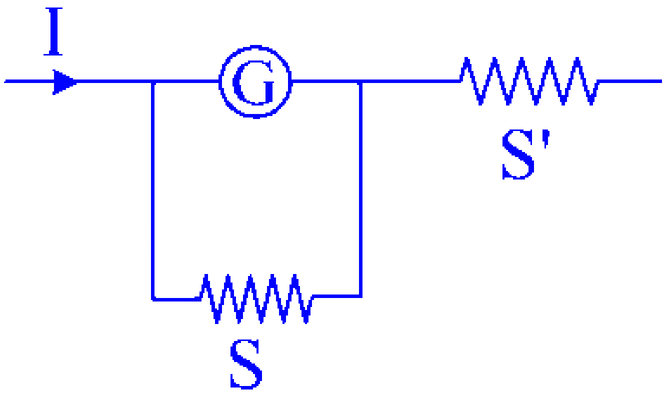
B. $\frac{G}{S+G}$

C. $\frac{S^2}{G+S}$

D. $\frac{GS}{S+G}$

Answer: A

Solution:



$$\text{Now, } G=\left(\frac{GS}{S+G}\right)+S'$$

$$\therefore \quad G-\frac{GS}{S+G}=S'$$

$$\therefore \quad S'=\frac{G^2}{S+G}$$

Question66

The resistances in the left and right gap of a metre bridge are 40Ω and 60Ω respectively. When the bridge is balanced, the distance of the null point from the centre of the wire towards left is

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Options:

A. 5 cm

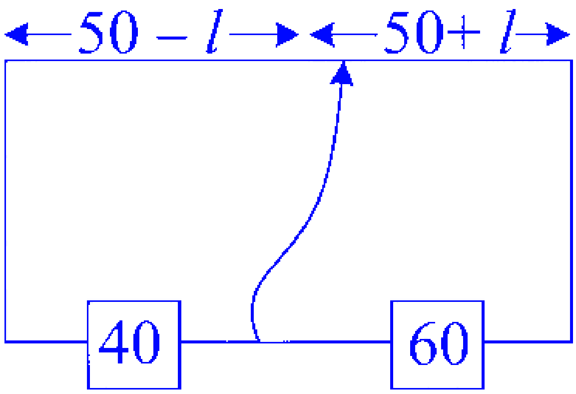
B. 10 cm

C. 15 cm

D. 20 cm

Answer: B

Solution:



From the given data,

$$\frac{40}{60} = \frac{50-l}{50+l}$$

$$2000 + 40l = 3000 - 60l$$

$$100l = 1000$$

$$\therefore \quad l = 10 \text{ cm}$$

Question67

When moving coil galvanometer (MCG) is converted into a voltmeter, the series resistance is 'n' times the resistance of galvanometer. How many times that of MCG the voltmeter is now capable of measuring voltage?

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Options:

A. n

B. $\frac{n+1}{n}$

C. $n + 1$

D. $n - 1$

Answer: C

Solution:

Series resistance is n times of galvanometer resistance: $R_s = nR_G$

Relation between voltage and current:

$$\therefore \quad V = I(R_s + R_G)$$
$$\therefore \quad V = I(nR_G + R_G)$$
$$\therefore \quad V = IR_G(n+1)$$

Question68

In potentiometer experiment, the balancing length is $8 \mathrm{~m}$ when two cells E_1 and E_2 are joined in series. When two cells are connected in opposition the balancing length is $4 \mathrm{~m}$. The ratio of the e.m.f. of the two cells $\left(\frac{E_1}{E_2}\right)$ is

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Options:

A. 1 : 2

B. 2 : 1

C. 1 : 3

D. 3 : 1

Answer: D

Solution:

$$\frac{E_1}{E_2} = \frac{l_1 + l_2}{l_1 - l_2} = \frac{8+4}{8-4}$$
$$\frac{E_1}{E_2} = \frac{12}{4}$$
$$\therefore \quad \frac{E_1}{E_2} = 3$$

Question69

A wire of length $3 \mathrm{~m}$ connected in the left gap of a meter-bridge balances 8Ω resistance in the right gap at a point, which divides the bridge wire in the ratio $3: 2$. The length of the wire corresponding to resistance of 1Ω is

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Options:

A. $1 \mathrm{~m}$

B. $0.75 \mathrm{~m}$

C. $0.5 \mathrm{~m}$

D. $0.25 \mathrm{~m}$

Answer: D

Solution:

Let R_1 be the resistance of 3 m long wire connected in the left gap.

For meter-bridge, $\frac{\mathrm{R}_1}{\mathrm{R}_2}=\frac{l_1}{l_2}$

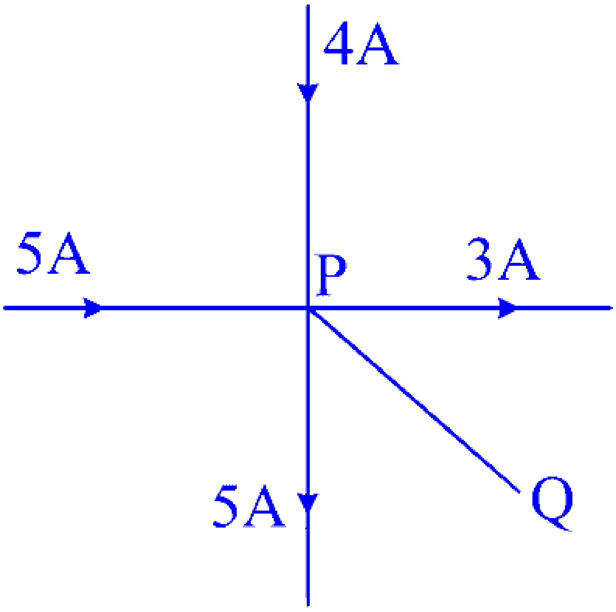
$$\therefore \quad \frac{\mathrm{R}_1}{8}=\frac{3}{2}$$

$$\therefore \quad \mathrm{R}_1=\frac{3}{2} \times 8=12 \Omega$$

Length of the wire corresponding to the resistance of 1Ω is $l=\frac{3}{12}=0.25 \mathrm{~m}$

Question70

Five current carrying conductors meet at point P. What is the magnitude and direction of the current in conductor PQ?



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Options:

A. 1 A form Q to P

B. 1 A form P to Q

C. 3 A form P to Q

D. 2 A form Q to P

Answer: B

Solution:

According to Kirchhoff's first law, at point P,

$5 \mathrm{~A}+4 \mathrm{~A}+\mathrm{I}-5 \mathrm{~A}-3 \mathrm{~A}=0$

$\mathrm{I}=-1 \mathrm{~A}$

$\therefore \quad I=-1 A$

1 A current flows from P to Q.

Question71

A $10 \mathrm{~m}$ long wire of resistance 20Ω is connected in series with a battery of emf $3 \mathrm{~V}$ (negligible internal resistance) and a resistance of 10Ω. The potential gradient along the wire is

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Options:

A. $3 \mathrm{~V} / \mathrm{m}$

B. $0.1 \mathrm{~V} / \mathrm{m}$

C. $0.2 \mathrm{~V} / \mathrm{m}$

D. $0.3 \mathrm{~V} / \mathrm{m}$

Answer: C

Solution:

Total length of wire $=10 \mathrm{~m}$

The equivalent resistance of the circuit, $R_{\text{eq}}=10+20=30 \Omega$

The current flowing through the wire, $i=V / R$

$=\frac{3 V}{30 \Omega}=0.1 \mathrm{~A}$

$\therefore$ Potential gradient along the wire,

$$=\frac{\text { potential difference across } 20 \Omega}{\text { length of } 20 \Omega \text { wire }}$$

$$=\frac{0.1 \times 20 \Omega}{10 \mathrm{~m}}=0.20 \mathrm{~V} / \mathrm{m}$$

Question72

Only 4% of the total current in the circuit passes through a galvanometer. If the resistance of the galvanometer is G, then the shunt resistance connected to the galvanometer is

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Options:

A. $\frac{G}{25}$

B. $\frac{G}{24}$

C. 24G

D. 25G

Answer: B

Solution:

From the given figure, we have $(I-I_G)S=I_G G$

Image

$\Rightarrow \quad S=\frac{I_G G}{(I-I_G)}$

Here, $I_G=\frac{4I}{100}=\frac{I}{25}$

$$\begin{aligned} \therefore \quad S &= \frac{\frac{1}{25}\times G}{I-\frac{1}{25}} \\ &= \frac{\frac{G}{25}}{\frac{24}{25}}=\frac{1}{24}\times G \\ &= \frac{G}{24} \end{aligned}$$

Question73

Two cells E_1 and E_2 having equal EMF 'E' and internal resistances r_1 and r_2 $(r_1>r_2)$ respectively are connected in series. This combination is connected to an external resistance 'R'. It is observed that the potential difference across the cell E_1 becomes zero. The value of 'R' will be

Options:

A. $r_1 - r_2$

B. $\mathrm{r}_1 + \mathrm{r}_2$

C. $\frac{r_1 - r_2}{2}$

D. $\frac{r_1 + r_2}{2}$

Answer: A

Solution:

The total current in the circuit is

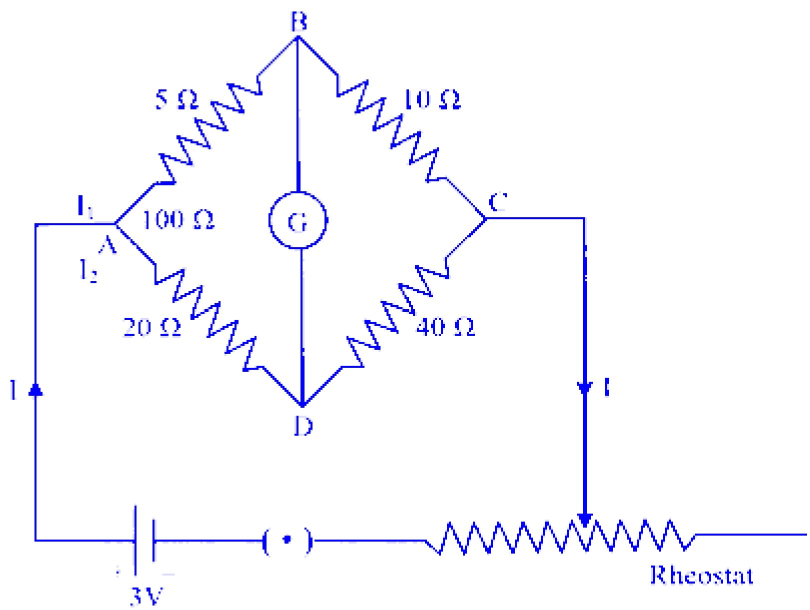
$\mathrm{I} = \frac{2\mathrm{E}}{\mathrm{r}_1 + \mathrm{r}_2 + \mathrm{R}}$ ... (1) .... (Given cells are in series, $\mathrm{E} + \mathrm{E} = 2\mathrm{E}$)

Now the potential drop across the first cell is $V_1 = E - r_1 = 0$

$$\begin{aligned} \therefore \quad & E - \left(\frac{2E}{r_1 + r_2 + R}\right) \times r_1 = 0 \\ & \frac{2E}{r_1 + r_2 + R} = \frac{E}{r_1} \Rightarrow 2r_1 = r_1 + r_2 + R \\ \therefore \quad & R = r_1 - r_2 \end{aligned}$$

Question74

In a given meter bridge, the current flowing through 40Ω resistor is



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Options:

A. $\mathrm{I_2 + I_g}$

B. $\mathrm{I_g}$

C. $\mathrm{I_2 - I_g}$

D. $\mathrm{I_2}$

Answer: D

Solution:

As the bridge is balanced, no current will flow through the galvanometer. Hence, the current through the 40Ω resistor will be $\mathrm{I_2}$.

Question75

A potentiometer wire of length $4 \mathrm{~m}$ and resistance 5Ω is connected in series with a resistance of 992Ω and a cell of e.m.f. $4 \mathrm{~V}$ with internal resistance 3Ω. The length of $0.75 \mathrm{~m}$ on potentiometer wire balances the e.m.f. of

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Options:

A. 4.00 mV

B. 3.75 mV

C. 3.00 mV

D. 2.50 mV

Answer: B

Solution:

$\therefore$ Total Resistance:

$\mathrm{R} = 992 + 5 + 3 = 1000\Omega$

Voltage across 4 m wire:

$\frac{5}{995+5} \times 4 = 0.02\ \mathrm{V}$

$\therefore$ For one metre wire:

$\frac{0.02}{4} = 0.005\ \mathrm{V}$

$\therefore$ For 0.75 m wire:

$$\begin{aligned} 0.004 \times 0.75 &= 0.00375 \\ &= 3.75\ \mathrm{mV} \end{aligned}$$

Question76

Two resistance X and Y are connected in the two gaps of a meterbridge and the null points is obtained at $20\ \mathrm{cm}$ from zero end. When the resistance of 20Ω is connected in series with the smaller of the two resistance X and Y, the null point shifts to $40\ \mathrm{cm}$ from left end. The value of smaller resistance in ohm is

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Options:

A. 6

B. 9

C. 12

D. 15

Answer: C

Solution:

For a meterbridge, $\frac{\mathrm{X}}{\mathrm{Y}} = \frac{l}{100-l}$

In the first case, $l=20$ cm

$$\frac{X}{Y}=\frac{20}{100-20}=\frac{20}{80}=\frac{1}{4}$$

$\therefore \quad 4X=Y$

In the second case, $l'=40$ cm

$\therefore \quad \frac{X'}{Y'}=\frac{40}{100-40}=\frac{40}{60}=\frac{2}{3}$

But, $X'=X+20$ and $Y'=Y$

$\therefore \quad \frac{X+20}{Y}=\frac{2}{3}$

$\therefore \quad \frac{X+20}{4X}=\frac{2}{3}$

$\therefore \quad 8X=3X+60$

$\therefore \quad X=12\Omega$

Question77

Resistance of a potentiometer wire is $2\Omega/\mathrm{m}$. A cell of e.m.f. 1.5 V balances at 300 cm. The current through the wire is

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Options:

A. 2.5 mA

B. 7.5 mA

C. 250 mA

D. 750 mA

Answer: C

Solution:

$l=300$ cm $=3$ m

Total resistance of wire,

$\mathrm{R}=3\times 2=6\Omega$

Since, the potentiometer is balanced. Voltage across wire segment $=1.5$ V

$\therefore \quad \mathrm{IR}=1.5 \mathrm{~V}$
$\therefore \quad \mathrm{I}=\frac{1.5}{6}=250 \mathrm{~mA}$

Question78

A potentiometer wire has length of $5 \mathrm{~m}$ and resistance of 16Ω. The driving cell has an e.m.f. of $5 \mathrm{~V}$ and an internal resistance of 4Ω. When the two cells of e.m.f.s $1.3 \mathrm{~V}$ and $1.1 \mathrm{~V}$ are connected so as to assist each other and then oppose each other, the balancing lengths are respectively

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Options:

A. $3 \mathrm{~m}, 0.25 \mathrm{~m}$

B. $0.25 \mathrm{~m}, 3 \mathrm{~m}$

C. $2.5 \mathrm{~m}, 0.3 \mathrm{~m}$

D. $0.3 \mathrm{~m}, 2.5 \mathrm{~m}$

Answer: A

Solution:

$$K=\frac{E R}{(R+r) L}$$

$\mathrm{E}=5 \mathrm{~V}, \mathrm{r}=4 \Omega, \mathrm{L}=5 \mathrm{~m}, \mathrm{R}=16 \Omega$

$$\therefore \quad \mathrm{K}=\frac{5 \times 16}{(16+4) \times 5}$$

$$\therefore \quad \mathrm{K}=0.8 \mathrm{~V} / \mathrm{m}$$

When 'E_1' and 'E_2' are connected so as to assist each other

$$\mathrm{E}_1+\mathrm{E}_2=\mathrm{K}_1$$
$$1.3+1.1=0.8 \times l_1$$
$$\therefore \quad l_1=3 \mathrm{~m}$$

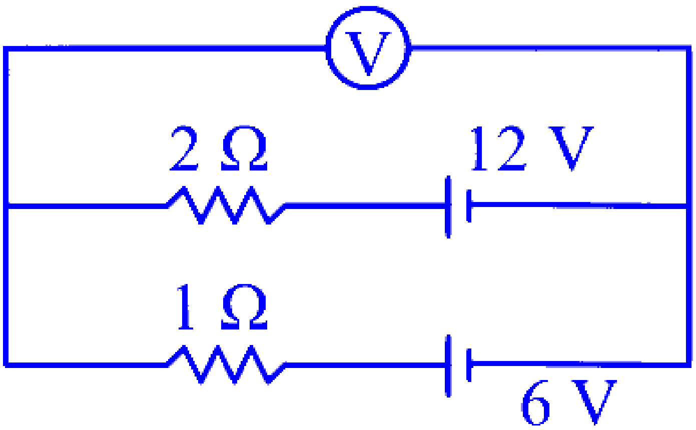
When 'E_1' and 'E_2' are connected so as to oppose each other,

$$E_1 - E_2 = Kl_2$$
$$1.3 - 1.1 = 0.8 \times l_2$$
$$\therefore \quad l_2 = 0.25 \text{ m}$$

As, value for balancing lengths are different in all the options. It is sufficient to calculate balancing length in any one case (Assisting/ opposing) to reach the final correct answer.

Question79

Two batteries, one of e.m.f. 12 V and internal resistance 2Ω and other of e.m.f. 6 V and internal resistance 1Ω, are connected as shown in the figure. What will be the reading of the voltmeter 'V'?



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Options:

A. 12 V

B. 8 V

C. 6 V

D. 4 V

Answer: B

Solution:

The formula for the equivalent emf of the parallel combination of batteries is

$$\varepsilon_e = r_{eq} \left(\frac{e_1}{r_1} + \frac{e_2}{r_2}\right)$$

Here, r_{eq} is the equivalent resistance

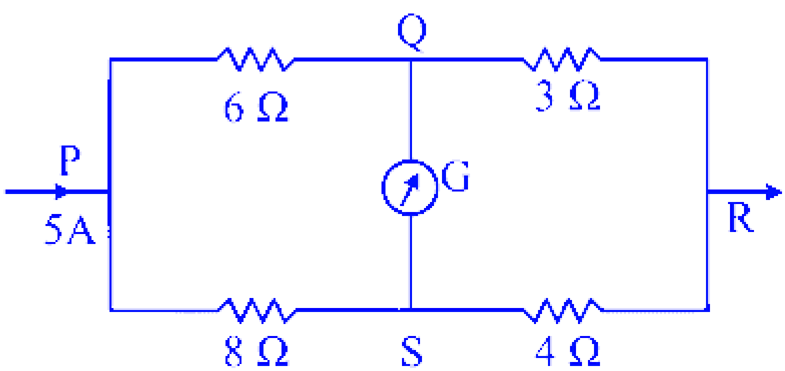
$$\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2}$$
$$\frac{1}{r_{eq}} = \frac{1}{2} + \frac{1}{1}$$
$$\frac{1}{r_{eq}} = \frac{3}{2}$$

Substituting the values

$$\varepsilon_e = r_{eq} \left(\frac{e_1}{r_1} + \frac{e_2}{r_2}\right)$$
$$\varepsilon_c = \frac{2}{3} \left(\frac{12}{2} + \frac{6}{1}\right)$$
$$\varepsilon_e = \frac{2}{3} \times 12$$
$$\therefore \quad \varepsilon_e = 8 \text{ V}$$

Question80

Potential difference between the points P and Q is nearly



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Options:

A. 17 V

B. 14 V

C. 12 V

D. 8 V

Answer: A

Solution:

Let total current be denoted as I. The given circuit is a Wheatstone bridge.

$$\Rightarrow \mathrm{R}_1 = 6 + 3 = 9\Omega$$
$$\Rightarrow \mathrm{R}_2 = 8 + 4 = 12\Omega$$

According to KCL, the current will get divided into two parts I_1 and I_2

$$\therefore \quad \mathrm{I}_1 = \frac{\mathrm{R}_2 \mathrm{I}}{(\mathrm{R}_1 + \mathrm{R}_2)}$$

Substituting the values,

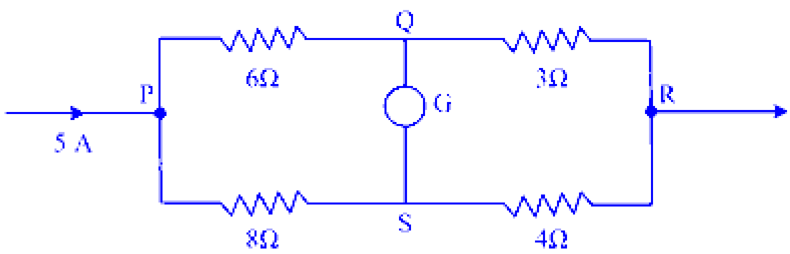
$$I_1 = \frac{12}{9 + 12} \times 5$$
$$I_1 = 2.85 \mathrm{~A}$$

Potential difference between P and Q is

$$V = I_1 R$$
$$V = 2.85 \times 6$$
$$V = 17V$$

Question81

Potential difference between the points P and Q is nearly



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Options:

A. 6 V

B. 8 V

C. 17 V

D. 21 V

Answer: C

Solution:

As, the resistors across each branch are in series.

$\mathrm{R}_1 = 6 + 3 = 9\Omega$
$\mathrm{R}_2 = 8 + 4 = 12\Omega$

According to KCL, the current (i) will get divided into two parts I_1 and I_2

$I_1 = \frac{R_2}{(R_1+R_2)i} = \frac{12}{9+12} \times 5 = 2.86 \mathrm{~A}$

Potential difference between P and Q is $V = I_1 R = 2.86 \times 6 = 17.14 \mathrm{~V}$

Question82

In potentiometer experiments, two cells of e. m. f. 'E_1' and 'E_2' are connected in series $(E_1 > E_2)$, the balancing length is $64 \mathrm{~cm}$ of the wire. If the polarity of E_2 is reversed, the balancing length becomes $32 \mathrm{~cm}$. The ratio $\mathrm{E}_1/\mathrm{E}_2$ is

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Options:

A. 3 : 2

B. 2 : 3

C. 1 : 3

D. 3 : 1

Answer: D

Solution:

For potentiometer,

$$\frac{E_1}{E_2} = \frac{l_1 + l_2}{l_1 - l_2}$$

$$\therefore \quad \frac{E_1}{E_2} = \frac{64 + 32}{64 - 32} \quad = \frac{96}{32} = \frac{3}{1} = 3 : 1$$

Question83

In meter bridge experiment, null point was obtained at a distance 'l' from left end. The values of resistances in the left and right gap are doubled and then interchanged. The new position of the null point is

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Options:

A. $(100 - l)$

B. $(100 - 2l)$

C. $(100 - 3l)$

D. $\left(100 - \frac{l}{2}\right)$

Answer: A

Solution:

For a Metre bridge,

$\frac{X}{R} = \frac{l_X}{l_R}$

After doubling and interchanging the left and right gap resistances, the ratio of the resistances do not change.

This means the null point does not change.

$\therefore$ The new position will remain at $(100 - l)$.

Question84

A galvanometer has resistance 'G' and range '$\mathrm{V}g$'. How much resistance is required to read voltage upto 'V' volt?

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Options:

A. $\mathrm{G}\left(\frac{\mathrm{V}}{\mathrm{V}_{\mathrm{g}}}-1\right)$

B. $\mathrm{G}\left(\frac{\mathrm{V}+\mathrm{V}_{\mathrm{g}}}{\mathrm{V}}\right)$

C. $\mathrm{G}\left(\frac{\mathrm{V}-\mathrm{V}_{\mathrm{g}}}{\mathrm{V}}\right)$

D. GV_{g}

Answer: A

Solution:

Given: Resistance of the galvanometer = G

Range of the galvanometer $=\mathrm{V}_{\mathrm{g}}$

The series resistance value to be used for converting the galvanometer into a voltmeter of range 0 to $\mathrm{V}_{\mathrm{g}^{\prime}}$ is,

$\mathrm{R}=\frac{\mathrm{V}_{\mathrm{g}}}{\mathrm{I}_{\mathrm{g}}}-\mathrm{G}$

Also,

$I_g=\frac{V_g}{G}$

To increase the measuring range to V, the new resistance value

$$
\begin{aligned}
\mathrm{R}^{\prime} & =\frac{\mathrm{V}}{\left(\frac{\mathrm{V}_{\mathrm{g}}}{\mathrm{G}}\right)}-\mathrm{G} \\
& =\frac{\mathrm{VG}}{\mathrm{V}_{\mathrm{g}}}-\mathrm{G}=\mathrm{G}\left(\frac{\mathrm{V}}{\mathrm{V}_{\mathrm{g}}}-1\right)
\end{aligned}
$$

Question85

If only 1% of total current is passed through a galvanometer of resistance 'G' then the resistance of the shunt is

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Options:

A. $\frac{G}{25} \Omega$

B. $\frac{\mathrm{G}}{49} \Omega$

C. $\frac{\mathrm{G}}{2} \Omega$

D. $\frac{\mathrm{G}}{99} \Omega$

Answer: D

Solution:

Given: $I_g=\frac{1}{100} I$

$$\therefore \quad \frac{\mathrm{I}}{\mathrm{I_g}}=100 \quad \text{..... (i)}$$

$$\mathrm{S}=\frac{\mathrm{GI_g}}{\mathrm{I}-\mathrm{I_g}}=\frac{\mathrm{G}}{\frac{\mathrm{I}}{\mathrm{I_g}}-1} \quad \text{..... (ii)}$$

Substituting, (i) into (ii),

$\mathrm{S}=\frac{\mathrm{G}}{100-1}=\frac{\mathrm{G}}{99}$

Question86

A voltmeter of resistance 150Ω connected across a cell of e.m.f. $3 \mathrm{~V}$ reads $2.5 \mathrm{~V}$. What is the internal resistance of the cell?

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Options:

A. 10Ω

B. 15Ω

C. 20Ω

D. 30Ω

Answer: D

Solution:

Internal resistance,

$$\begin{aligned} r & =\left[\frac{E}{V}-1\right] R \\ & =\left[\frac{3}{2.5}-1\right] 150 \\ & =30 \Omega \end{aligned}$$

Question87

A galvanometer of resistance 20Ω gives a deflection of 5 divisions when $1 \mathrm{~mA}$ current flows through it. The galvanometer scale has 50 divisions. To convert the galvanometer into a voltmeter of range 25 volt, we should connect a resistance of

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Options:

A. 1240Ω in series.

B. 2480Ω in series.

C. 2480Ω in parallel.

D. 20Ω in parallel.

Answer: B

Solution:

$$R = \frac{V}{I_g} - G$$

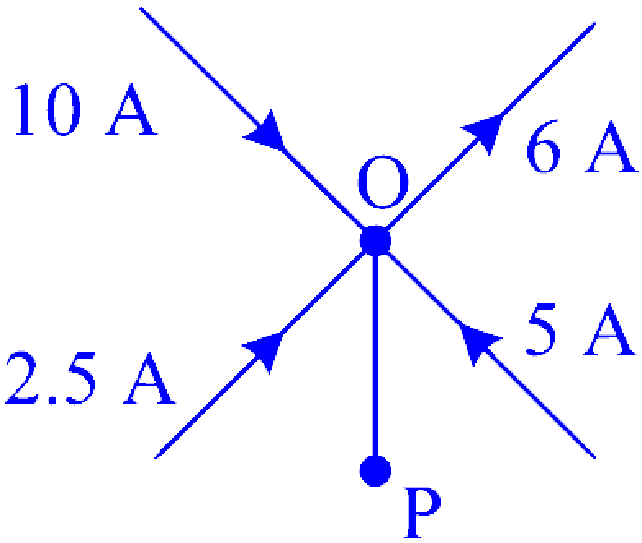
$$\text{Here, } I_g = \frac{50}{5} = 10 \text{ mA}$$

$$\therefore \quad R = \frac{25}{10 \times 10^{-3}} - 20$$

$$= 2480\Omega \text{ in series}$$

Question88

Five current carrying conductors meet at a point 'O' as shown in figure. The magnitude and direction of the current in conductor 'OP ' is



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Options:

A. 6.5 A from O to P.

B. 9 A from P to O.

C. 10.5 A from P to O.

D. 11.5 A from O to P.

Answer: D

Solution:

Using Kirchhoff's current Law,

Current flowing in = Current flowing out $10 + 2.5 + 5 = 6 + x$

$\therefore \quad x = 17.5 - 6$

$\therefore \quad \mathrm{x} = 17.5 - 6$
$\quad\quad = 11.5 \mathrm{~A}$

$\therefore$ Magnitude and direction of the current in 'OP' should be 11.5 A from O to P.

Question89

A galvanometer of resistance G is shunted with a resistance of 10% of G. The part of the total current that flows through the galvanometer is

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Options:

A. $\frac{1}{11} \mathrm{I}$

B. $\frac{2}{11} \mathrm{I}$

C. $\frac{1}{10} \mathrm{I}$

D. $\frac{1}{5} \mathrm{I}$

Answer: A

Solution:

$$\frac{I_g}{I} = \frac{S}{S+G} = \frac{0.1G}{0.1G+G} = \frac{1}{11}$$

$$\therefore \quad I_g = \frac{1}{11} I$$

Question90

In a meter bridge experiment null point is obtained at l cm from the left end. If the meter bridge wire is replaced by a wire of same material but twice the area of across-section, then the null point is obtained at a distance

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Options:

A. $2l$ cm from left end.

B. l cm from left end.

C. $l/2$ cm from left end.

D. $l/4$ cm from left end.

Answer: B

Solution:

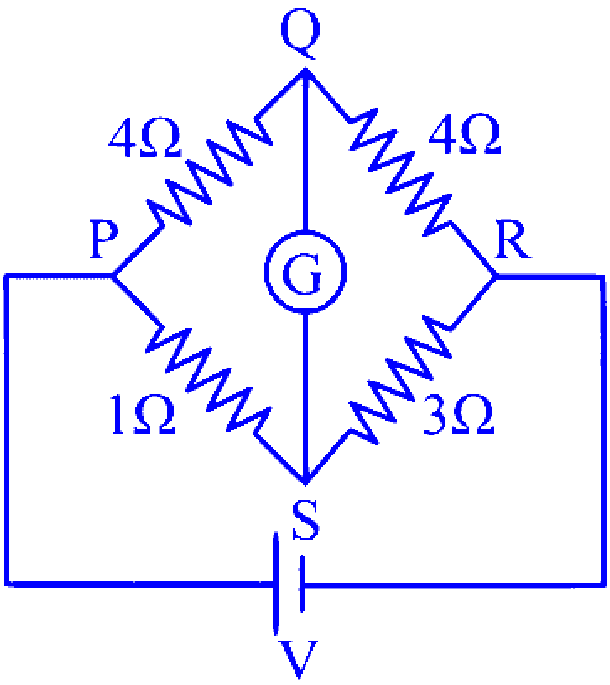
At null condition, $\frac{R_1}{R_2} = \frac{X}{100-X}$

This condition is independent of the cross-sectional area of the wire used.

$\therefore$ The null point will remain the same. (i.e., l cm from left end)

Question91

In the following network, the current through galvanometer will



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Options:

A. be zero

B. flow from Q to S

C. flow in a direction which depends on value of V

D. flow from S to Q

Answer: D

Solution:

This is an unbalanced network.

Current through the branch PQR is $I_1 = \frac{V}{8}$ and current through the branch PSR $= I_2 = \frac{V}{4}$

$$\therefore V_P - V_Q = I_1 \times 4 = \frac{V}{8} \times 4 = \frac{V}{2}$$

and $V_P - V_S = I_2 \times 1 = \frac{V}{4} \times 1 = \frac{V}{4}$

$\therefore (V_P - V_Q) - (V_P - V_S) = \frac{V}{2} - \frac{V}{4} = \frac{V}{4}$

$\therefore V_S - V_Q = \frac{V}{4}$

$\therefore V_S > V_Q$

$\therefore$ The current will flow from **S** to **Q**.

Question92

A galvanometer of resistance 200Ω is to be converted into an ammeter. The value of shunt resistance which allows 3% of the mains current through the galvanometer is equal to (nearly)

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Options:

A. 6Ω

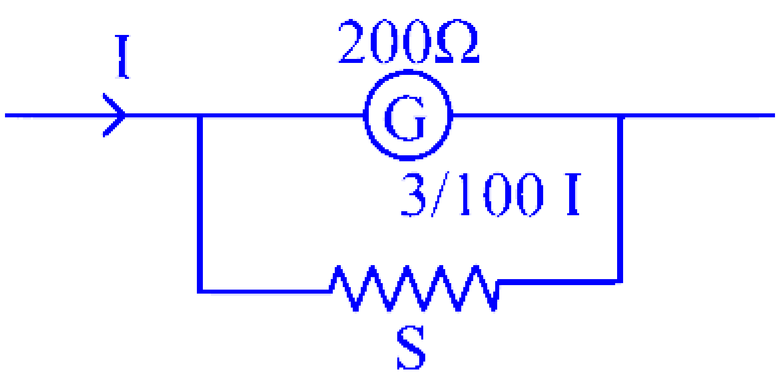
B. 7Ω

C. 10Ω

D. 5Ω

Answer: A

Solution:



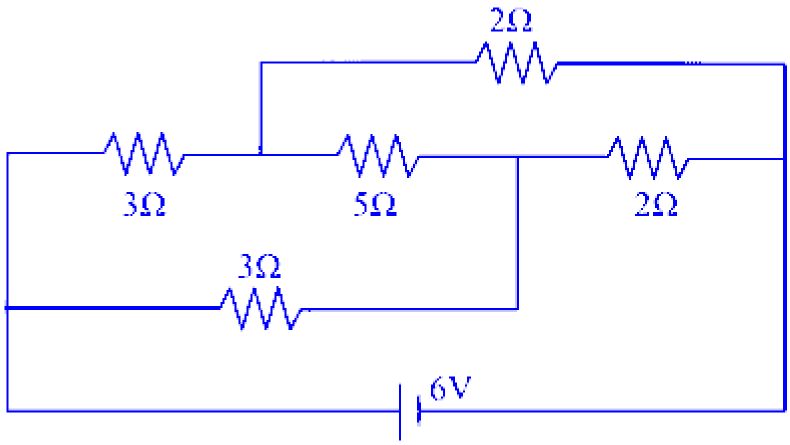
The value of the required shunt (S) is calculated by using

$$\frac{I_g}{\mathrm{I}}=\frac{\mathrm{S}}{\mathrm{S}+\mathrm{G}}$$
$$\therefore \frac{3}{100}=\frac{\mathrm{S}}{\mathrm{S}+200}$$
$$\therefore 100\ \mathrm{S}=3\ \mathrm{S}+600 \quad \therefore 97\ \mathrm{S}=600$$
$$\therefore \mathrm{S}=\frac{600}{97} \doteqdot 6 \Omega$$

[Note for $\mathrm{S}=6, 97\ \mathrm{S}=582$ and for $\mathrm{S}=7, 97\ \mathrm{S}=679$]

Question93

The current drawn from the battery in the given network is (Internal resistance of the battery is negligible)



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Options:

A. 2.4 A

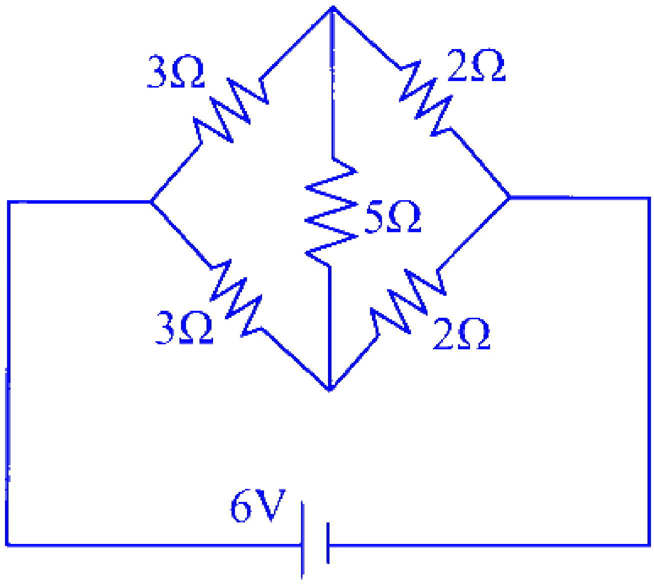
B. 1.6 A

C. 2.0 A

D. 3.0 A

Answer: A

Solution:

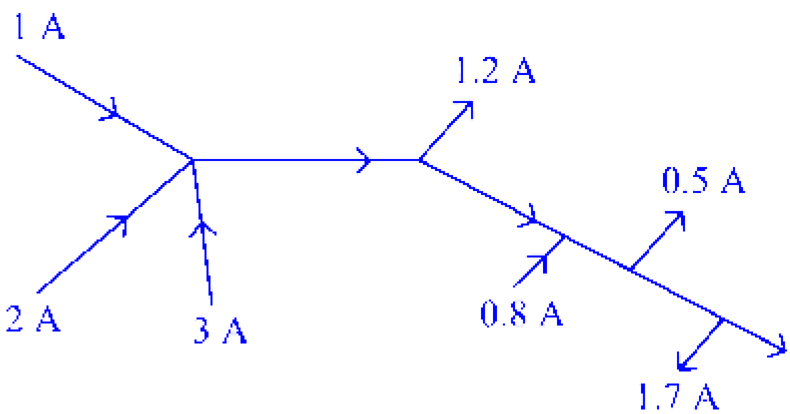


The given circuit can be redrawn as shown in the figure. It is a balanced Wheatstone bridge. No current will flow through 5Ω resistance, and hence it can be removed from the circuit. 3Ω and 2Ω resistances are in series. Hence we have two branches with 5Ω resistances each, connected in parallel. Their equivalent resistance is 2.5Ω

$\therefore \quad \mathrm{I}=\frac{\mathrm{V}}{\mathrm{R}}=\frac{6}{2.5}=2.4 \mathrm{~A}$

Question94

In the following electrical network, the value of 1 is



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Options:

A. 1.5 A

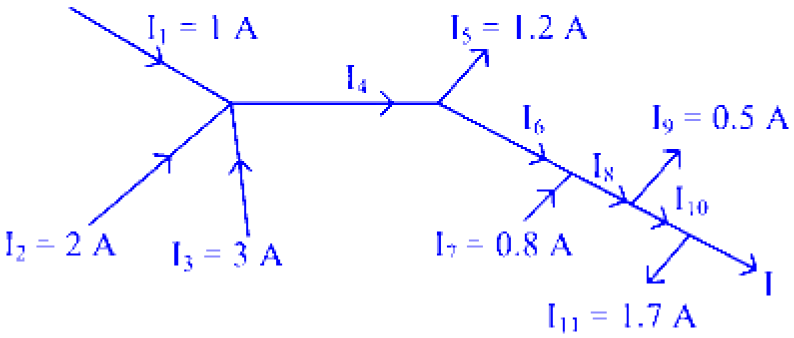
B. 3.0 A

C. 3.4 A

D. 2.5 A

Answer: C

Solution:



$I_4 = I_1 + I_2 + I_3 = 1 + 2 + 3 = 6$ A
$I_6 = I_4 - I_5 = 6 - 1.2 = 4.8$ A
$I_8 = I_6 + I_7 = 4.8 + 0.8 = 5.6$ A
$I_{10} = I_8 - I_9 = 5.6 - 0.5 = 5.1$ A
$I = I_{10} - I_{11} = 5.1 - 1.7 = 3.4$ A

Question95

In a potentiometer experiement, when three cells A, B and C are connected in series, the balancing length is found to be 420 cm. If cells A and B are connected in series the balancing length is 220 cm and for cells B and C connected in series in balancing length is 320 cm. The emf of cells A, B and C are respectively in the ratio of

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Options:

A. 2 : 3 : 5

B. 5 : 4 : 3

C. 1 : 1.2 : 2

D. 1.2 : 1 : 2

Answer: C

Solution:

$B+C=420$
$A+B=220 \text{ cm} \quad \therefore C=420-220=200 \text{ cm}$
$B+C=320 \text{ cm} \quad \therefore B=320-200=120 \text{ cm}$
$A=220-B=100 \text{ cm}$
$\therefore A:B:C::1:1.2:2$

Question96

To determine the internal resistance of a cell by using a potentiometer, the null point is at $1 \mathrm{~m}$ when shunted by 3Ω resistance and at a length $1.5 \mathrm{~m}$, when cell is shunted by 6Ω resistance The internal resistance of the cell is

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Options:

A. 1Ω

B. 4Ω

C. 2Ω

D. 6Ω

Answer: D

Solution:

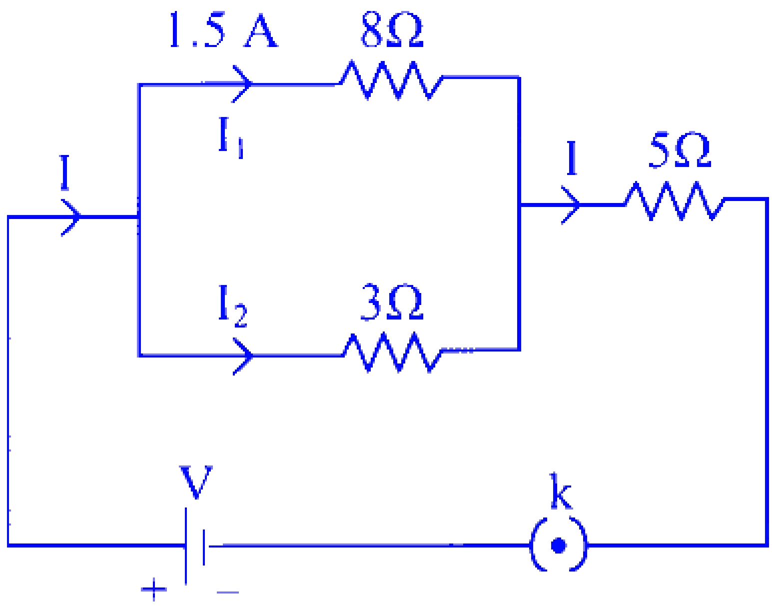
$\mathrm{r}=\mathrm{R}\left(\frac{\ell_1}{\ell_2}-1\right)=\mathrm{R}^{\prime}\left(\frac{\ell_1}{\ell_2^{\prime}}-1\right)$
$\ell_2=1 \mathrm{~m}, \ell_2^{\prime}=1.5 \mathrm{~mR}=3 \Omega, \mathrm{R}^{\prime}=6 \Omega$
$\therefore 3\left(\frac{\ell_1}{1}-1\right)=6\left(\frac{\ell_1}{1.5}-1\right)$

Solving we get $\ell_1=3 \mathrm{~m}$

$\therefore \quad r=3\left(\frac{3}{1}-1\right)=3 \times 2=6 \Omega$

Question97

In the given circuit, the current in 8Ω resistance is 1.5 A. The total current (I) flowing in the circuit is



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Options:

A. 5 A

B. 4.5 A

C. 3 A

D. 5.5 A

Answer: D

Solution:

$\mathrm{I}_1=1.5 \mathrm{~A}, \mathrm{R}_1=8 \Omega$

P.D. across $\mathrm{R}_1=1.5 \times 8=12 \mathrm{~V}$

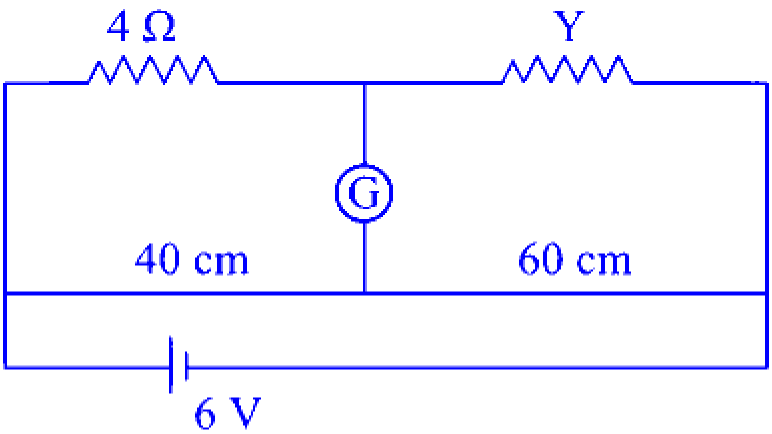
$\mathrm{R}_2=3 \Omega ; \mathrm{R}_2$ is in parallel with R_1 and hence P.D. across it is also 12 V.

$\therefore I_2 = \frac{12}{3} = 4 \text{ A}$

Total current $I = I_1 + I_2 = 1.5 + 4 = 5.5 \text{ A}$

Question98

A balanced bridge is shown in the circuit diagram. The metre bridge wire has resistance $1\Omega m^{-1}$. The current drawn from the battery is (Internal resistance of battery is negligible)



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Options:

A. 0.44 A

B. 0.66 A

C. 0.88 A

D. 0.22 A

Answer: B

Solution:

Wire has a resitance $1\Omega cm^{-1}$.

$\therefore$ Resistance of 40 cm of wire $= 40\Omega$ and resistance of 60 cm of wire $= 60\Omega$

No current flows through the galvanometer since the bridge in balanced. Hence the branch containing the galvanometer can be removed.

For balanced bridge $\frac{4}{40}=\frac{Y}{60}$

$\therefore Y=\frac{4\times 60}{40}=6\Omega$

4Ω and 6Ω are in series. Their equivalent resistance is 10Ω.

40Ω and 60Ω are in series. Their equivalent resistance is 100Ω.

10Ω and 100Ω are in parallel

Their equivalent resistance is $\frac{1000}{110}\Omega$.

$\therefore$ The current $\mathrm{I}=\frac{\mathrm{V}}{\mathrm{R}}=\frac{6\times 110}{1000}=0.66\ \mathrm{A}$

Question99

In potentiometer experiment, cells of e.m.f. 'E_1' and 'E_2' are connected in series $(E_1>E_2)$ the balancing length is $64\ \mathrm{cm}$ of the wire. If the polarity of E_2 is reversed, the balancing length becomes $32\ \mathrm{cm}$. The ratio $\frac{E_1}{E_2}$ is

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Options:

A. 1 : 1

B. 6 : 1

C. 3 : 1

D. 2 : 1

Answer: C

Solution:

$\frac{\mathrm{E}_1}{\mathrm{E}_2}=\frac{\ell_1+\ell_2}{\ell_1+\ell_2}=\frac{64+32}{64-32}=\frac{96}{32}=3$

Question100

In a potentiometer experiment, the balancing length for a cell is $240 \mathrm{~cm}$. On shunting the cell with a resistance of 2Ω, the balancing length becomes half the initial balancing length. The internal resistance of the cell is

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Options:

A. 1.5Ω

B. 1Ω

C. 0.5Ω

D. 2Ω

Answer: D

Solution:

The internal resistance is given by

$$
\begin{aligned}
r & =R\left(\frac{\ell_1-\ell_2}{\ell_2}\right) \\
& =2\left(\frac{240-120}{120}\right)=2 \times \frac{120}{120}=2 \Omega
\end{aligned}
$$

Question101

Kirchhoff's current and voltage law are respectively based on the conservation of

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Options:

A. momentum, charge

B. energy, charge

C. charge, energy

D. charge, momentum

Answer: C

Solution:

Kirchhoff's laws are fundamental principles in electrical circuit theory that are based on the conservation of certain physical quantities. Let's understand the principle behind each law to select the correct option:

Kirchhoff's Current Law (KCL) states that the total current entering a junction (or a node) in an electrical circuit equals the total current leaving the junction. This law is based on the principle of conservation of **charge**. According to this principle, charge cannot be created or destroyed in an electrical circuit, which means the sum of currents entering a node (where these currents are considered positive) and the sum of currents leaving the node (considered negative) must equal zero. Thus, for KCL, the conservation principle involved is **charge**.

Kirchhoff's Voltage Law (KVL) states that the total voltage around any closed loop in a circuit must be zero. This law is derived from the principle of conservation of **energy**. It means that the sum of all electrical potential differences (voltage) around any closed loop must equal zero, as the total energy gained by charges in traveling around a loop must equal the total energy lost. Thus, for KVL, the conservation principle involved is **energy**.

Therefore, the correct option is:

Option C: charge, energy

Question102

In a wheatstone's bridge, three resistances P, Q and R are connected in the three arms and the fourth arm is formed by two resistances S_1 and S_2 connected in parallel. The condition for the bridge to be balanced is

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Options:

A. $\frac{P}{Q}=\frac{2R}{S_1+S_2}$

B. $\frac{P}{Q}=\frac{R(S_1+S_2)}{2S_1S_2}$

C. $\frac{P}{Q}=\frac{R(S_1+S_2)}{S_1 S_2}$

D. $\frac{P}{Q}=\frac{R(S_1 S_2)}{S_1+S_2}$

Answer: C

Solution:

In a Wheatstone's bridge, we have four arms with resistances. For the given problem, three resistances P, Q, and R are connected in three arms, and the fourth arm is formed by the parallel combination of two resistances S_1 and S_2.

The condition for the Wheatstone's bridge to be balanced is that the ratio of the resistances in one pair of opposite arms is equal to the ratio of the resistances in the other pair of opposite arms.

Let's first find the equivalent resistance of the parallel combination of S_1 and S_2. The equivalent resistance S_{eq} for resistances in parallel is given by:

$$\frac{1}{S_{\text{eq}}}=\frac{1}{S_1}+\frac{1}{S_2}$$

Solving for S_{eq}, we get:

$$S_{\text{eq}}=\frac{S_1 S_2}{S_1+S_2}$$

Now, applying the condition for the Wheatstone's bridge to be balanced:

$$\frac{P}{Q}=\frac{R}{S_{\text{eq}}}$$

Substituting the equivalent resistance S_{eq}, we get:

$$\frac{P}{Q}=\frac{R}{\frac{S_1 S_2}{S_1+S_2}}=\frac{R(S_1+S_2)}{S_1 S_2}$$

So, the condition for the bridge to be balanced is:

$$\frac{P}{Q}=\frac{R(S_1+S_2)}{S_1 S_2}$$

Therefore, the correct option is:

Option C

Question103

If a current flowing in a coil is reduced to half of its initial value, the relation between the new energy (E_2) and the original energy (E_1) stored in the coil will be

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Options:

A. $E_2 = \frac{E_1}{4}$

B. $\mathrm{E}_2 = \frac{\mathrm{E}_1}{2}$

C. $\mathrm{E}_2 = \mathrm{E}_1$

D. $\mathrm{E}_2 = 4\mathrm{E}_1$

Answer: A

Solution:

To understand the relationship between the new energy (E_2) and the original energy (E_1) stored in the coil when the current is reduced to half of its initial value, we need to consider the formula for the energy stored in an inductor. The energy stored in a coil (inductor) is given by:

$E = \frac{1}{2} L I^2$

where E is the energy, L is the inductance of the coil, and I is the current flowing through it.

If the current is reduced to half of its initial value, let the new current be $I_2 = \frac{I_1}{2}$ where I_1 is the original current.

Substituting I_2 into the energy formula, we get the new energy E_2:

$E_2 = \frac{1}{2} L \left(\frac{I_1}{2}\right)^2$

which simplifies to:

$E_2 = \frac{1}{2} L \frac{I_1^2}{4}$

Therefore:

$E_2 = \frac{1}{2} \cdot \frac{1}{4} L I_1^2$

Simplifying further:

$E_2 = \frac{1}{4} \cdot \frac{1}{2} L I_1^2$

Since $E_1 = \frac{1}{2} L I_1^2$, we see that:

$E_2 = \frac{E_1}{4}$

Thus, the correct option is Option A:

$E_2 = \frac{E_1}{4}$

Question104

The Kirchhoff's current law and voltage law are respectively based upon the conservation of

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Options:

A. charge, energy

B. charge, momentum

C. energy, charge

D. momentum, charge

Answer: A

Solution:

Kirchhoff's laws are fundamental principles in electrical circuit theory and are based on the conservation principles of physics.

Kirchhoff's Current Law (KCL): This law states that the total current entering a junction in a circuit is equal to the total current leaving the junction. Mathematically, it can be expressed as:

$\sum I_{in} = \sum I_{out}$

This is based on the principle of conservation of **charge**. Since charge cannot accumulate at a junction, the amount of charge (and therefore current) flowing into the junction must equal the amount flowing out.

Kirchhoff's Voltage Law (KVL): This law states that the sum of all electrical potential differences (voltages) around any closed loop in a circuit is zero. Mathematically, it can be expressed as:

$\sum V = 0$

This is based on the principle of conservation of **energy**. Because energy cannot be created or destroyed, the energy gained by the charges in a loop must equal the energy lost.

Considering these explanations, the correct option is:

Option A: charge, energy

Question105

A moving coil galvanometer is converted into an ammeter, reading upto 0.04 A by connecting a shunt of resistance '3r' across it and then into an ammeter reading upto 0.8 A, when a shunt of resistance 'r' is connected across it. What is the maximum current which can be sent through this galvanometer if no shunt is used?

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Options:

A. 0.02 A

B. 0.04 A

C. 0.08 A

D. 0.01 A

Answer: A

Solution:

Shunt resistance is given by

$S = \frac{I_g G}{I - I_g}$

In the first case : $3r = \frac{I_g G}{0.04 - I_g}$ ..... (1)

In the second case : $r = \frac{I_g G}{0.08 - I_g}$ ..... (2)

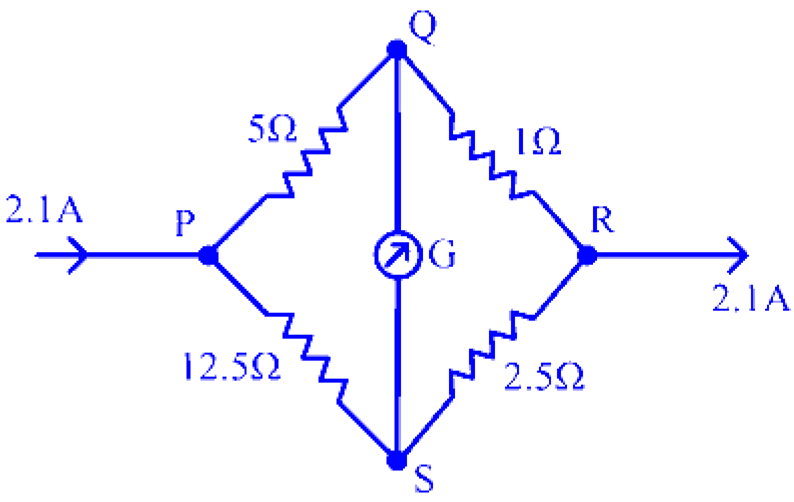
Dividing Eq.(1) by Eq.(2) we get

$3 = \frac{0.08 - I_g}{0.04 - I_g}$

Solving, we get $I_g = 0.02$ A

Question106

A current through 1 Ω resistance in the following circuit is



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Options:

A. 1.8 A

B. 1.2 A

C. 1.5 A

D. 1 A

Answer: C

Solution:

It is a balanced Wheatstone bridge. Hence no current flows through the galvanometer and it can be removed from the circuit. 5Ω and 1Ω resistances are in series. Their equivalent resistance is $5+1=6\Omega$. 12.5Ω and 2.5Ω resistances are also in series. Their equivalent resitance is 15Ω. 6Ω and 15Ω resistances are in parallel. If I_1 and I_2 are the currents in them then

$$6\mathrm{I}_1=15\mathrm{I}_2 \quad \therefore \mathrm{I}_2=0.4\mathrm{I}_1$$
$$\mathrm{I}_1+\mathrm{I}_2=2.1\ \mathrm{A} \quad \therefore \mathrm{I}_1=\frac{2.1}{1.4}=1.5\ \mathrm{A}$$

Question107

In a meter bridge experiment, the balance point is obtained at length ℓ_1 cm from left end when resistances in the left gap and right gap are 5Ω and $R\Omega$ respectively. When the resistance R is shunted with

equal resistance, the new balance point is at $1.6\ell_1$. The resitance R in ohm is

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Options:

A. 25

B. 15

C. 10

D. 20

Answer: B

Solution:

$$\frac{5}{R}=\frac{\ell_1}{100\ell_1} \quad ....(1)$$
$$\frac{5\times 2}{R}=\frac{1.6\ell_1}{100-1.6\ell}$$
$$\therefore \quad \frac{5}{R}=\frac{0.8\ell_1}{100-1.6\ell_1} \quad ....(2)$$

Equating (1) and (2) and solving we get $\ell_1=25$ cm Putting this in Eq.(1), we get $\mathrm{R}=15\Omega$

Question108

Two wires 'A' and 'B' of equal length are connected in left and right gap respectively of meter bridge, null point is obtained at $40\ \mathrm{cm}$, from the left end. Diameters of the wires 'A' and 'B' are in the ratio $3:1$ respectively, the ratio of specific resistance of 'A' to that of 'B' is

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Options:

A. 6 : 1

B. 8 : 1

C. 16 : 1

D. 12 : 1

Answer: A

Solution:

$$\frac{R_A}{R_B} = \frac{40}{60} = \frac{2}{3}$$
$$R = \rho \cdot \frac{\ell}{A} = \rho \cdot \frac{\ell}{\pi r^2}$$

Length of the wires are same.

$$\therefore \frac{\mathrm{R_A}}{\mathrm{R_B}} = \frac{\rho_\mathrm{A}}{\rho_\mathrm{B}}\left(\frac{\mathrm{r_B}}{\mathrm{r_A}}\right)^2$$
$$\therefore \frac{2}{3} = \frac{\rho_\mathrm{A}}{\rho_\mathrm{B}}\left(\frac{1}{3}\right)^2 = \frac{\rho_\mathrm{A}}{\rho_\mathrm{B}} \cdot \frac{1}{9}$$
$$\therefore \frac{\rho_\mathrm{A}}{\rho_\mathrm{B}} = 6$$

Question109

A galvanometer has resistance 'G' Ω and '$\mathrm{I_g}$' is current flowing through it which produces full scale deflection. '$\mathrm{S_1}$' is the value of shunt which converts it into an ammeter of range 0 to '$3\mathrm{I}$' and '$\mathrm{S_2}$' is the shunt value which converts it into an ammeter of range 0 to '$4\mathrm{I}$', the ratio $\mathrm{S_2} : \mathrm{S_1}$ is

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Options:

A. $\frac{4}{3}$

B. $\frac{3\mathrm{I}-\mathrm{I_g}}{4\mathrm{I}-\mathrm{I_g}}$

C. $\frac{3}{4}$

D. $\frac{4I-I_g}{3I-I_g}$

Answer: B

Solution:

$$s_1 = \frac{I_g G}{3I - I_g}, s_2 = \frac{I_g G}{4I - I_g}$$

$$\therefore \quad \frac{s_2}{s_1} = \frac{3I - I_g}{4I - I_g}$$

Question110

In potentiometer experiment, null point is obtained at a particular point for a cell on potentiometer wire 'x' cm long. If length of potentiometer wire is increased by few centimeter without changing the cell, the balancing length will [Driving source is not changed]

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Options:

A. will net change.

B. increase

C. decrease

D. become zero

Answer: B

Solution:

If the length of potentiometer wire increases, the potential gradient will decrease. Hence to balance the same p.d., the length will increase.

Question111

A galvanometer of resistance 50Ω is converted to an ammeter. After shunting, the effective resistance of ammeter is 2.5Ω. The value of shunt is

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Options:

A. $\frac{100}{19} \Omega$

B. $\frac{50}{19} \Omega$

C. $\frac{25}{19} \Omega$

D. $\frac{75}{19} \Omega$

Answer: B

Solution:

The resistance of the galvanometer and the shunt are in parallel. Their equivalent resistance is given by

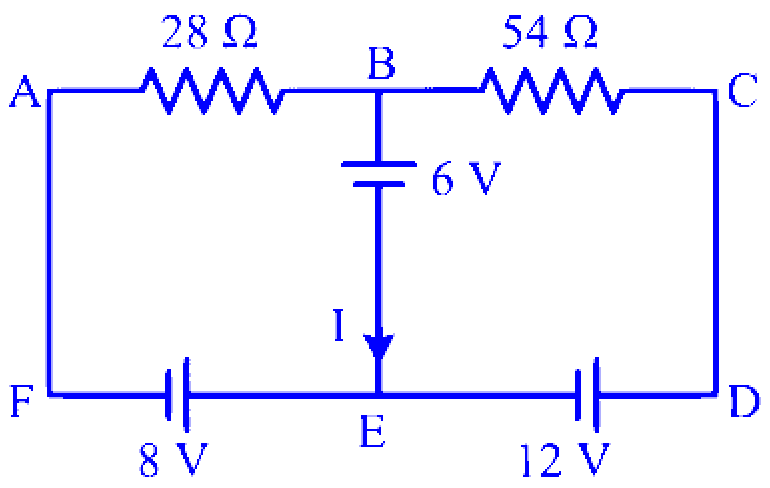
$$\frac{1}{R}=\frac{1}{G}+\frac{1}{S}$$

$$\therefore \frac{1}{S}=\frac{1}{R}-\frac{1}{G}$$

$$\therefore \frac{1}{S}=\frac{1}{2.5}-\frac{1}{50}=\frac{19}{50} \quad \therefore S=\frac{50}{19} \Omega$$

Question112

Consider the circuit shown in the figure. The value of current 'I' is



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Options:

A. $-\frac{7}{18}$A

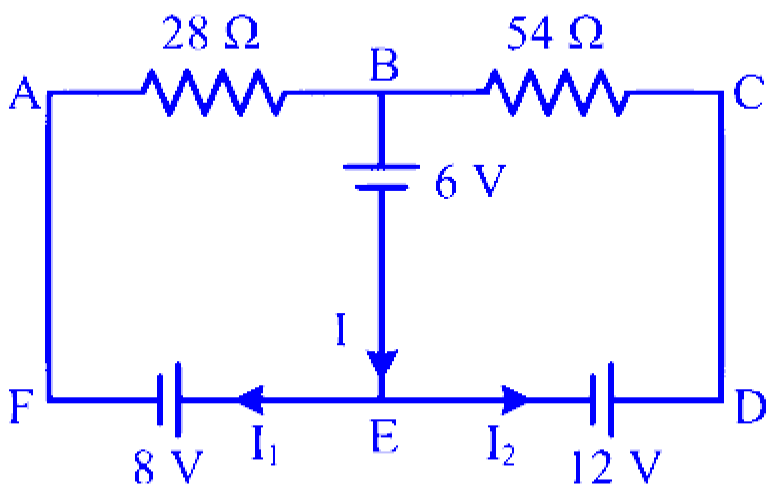
B. 5A

C. 3A

D. -3A

Answer: A

Solution:



Applying Kirchoff's voltage law to loop ABEFA we get

$$-28I_1 - 6 - 8 = 0$$

$$-28I_1 - 14 = 0$$

$$\therefore -28I_1 = 14$$

$$\therefore \quad I_1 = \frac{-14}{28} = -\frac{1}{2}\text{ A}$$

Applying KVL to BCDEB

$$54I_2 - 12 + 6 = 0$$

$$\therefore \quad 54I_2 = 6$$

$$\therefore I_2 = \frac{6}{54} = \frac{1}{9}\text{A} \quad \therefore I = I_1 + I_2 = -\frac{1}{2} + \frac{1}{9} = -\frac{7}{18}\text{A}$$

Question113

A milliammeter of resistance 40Ω has a range $0 - 30\text{ mA}$. What will be the resistance used in series to convert it into voltmeter of range $0 - 15\text{ V}$?

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Options:

A. 460Ω

B. 920Ω

C. 640Ω

D. 560Ω

Answer: A

Solution:

To convert a milliammeter into a voltmeter with a range of $0 - 15\text{ V}$, the following information is given:

Maximum Voltage, $V = 15\text{ V}$

Current through the galvanometer, $I_g = 30\,\text{mA} = 30 \times 10^{-3}\,\text{A}$

Internal resistance of the galvanometer, $G = 40\,\Omega$

We need to determine the resistance R that should be added in series. The relationship for the voltmeter is given by:

$V = I_g(R + G)$

Substituting the known values:

$15 = 30 \times 10^{-3}(R + 40)$

Solving for R:

$$\begin{aligned} 15 &= 30 \times 10^{-3}(R + 40) \\ 15 &= 0.03(R + 40) \\ \frac{15}{0.03} &= R + 40 \\ 500 &= R + 40 \\ R &= 500 - 40 = 460\,\Omega \end{aligned}$$

Therefore, the resistance that should be used in series is $460\,\Omega$.

Question114

Two cells having unknown emfs E_1 and E_2 $(E_1 > E_2)$ are connected in potentiometer circuit, so as to assist each other. The null point obtained is at 490 cm from the higher potential end. When cell E_2 is connected, so as to oppose cell E_1, the null point is obtained at 90 cm from the same end. The ratio of the emfs of two cells $\left(\frac{E_1}{E_2}\right)$ is

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Options:

A. 0.689

B. 5.33

C. 1.45

D. 0.182

Answer: C

Solution:

The emf of a cell in a potentiometer is

$E=\frac{V}{L} I$

where, $I=$ length of wire at null point,

$V=$ voltage of source

and $L=$ total length of potentiometer wire.

$\therefore \quad E \propto I$

When two cell of emf E_1 and E_2 $\left(E_1>E_2\right)$ are connected to assist each other, then

$E_1+E_2=490 \quad$ ... (i)

When the cell of emf E_2 is connected, so as to oppose cell E_1, then

$E_1-E_2=90 \quad$ .... (ii)

From Eqs. (i) and (ii), we get

$$
\begin{aligned}
& E_1=290 \text{ V and } E_2=200 \text{ V} \\
\therefore \quad & \frac{E_1}{E_2}=\frac{290}{200}=\frac{29}{20}=1.45
\end{aligned}
$$

Question115

A 10 m long wire of resistance 20Ω is connected in series with a battery of emf 3 V and a resistance of 10Ω. The potential gradient along the wire in V / m is

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Options:

A. 1.2

B. 0.10

C. 0.02

D. 0.20

Answer: D

Solution:

The equivalent resistance of the circuit,

$R_{\text{eq}} = 20 + 10 = 30\Omega$

The current flowing through the wire,

$i = \frac{V}{R} = \frac{3\text{ V}}{30\Omega} = 0.1\text{ A}$

The potential gradient along the wire,

$$= \frac{\text{Potential difference across } 20\Omega}{\text{Length of } 20\Omega \text{ wire}}$$
$$= \frac{0.1 \times 20\Omega}{10\text{ m}} = 0.20\text{ V/m}$$

Question116

Two galvanometers A and B require currents of 4 mA and 7 mA , respectively to produce the same deflection of 20 divisions. If S_A and S_B are their sensitivities respectively, then

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Options:

A. $S_A < S_B$

B. $S_A > S_B$

C. $S_B = \frac{7}{4} = S_A$

D. $S_A = S_B = \frac{4}{7}$

Answer: B

Solution:

The sensitivity of a galvanometer is defined as the deflection per unit current. Mathematically, sensitivity (S) can be expressed as:

$$S = \frac{\text{deflection (divisions)}}{\text{current (A)}}$$

For galvanometer A:

Deflection = 20 divisions

Current required = 4 mA = 0.004 A

Thus, the sensitivity of galvanometer A, S_A, is:

$$S_A = \frac{20 \text{ divisions}}{0.004 \text{ A}} = 5000 \text{ divisions/A}$$

For galvanometer B:

Deflection = 20 divisions

Current required = 7 mA = 0.007 A

Therefore, the sensitivity of galvanometer B, S_B, is:

$$S_B = \frac{20 \text{ divisions}}{0.007 \text{ A}} \approx 2857.14 \text{ divisions/A}$$

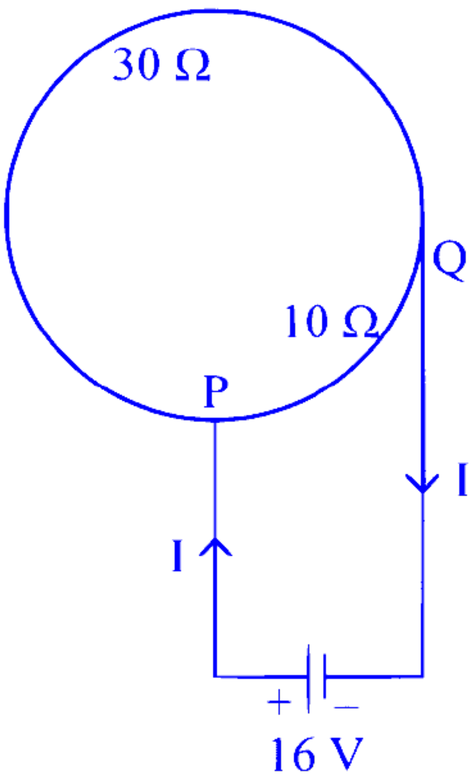
Comparing S_A and S_B, we have:

$S_A = 5000 \text{ divisions/A} > S_B = 2857.14 \text{ divisions/A}$

Thus, the correct answer is Option B: $S_A > S_B$.

Question117

A circular coil of radius R has a resistance of 40Ω. Figure shows two points P and Q on the circumference separated by a distance $\frac{\pi R}{2}$ which are connected to a 16 V battery with internal resistance of 0.5Ω. What is the value of current I flowing through the circuit?



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Options:

A. 3A

B. 2A

C. 1A

D. 0.5A

Answer: B

Solution:

First, calculate the total resistance between points P and Q :

$$R_{PQ} = \left(\frac{30\Omega \times 10\Omega}{30\Omega + 10\Omega}\right) + 0.5\Omega$$

$$= \frac{300\Omega}{40\Omega} + 0.5\Omega$$

$= 7.5\Omega + 0.5\Omega$

$= 8\Omega$

Next, determine the current flowing through the circuit using Ohm's law : $V = IR$

$I = \frac{V}{R_{PQ}}$

Where V is the voltage of the source. Therefore,

$I = \frac{16\text{ V}}{8\Omega} = 2\text{ A}$

The current I flowing through the circuit is thus 2 A.

Question118

Which of the following instruments is not a direct reading instrument?

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Options:

A. Electronic balance

B. Potentiometer

C. Ammeter

D. Voltmeter

Answer: B

Solution:

The potentiometer is used for measuring voltage or potential difference by comparison of an unknown voltage with the known voltage, hence it is not a direct reading instrument.

Question119

In conversion of moving coil galvanometer into an ammeter of required range, the resistance of ammeter, so formed is

[$S =$ shunt and $G =$ resistance of galvanometer]

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Options:

A. $\frac{S+G}{SG}$

B. $\frac{SG}{S+G}$

C. $\frac{S-G}{SG}$

D. $\frac{SG}{S-G}$

Answer: B

Solution:

To convert a moving coil galvanometer into an ammeter with a specific range, you need to connect a low resistance, known as a shunt resistance, in parallel with the galvanometer. This helps the galvanometer measure higher currents by bypassing most of the current through the shunt.

The resistance R of the resulting ammeter is calculated using the formula for parallel resistances:

$\frac{1}{R} = \frac{1}{S} + \frac{1}{G}$

Solving for R, we get:

$R = \frac{S \cdot G}{S+G}$

Here, S represents the shunt resistance, and G is the resistance of the galvanometer.

Question120

An ammeter of resistance 20Ω gives full scale deflection, when $1 \mathrm{~mA}$ current flows through it. What is the maximum current that can be measured by connecting 4 resistors each of 16Ω in parallel with the ammeter?

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Options:

A. 6 mA

B. 4 mA

C. 8 mA

D. 2 mA

Answer: A

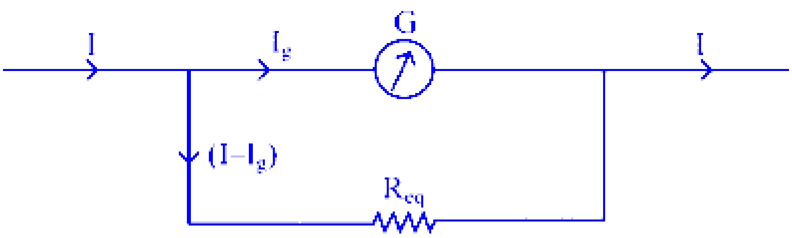
Solution:

Given, $G=20 \Omega$ and $I_g=1 \mathrm{~mA}=1 \times 10^{-3} \mathrm{~A}$

The equivalent resistance of 4 resistors of 16Ω each, connected in parallel is

$R_{\text {eq }} \quad=\frac{R}{n}=\frac{16}{4}=4 \Omega$

The circuit diagram of an ammeter is



So, the maximum current that can be measured,

$I=\frac{I_g G+I_g R_{\text {eq }}}{R_{\text {eq }}}=\frac{I_g\left(G+R_{\text {eq }}\right)}{R_{\text {eq }}}$

$$=\frac{1 \times 10^{-3}(20+4)}{4}$$
$=6 \times 10^{-3} \mathrm{~A}$ or $6 \mathrm{~mA}$

Question121

Two wires A and B of equal lengths are connected in left and right gap of a meter bridge, null point is obtained at $40 \mathrm{~cm}$ from left end. Diameters of the wire A and B are in that ratio $3 : 1$. The ratio of specific resistance of A to the of B is

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Options:

A. 4 : 1

B. 3 : 1

C. 6 : 1

D. 8 : 1

Answer: C

Solution:

In a meter bridge setup, the ratio of the resistances is directly proportional to the lengths of the wires if the wires are made up of the same material and have the same cross-sectional area. However, when the materials or the dimensions of the wires differ, we have to account for these differences to calculate the resistance.

The resistance (R) of a wire is given by the formula:

$R=\rho \frac{L}{A}$

where ρ is the resistivity (or specific resistance) of the material, L is the length of the wire, and A is the cross-sectional area of the wire. For a wire of circular cross-section, $A=\pi\left(\frac{d}{2}\right)^2$.

In this case, both wires A and B have equal lengths but different diameters. Let's denote their diameters as d_A and d_B respectively, with the given ratio $d_A : d_B=3 : 1$. Therefore, the cross-sectional areas of wires A and B, denoted as A_A and A_B respectively, will be in the ratio:

$\frac{A_A}{A_B}=\frac{\pi\left(\frac{d_A}{2}\right)^2}{\pi\left(\frac{d_B}{2}\right)^2}=\left(\frac{d_A}{d_B}\right)^2=(3 : 1)^2=9 : 1$

The resistance of wire A to wire B is given by:

$\frac{R_A}{R_B}=\frac{\rho_A \frac{L}{A_A}}{\rho_B \frac{L}{A_B}}$

Given that lengths of the two wires are the same and the resistances are inversely proportional to their respective cross-sectional areas, we have:

$\frac{R_A}{R_B} = \frac{\rho_A}{\rho_B} \cdot \frac{A_B}{A_A}$

At the balanced condition of the meter bridge:

$\frac{R_A}{R_B} = \frac{l}{100-l}$

where $l = 40\,\text{cm}$ (the distance from the left end for the null point), giving $\frac{l}{100-l} = \frac{40}{60} = \frac{2}{3}$.

Thus,

$\frac{\rho_A}{\rho_B} \cdot \frac{A_B}{A_A} = \frac{2}{3}$

Substituting the ratio of $\frac{A_B}{A_A} = 1 : 9$ or $\frac{A_A}{A_B} = 9 : 1$ into the equation gives us:

$\frac{\rho_A}{\rho_B} \cdot \frac{1}{9} = \frac{2}{3}$

Thus, solving for $\frac{\rho_A}{\rho_B}$:

$\frac{\rho_A}{\rho_B} = \frac{2}{3} \times 9 = 6$

Therefore, the ratio of the specific resistance of A to that of B is $6 : 1$, which makes Option C the correct answer.

Question122

A potentiometer wire is $4\ \text{m}$ long and potential difference of $3\ \text{V}$ is maintained between the ends. The emf of the cell, which balances against a length of $100\ \text{cm}$ of the potentiometer wire is

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Options:

A. 0.60 V

B. 0.50 V

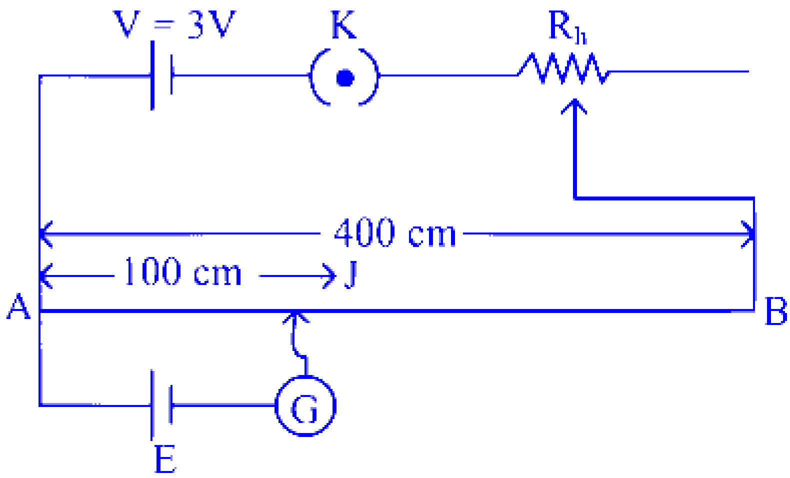
C. 0.25 V

D. 0.75 V

Answer: D

Solution:

The arrangement of potentiometer is shown below



When the potentiometer is in balanced condition, Potential difference across $AJ =$ Potential difference across AEJ

$\Rightarrow \quad \frac{V}{L} \times I = E$

$\therefore$ emf of cell, $E = \frac{3}{400} \times 100 = \frac{3}{4} = 0.75$ V

Question123

A potentiometer wire has length L For given cell of emf E, the balancing length is $\frac{L}{3}$ from the positive end of the wire. If the length of potentiometer wire is increased by 50%, then for the same cell, the balance point is obtained at length

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Options:

A. $\frac{L}{2}$ from positive end

B. $\frac{L}{5}$ from positive end

C. $\frac{L}{3}$ from positive end

D. $\frac{L}{4}$ from positive end

Answer: A

Solution:

For cell of emf E balancing length $= \frac{L}{3} = \frac{1}{3} \times L($ length of wire $)$

Increased length of wire $= L + \frac{L}{2} = \frac{3L}{2}$

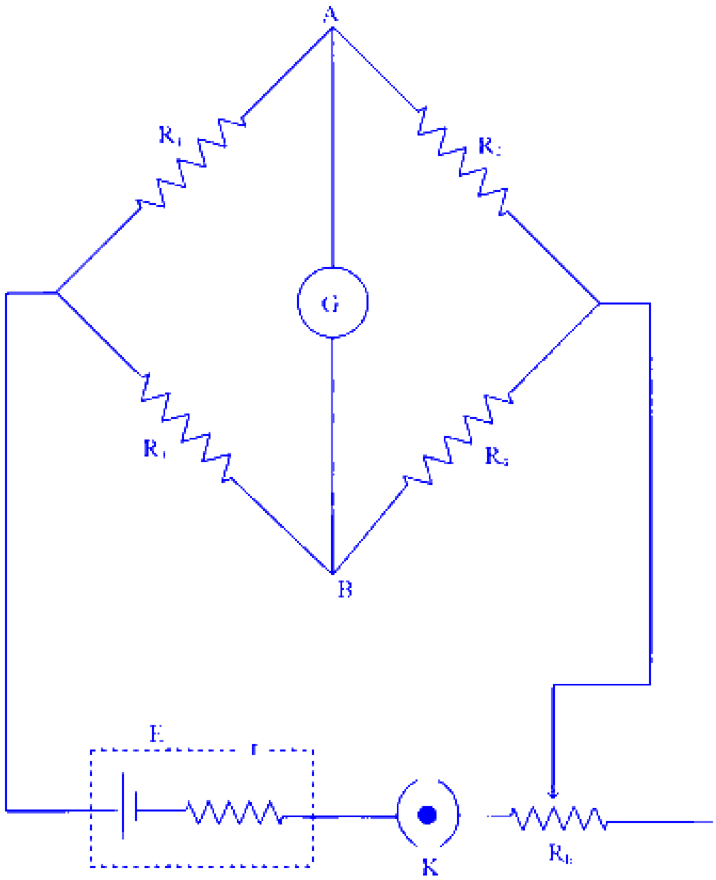
Since, the cell is the same, therefore the new balancing length $= \frac{1}{3}$ (new increased length)

$$= \frac{1}{3} \times \frac{3}{2} L$$
$$= \frac{L}{2}$$

Therefore, for the same cell the balance point will be as length $\frac{L}{2}$ from positive end.

Question124

In the network shown cell E has internal resistance r and the galvanometer shows zero deflection. If the cell is replaced by a new cell of emf $2E$ and internal resistance $3r$ keeping everything else identical, then



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Options:

A. The galvanometer will show deflection of 10 divisions.

B. The galvanometer show zero deflection,

C. Current will flow from B to A.

D. Current will flow from A to B.

Answer: B

Solution:

In given circuit diagram, galvanometer shows

zero deflection, hence it is a Wheatstone balanced circuit.

Hence, $V_A = V_B$

On replacing a new cell of emf $2E$ and internal resistance $3r$, no effect occurs on balanced condition of bridge, i.e., $V_A = V_B$.

Hence, the galvanometer will shows zero deflection.

Question125

The range of an ammeter of resistance ' G can be increased from ' I ' to ' nI ' by connecting

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Options:

A. a series resistance of $\frac{G}{n+1} \Omega$

B. a shunt of $\frac{G}{n-1} \Omega$

C. a shunt of $\frac{G}{n+1} \Omega$

D. a series resistance of $\frac{G}{n-1}\Omega$

Answer: B

Solution:

The range of an ammeter can be increased by connecting a shunt or parallel resistance to it, whose value is given by

$R=\left(\frac{I_g}{I-I_g}\right)G\Omega$ .... (i)

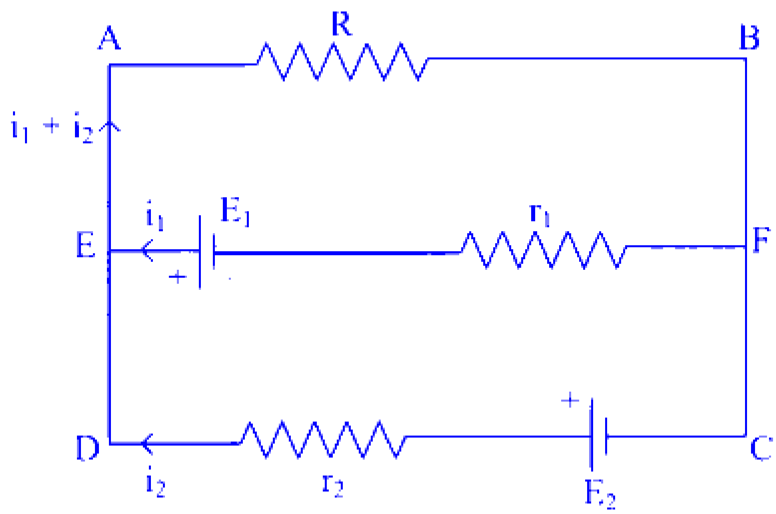
To increase the range from / to nl , the current passing through it is $I=nI_g$

Using this value in Eq. (i), we get

$$R=\left(\frac{I_g}{nI_g-I_g}\right)G$$
$$=\frac{G}{(n-1)}\Omega$$

Question126

In the given electrical circuit, which one of the following equations is a correct equation?



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Options:

A. $E_2-i_2r_2-E_1-i_1r_1=0$

B. $E_1-(i_1+i_2)R+i_1r_1=0$

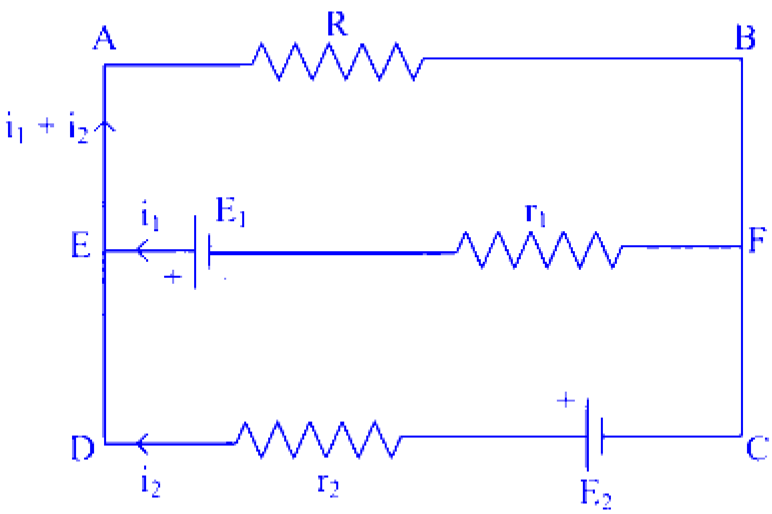
C. $E_1-(i_1+i_2)R-i_1r_1=0$

D. $-E_2-(i_1+i_2)R+i_2r_2=0$

Answer: C

Solution:

The given circuit can be drawn as



Applying Kirchhoff's voltage law (KVL) in loop $ABCDA$, we get

$-(i_1+i_2)R+E_2-i_2r_2=0 \quad \text{.... (i)}$

Applying KVL in loop ABFEA, we get

$-(i_1+i_2)R-i_1r_1+E_1=0 \quad \text{.... (ii)}$

Applying KVL in loop EFCDE, we get

$-E_1+i_1r_1+E_2-i_2r_2=0 \quad \text{.... (iii)}$

From the given options, only option (c) satisfies Eq. (ii), hence it is the correct equation.

Question127

With a resistance of ' X ' in the left gap and resistance of 9Ω in the right gap of a meter bridge, the balance point is obtained at 40 cm from the left end.In what way and to which resistance 3Ω resistance be connected to obtain the balance at 50 cm from the left end?

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Options:

A. In series with 9Ω

B. Parallel to $X\Omega$

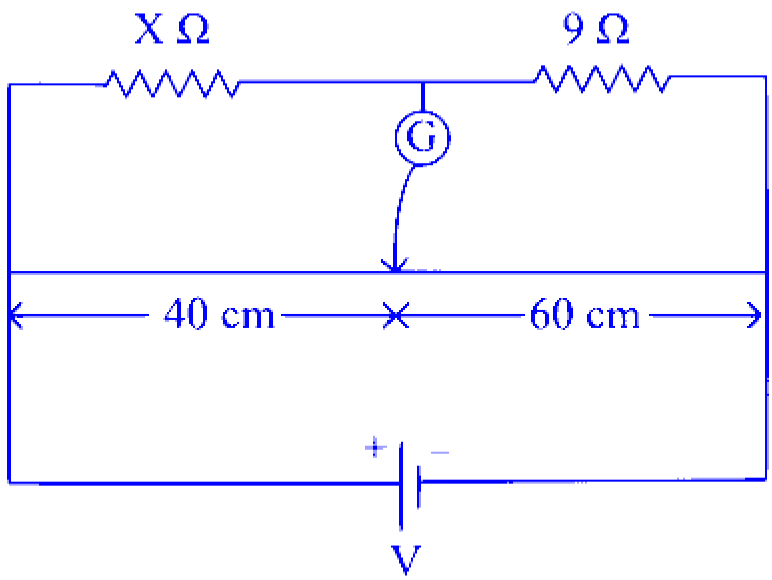
C. In series with $X\Omega$

D. Parallel to 9Ω

Answer: C

Solution:

The balanced condition of bridge is shown below in the first case



Then, $\frac{x}{9} = \frac{40}{60} \Rightarrow X = \frac{2}{3} \times 9 = 6\Omega$

To get the balance point at 50 cm from left end, the balanced condition becomes,

$\frac{X'}{9} = \frac{50}{50} = 1 \Rightarrow X' = 9\Omega$

As, in series combination resistances are added, so to get 9Ω at left gap the 3Ω resistance should be added in series with $X\Omega(6 + 3 = 9\Omega)$.

Question128

In moving coil galvanometer, strong horse shoe magnet of concave shaped pole pieces is used to

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Options:

A. increase space for rotation of coil

B. reduce weight of galvanometer

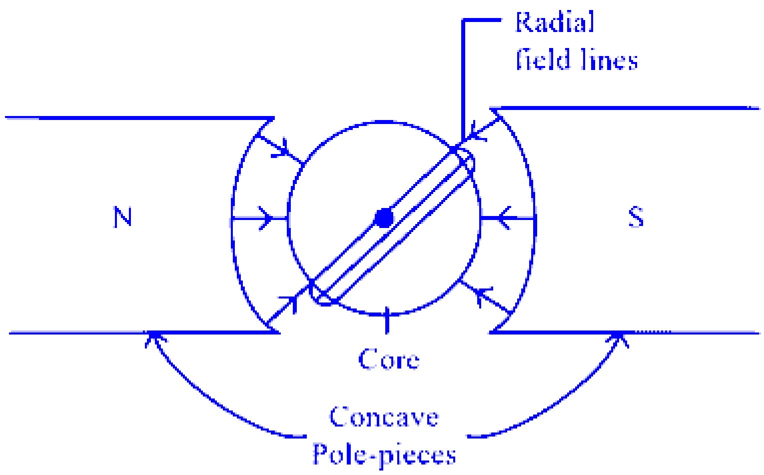
C. produce magnetic field which is parallel to plane of coil at any position

D. make magnetic induction weak at the centre.

Answer: C

Solution:

The horseshoe magnet has cylindrically concave pole-pieces. Due to its shape the magnet produces radial magnetic field, so that when the coil rotates in any position its plane is always parallel to the direction of the magnetic field. This has been shown in the figure given below.



Question129

For a metallic wire, the ratio of voltage to corresponding current is

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Options:

A. independent of temperature.

B. increases with rise in temperature.

C. increases or decreases with rise in temperature depending upon the metal.

D. decreases with rise in temperature.

Answer: B

Solution:

According to Ohm's law, the ratio of voltage to the corresponding current is represented as resistance, which can be expressed by the formula:

$\frac{V}{I} = R\,(\text{resistance})$

For a metallic wire, as the temperature increases, the resistance increases as well. This is due to the increased thermal motion of electrons within the wire, which causes more frequent collisions and impedes the flow of current.

Question130

A galvanometer has resistance of 100Ω and a current of 10 mA produces full scale deflection in it. The resistance to be connected in series, to get a voltmeter of range 50 volt is

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Options:

A. 3900Ω

B. 4000Ω

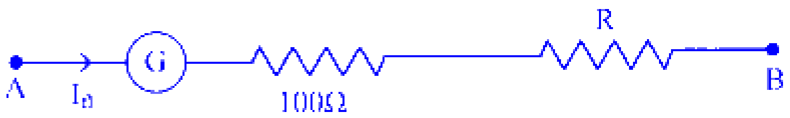
C. 4600Ω

D. 4900Ω

Answer: D

Solution:

A galvanometer is converted into a voltmeter by connecting a resistance in series with the galvanometer as shown in the circuit diagram,



where, R is resistance of the resistor connected in series.

Given, galvanometer resistance, $R_G = 100\Omega$

Voltmeter range, $V_{\max} = 50$ V and full deflection current $I_f = 10$ mA

So, by applying the KVL in above circuit diagram,

$V_{AB} = 100I_n + RI_n$
$\Rightarrow \quad V_{\mathrm{AB}} \quad = (100 + R)_{\mathrm{I}}$

$\therefore$ For a 50 V voltmeter range there must be,

$V_{AB} = 50$ V and $I_f = 10$ mA

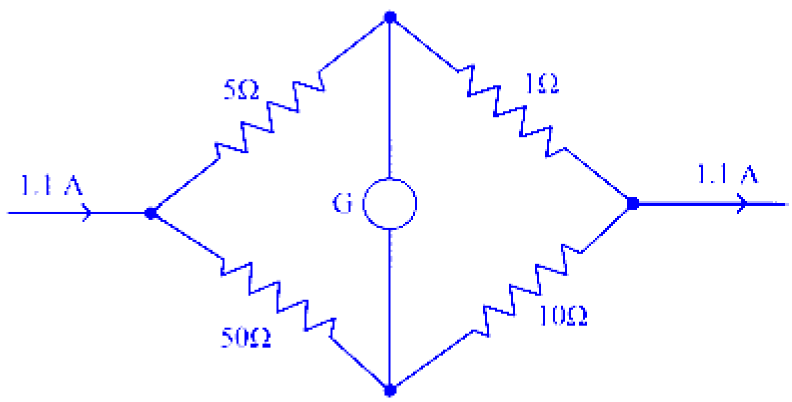
Now, substituting the values of V_{AB} and I_{fl} in Eq. (i) we get,

$$50 = (100 + R)10 \times 10^{-3}$$
$$\therefore \quad R = 4900\Omega$$

Hence, the resistance to be connected in series, to get a voltmeter of range 50 V is 4900Ω.

Question131

The circuit in 1Ω resistor in the following circuit is



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Options:

A. 1 A

B. 0.5 A

C. 1.1 A

D. 0.8 A

Answer: A

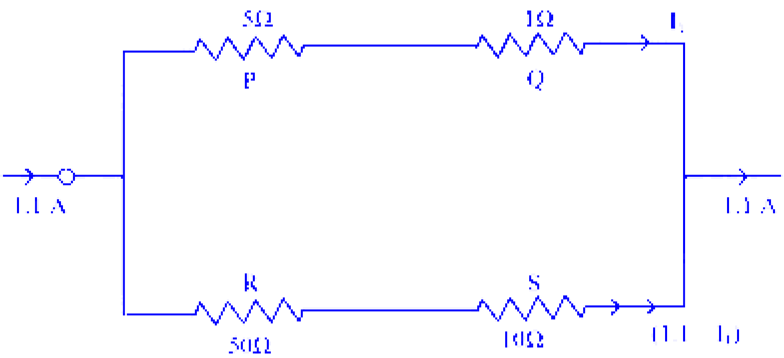
Solution:

Condition for balanced wheatstone-bridge,

$$\frac{P}{Q} = \frac{R}{S}$$
$$\Rightarrow \quad \frac{5}{1} = \frac{50}{10}$$
$$\Rightarrow \quad \frac{5}{1} = \frac{5}{1}$$

So, it is a balanced wheatstone-bridge and hence no current will flow through the arm G.

The, circuit can be redrawn as given below,



As, we know that in a series branch, same current flows.

Hence, from the KVL loop rule,

$V_{PQ} = l_1(5+1) = 6l_1$ .... (i)

and $V_{RS} = (50+10)(1.1 - l_1)$ ... (ii)

Since, for the parallel branches, the voltage drop across them remains same,

So,

$V_{PQ} = V_{RS}$

$\Rightarrow \quad 6I_1 = 60(1.1 - I_1)$ (using Eqs. (i) and (ii)) Hence, current of 1 A passes through 1Ω resistance.

$\Rightarrow \quad I_1(60+6) = 66$

$\Rightarrow \quad I_1 = 1$ A