BYJU'S Study Planner for Board Term I (CBSE Grade 12)

Date: 11/11/2021

Subject: Physics

Topic : Current Electricity

Class: Standard XII

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1. A current of 5 A\left{\dfrac{1}{4}\right)^{th} is passing through a metallic wire of cross sectional area $14 \times 10^{-6}\ \mathrm{m}^2$. If the density of the charge carries in the wire is $5 \times 10^{26}\ \mathrm{C/m^3}$, the drift speed of the electrons.

   - **A.** $3.46 \times 10^{-3}\ \mathrm{ms^{-1}}$
   - **B.** $4.46 \times 10^{-3}\ \mathrm{ms^{-1}}$ ✔
   - **C.** $5.46 \times 10^{-3}\ \mathrm{ms^{-1}}$
   - **D.** $6.46 \times 10^{-3}\ \mathrm{ms^{-1}}$

   $I = 5\ \mathrm{A}\ ;\ A = 14 \times 10^{-6}\ \mathrm{m}^2;\ n = 5 \times 10^{26}\ \mathrm{C/m^3}$

   Charge of an electron, $e = 1.6 \times 10^{-19}\ \mathrm{C}$

   Drift speed $V_d = \dfrac{I}{neA}$

   Substituting the data given in the question,

   $$V_d = \frac{5}{5 \times 10^{26} \times 1.6 \times 10^{-19} \times 14 \times 10^{-6}}$$

   $$V_d = \frac{1}{16 \times 14} = \frac{1}{244} = 4.46 \times 10^{-3}\ \mathrm{ms^{-1}}$$

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2. A hollow cylinder of length $3 \mathrm{~m}$ has inner and outer diameters of $4 \mathrm{~mm}$ and $8 \mathrm{~mm}$ respectively. The resistance of the cylinder is (specific resistance of the material $=2.2 \times 10^{-8} \Omega \mathrm{m}$)

- ✔ **A.** $1.75 \times 10^{-3} \Omega$
- ✖ **B.** $1.25 \times 10^{-3} \Omega$
- ✖ **C.** $1.5 \times 10^{-3} \Omega$
- ✖ **D.** $1.95 \times 10^{-3} \Omega$

$l=3 \mathrm{~m} ; \rho=2.2 \times 10^{-8} \mathrm{~mm} ; r_1=\frac{4}{2}=2 \mathrm{~mm}=2 \times 10^{-3} \mathrm{~m} ; r_2=\frac{8}{2}=4 \mathrm{~mm}=4 \times 10^{-3} \mathrm{~m}$

The resistance , $R=\dfrac{2.2 \times 10^{-8} \times 3}{\frac{22}{7} \times\left[4^2-2^2\right] \times 10^{-6}}$

$R=\dfrac{21 \times 10^{-9}}{12 \times 10^{-6}}=\dfrac{7}{4} \times 10^{-3} \Omega$

$R=1.75 \times 10^{-3} \Omega$

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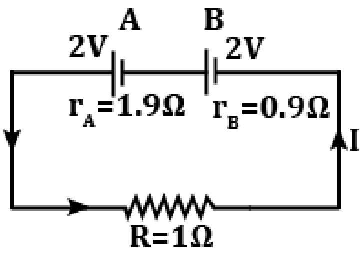
3. Two cells A and B each of 2 V are connected in series to an external resistance $R = 1\ \Omega$ as shown in figure. If the internal resistance of A is $r_A = 1.9\ \Omega$ and that of B is $r_B = 0.9\ \Omega$, then the potential difference between the terminals of A is

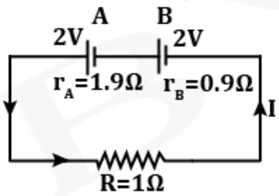


A. 1.75 V

B. 1.5 V

C. 1.25 V

D. zero ✔



$$I = \frac{\text{Total voltage}}{\text{Total resistance}}$$

$$\therefore I = \frac{V_A + V_B}{(R + r_A + r_B)}$$

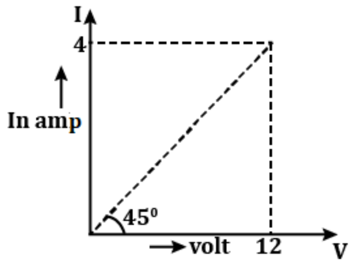
Substituting the data given in the question gives,

$$I = \frac{2+2}{1+1.9+0.9} = \frac{4}{3.8}\text{A}$$

Potential difference of A is , $V_A = E_A - Ir_A$

$$\Rightarrow V_A = 2 - \left(\frac{4}{3.8} \times 1.9\right) = 2 - 2 = 0\text{ V}$$

4. The variation of current and voltage in a conductor has been shown in figure. The conductance of the conductor is (Give your answer in Ω^{-1}).



A. $\frac{1}{2}$

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

C. $\frac{1}{3}$

D. $\frac{1}{4}$

From the given figure, Slope $= \frac{\Delta I}{\Delta V} = \frac{1}{R}$

$$\tan 45^\circ = \frac{4}{12} = \frac{1}{R} \Rightarrow R = \frac{12}{4} = 3\Omega$$

$$\Rightarrow R = 3\Omega$$

Thus, Conductance $G = \frac{1}{R} = \frac{1}{3}\Omega^{-1}$.

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5. The resistance of a metal wire is 10Ω. A current of $30 \mathrm{~mA}$ is flowing in it at $20^{\circ} C$. If the potential difference across its ends is constant and its increased to $120^{\circ} \mathrm{C}$, then the current flowing in the wire will be in (mA) (temperature coefficient of resistance is $5 \times 10^{-3}{ }^{\circ} C^{-1}$.

   ✗ **A.** 10

   ✗ **B.** 15

   ✓ **C.** 20

   ✗ **D.** 40

From Ohm's law, when the potential difference between two points is same, then we can say that,

$V=I_1 R_1=I_2 R_2$

Where R_1 and R_2 are the resistance at $t_1^{\circ} C$ and $t_2^{\circ} C$ respectively.

Thus, $I_2=I_1\left(\frac{R_1}{R_2}\right)$ and from the data given in the question, $\alpha=5 \times 10^{-3}{ }^{\circ} C^{-1}$

Also, $\frac{R_1}{R_2}=\frac{R_0\left[1+\alpha t_1\right]}{R_0\left[1+\alpha t_2\right]}$

Substituting the data gives,

$$\frac{R_1}{R_2}=\frac{1+\left(5 \times 10^{-3} \times 20\right)}{1+\left(5 \times 10^{-3} \times 120\right)}=\frac{1+0.1}{1+0.6}=\frac{1.1}{1.6}=\frac{11}{16}$$

$$\therefore I_2=I_1\left(\frac{R_1}{R_2}\right)=30 \times \frac{11}{16}=\frac{330}{16} \approx 20 \mathrm{~mA}$$

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6. In an experiment with potentiometer , to measure the internal resistance of a cell. When it is shunted by 5Ω the null point obtained is at $2\ \mathrm{m}$ from one end. When cell is shunted by 20Ω, the null point is obtained at $3\ \mathrm{m}$ from the same end. The internal resistance of cell is

   A. 8Ω

   B. 6Ω

   C. 4Ω ✔

   D. 2Ω

Let the internal resistance of the cell be r.

$$V_1 = I_1R_1 \ \ldots\ldots(1) \qquad V_2 = I_2R_2 \ldots\ldots(2) \qquad \Big| \qquad \mathcal{E} = I_2(R_2 + r) = I_1(R_1 + r)\ldots\ldots(3)$$

Using these equation we get,

$$\frac{I_1}{I_2} = \frac{R_2 + r}{R_1 + r}$$

$$\frac{V_1}{V_2} = \frac{I_1}{I_2} \times \left(\frac{R_1}{R_2}\right) = \frac{I\rho l_1}{I\rho l_2} = \frac{R_1}{R_2} \times \left[\frac{R_2 + r}{R_1 + r}\right]$$

$$\frac{l_1}{l_2} = \frac{R_1}{R_2}\left[\frac{R_2 + r}{R_1 + r}\right] \Rightarrow \frac{2}{3} = \frac{5}{20}\left[\frac{20 + r}{5 + r}\right]$$

$$8(5 + r) = 60 + 3r$$

$$8r - 3r = 60 - 40 = 20$$

$$5r = 20$$

$$r = \frac{20}{5} = 4\Omega$$

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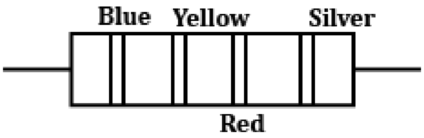
7. The colour coding on a resistor from the left are blue, yellow, red and silver as shown in figure. The value of resistance is

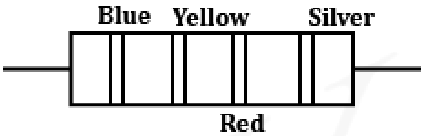


A. $6400\ \Omega \pm 20$

B. $6400\ \Omega \pm 10$

C. $4600\ \Omega \pm 10$

D. $6400\ \Omega \pm 5$



Blue : 6 ; Yellow : 4 ; Red : 2 ; Silver : $10\ \%$

$\therefore$ Resistance $R = 64 \times 10^2\ \Omega \pm 10$

(i.e) $R = 6400\ \Omega \pm 10$

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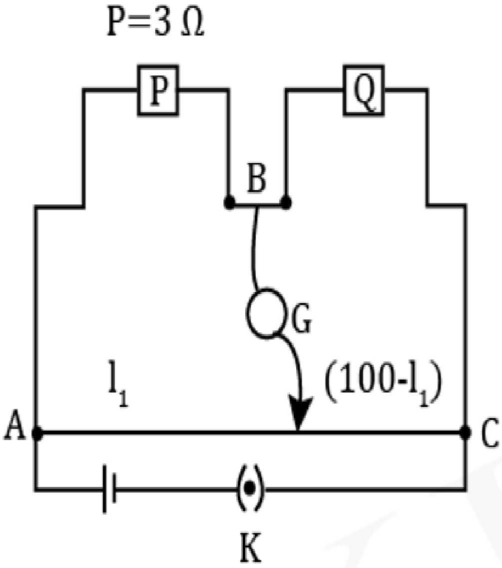
8. In a meter bridge experiment, resistances are connected as shown in figure. The balancing length l_1 is $55 \mathrm{~cm}$. Now an unknown resistance x is connected in series with P and the new balancing length is found to be $75 \mathrm{~cm}$. The value of x is



A. $\frac{54}{13} \Omega$

B. $\frac{20}{11} \Omega$

C. $\frac{48}{11} \Omega$ ✔

D. $\frac{11}{48} \Omega$

For the meter bridge shown in figure the balancing length is $l_1=55 \mathrm{~cm}$.

Applying balanced condition for meter bridge

$$\frac{R_P}{R_Q}=\frac{l_1}{100-l_1}$$

$$\frac{3}{R_Q}=\frac{55}{45}$$

$$\therefore R_Q=\frac{45 \times 3}{55}=\frac{27}{11} \Omega$$

Now an unknown resistance is connected in series with P and the balancing length is found to be $l_2=75 \mathrm{~cm}$

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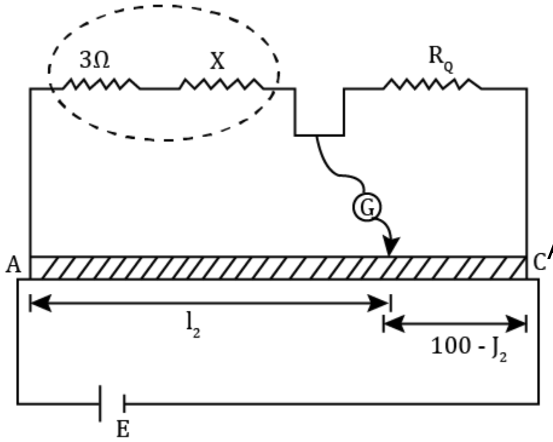

Applying the balancing condition for 2nd case,

$$\frac{3+x}{R_Q}=\frac{l_2}{100-l_2}$$

$(\because R_Q = 27/11\ \Omega$ & $l_2 = 75\text{ cm})$

$$\frac{(3+x)11}{27}=\frac{75}{25}$$

$$(3+x)11 = 81$$

$$\therefore x = \frac{48}{11}\Omega$$

Ans : (c)

Why this question ?
Tip: In such problems of meter bridge whenever an unknown resistance is connected in series or parallel with any of the arm resistances, first find out net resistance for that arm and then apply balanced bridge condition for new null point.

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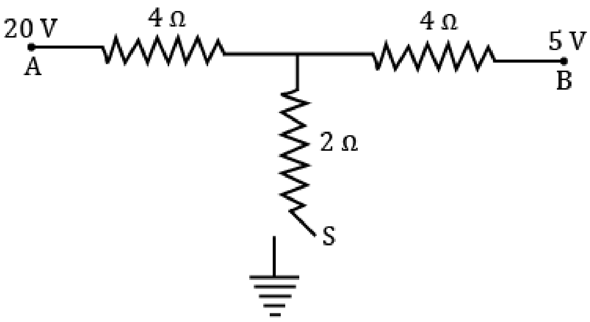
9. As the switch S is closed in the circuit shown in figure, current passing through it will be



A. 4.5 A

B. 6.0 A

C. 8/25 A

D. 25/8 A ✔

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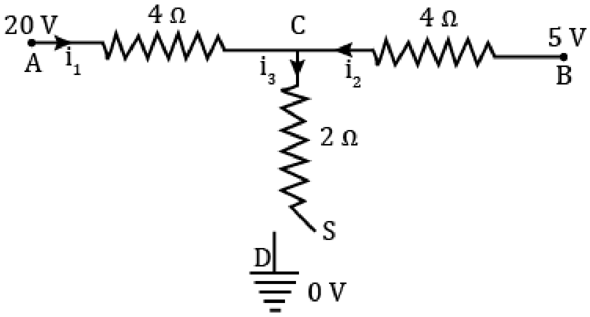
Let at junction C, potential is V



Applying Kirchhoff's junction law at C.

$$i_1 + i_2 = i_3$$

$$\Rightarrow \frac{V_A - V_C}{4} + \frac{V_B - V_C}{4} = \frac{V_C - V_D}{2}$$

putting the given values, we get

$$\Rightarrow \frac{20 - V}{4} + \frac{5 - V}{4} = \frac{V - 0}{2}$$

$$\Rightarrow 4V = 25$$

$$\therefore V = \frac{25}{4}\mathrm{V}$$

Therefore, current through switch S will be

$$i_3 = \frac{V}{R} = \frac{25/4 - 0}{2} = \frac{25}{8}\mathrm{A}$$

Hence, option (d) is correct.

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10. Resistance of a wire is 8Ω.It is stretched in such away that it experiences a longitudinal strain of 400%. The new resistance is

- ✗ A. $400\ \Omega$
- ✗ B. $300\ \Omega$
- ✓ C. $200\ \Omega$
- ✗ D. $100\ \Omega$

longitudinal strain , $\frac{\Delta l}{l} = \frac{400}{100} = 4$

$\Rightarrow \Delta l = 4l$

Initial length $= l$

Final length $= l + \Delta l = l + 4l = 5l$

As length is increased by $n = 5$

We know that , Resistance $R = \frac{\rho l^2}{V}$

The new resistance $R' = n^2 R$

$\Rightarrow R' = 5^2 \times 8 = 25 \times 8 = 200\ \Omega$

11. In the question given below, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements mark the correct answer.

Assertion (A): Potentiometer is much better than a voltmeter for measuring emf of cell.

Reason (R): A potentiometer draws no current while measuring emf of a cell.

- ✓ A. Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'.
- ✗ B. Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'
- ✗ C. 'A' is true and 'R' is false
- ✗ D. 'A' is false and 'R' is true

Because voltmeter draws a small current from the main circuit, where the Potential difference between the two points is to be measured, the reading shown by the voltmeter is not accurate.

But in potentiometer, it draws no current while measuring either emf/Potential difference. So, it is more accurate in measuring the emf.

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12. In the question given below, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements mark the correct answer.

Assertion (A): In meterbridge experiment a high resistance is connected in series with the galvanometer.

Reason (R): As resistance increases, current through the circuit increases.

- ✗ **A.** Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'.
- ✗ **B.** Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'
- ✓ **C.** 'A' is true and 'R' is false
- ✗ **D.** 'A' is false and 'R' is true

The purpose of connecting the high resistance in series with galvanometer is to protect the galvanometer from the high current. i.e high current flow through the galvanometer damages its coil.

13. In the question given below, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements mark the correct answer.

Assertion (A): Terminal voltage of a cell is greater than emf of the cell, during charging of the cell.

Reason (R): The emf of a cell is always greater than its terminal voltage.

- ✗ **A.** Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'.
- ✗ **B.** Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'
- ✓ **C.** 'A' is true and 'R' is false
- ✗ **D.** 'A' is false and 'R' is true

During charging, the terminal voltage across the battery is greater than the emf of the cell. Then only the cell will be charged i.e the current will flow through it.

EMF is greater than the terminal voltage only when the cell delivers the current to the external circuit.

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14. In the question given below, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements mark the correct answer.

Assertion (A): At any junction of a network , the algebraic sum of various currents is zero.

Reason (R): At steady state , there is no accumulation of charges at the junction.

- ✔ **A.** Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'.
- ✖ **B.** Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'
- ✖ **C.** 'A' is true and 'R' is false
- ✖ **D.** 'A' is false and 'R' is true

From the statement of Kirchhoff's junction law, "Sum of all the incoming currents is equal to sum of all outgoing currents at a junction" , when the circuit is in its steady state.

15. Assertion (A): A piece of copper and other of germanium are cooled from room temperature to 100 K. Conductivity of copper increases and that of germanium decreases.
Reason (R): Copper has positive temperature coefficient where as germamium has negative temperature coefficient.

Study both the statements carefully and then
Select your answers, according to the codes given below

- ✔ **A.** Both A and R are true and R is the correct explanation of A.
- ✖ **B.** Both A and R are true and R is not the correct explanation of A
- ✖ **C.** A is true and R is false
- ✖ **D.** A is false and R is true

Variation of resistivity with temperature is
$\rho = \rho_0(1 + \alpha\Delta T)$
As copper is a conductor and germanium is a semi-conductor, copper has positive temperature coefficient where as germamium has negative temperature coefficient.
So, when cooled resistivity of copper decreases, while its conductivity increases.
Similarly, when cooled resistivity of germanium increases, while its conductivity decreases.

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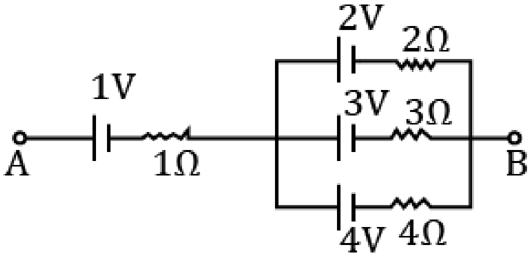
16. The circuit given below consists of cells with their internal resistance,



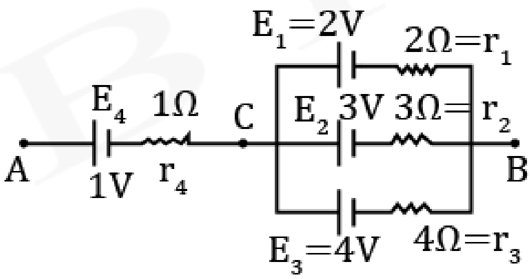
(i) The equivalent emf between the terminals A and B is

A. $\frac{24}{13}\mathrm{V}$

B. $\frac{37}{13}\mathrm{V}$

C. $\frac{36}{13}\mathrm{V}$

D. $\frac{49}{13}\mathrm{V}$



The effective emf between C and B

$$E_{CB}=\frac{\frac{E_1}{r_1}+\frac{E_2}{r_2}+\frac{E_3}{r_3}}{\left(\frac{1}{r_1}+\frac{1}{r_2}+\frac{1}{r_3}\right)}=\frac{\frac{2}{2}+\frac{3}{3}+\frac{4}{4}}{\left(\frac{1}{2}+\frac{1}{3}+\frac{1}{4}\right)}=\frac{36}{13}$$

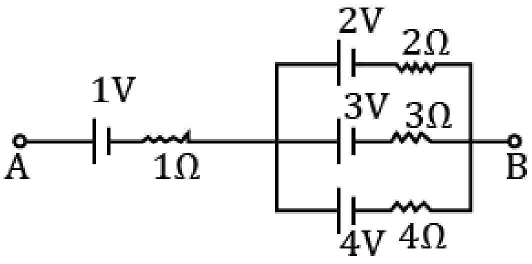
The effective emf between A and B is

$\therefore E_{AB}=E_{AC}+E_{CB}$

$E_{AB}=1+\frac{36}{13}$

$E_{AB}=\frac{49}{13}\mathrm{V}$

17. The circuit given below consists of cells with their internal resistance



(ii) The equivalent internal resistance of the combination is

A. $\frac{24}{13}\Omega$

B. $\frac{13}{24}\Omega$

C. $\frac{25}{13}\Omega$ ✔

D. $\frac{13}{12}\Omega$

As three cells are in parallel, their effective internal resistance is

$$\frac{1}{r_{123}}=\frac{1}{r_1}+\frac{1}{r_2}+\frac{1}{r_3}$$
$$=\frac{1}{2}+\frac{1}{3}+\frac{1}{4}$$
$$=\frac{6+4+3}{12}=\frac{13}{12}$$
$$r_{123}=\frac{12}{13}$$

Now $1\ \mathrm{V}$ is in series to the parallel combination, hence net resistance of combination is

$$R_{eff}=r_4+r_{123}$$
$$=1+\frac{12}{13}$$
$$=\frac{25}{13}\Omega$$

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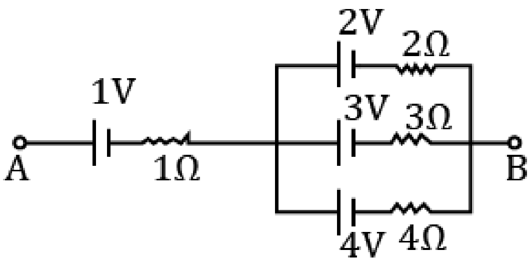
18. The circuit given below consists of cells with their internal resistance



(iii) If the polarity of cell of $4\ \mathrm{V}$ is reversed, the equivalent emf between the terminals A and B is

- ✗ **A.** $\frac{1}{13}\mathrm{V}$
- ✗ **B.** $\frac{37}{13}\mathrm{V}$
- ✓ **C.** $\frac{25}{13}\mathrm{V}$
- ✗ **D.** $\frac{12}{13}\mathrm{V}$

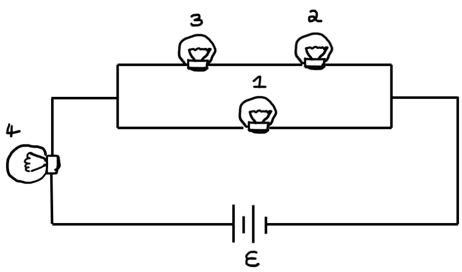
If the polarity of cell $4\ \mathrm{V}$ is reversed

$$E_{AB} = E_{AC} + E_{AB} = 1 + \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2} - \frac{E_3}{r_3}}{\left(\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}\right)}$$

$$E_{AB} = 1 + \frac{\frac{2}{2} + \frac{3}{3} - \frac{4}{4}}{\frac{1}{2} + \frac{1}{3} + \frac{1}{4}} = 1 + \frac{1}{\left(\frac{13}{12}\right)}$$

$$E_{AB} = \frac{25}{13}\mathrm{V}$$

19. All bulbs consume same power. The resistance of bulb 1 is $36\ \Omega$.



(i) What is the resistance of bulb 3 ?

A. $4\ \Omega$

B. $9\ \Omega$ ✔

C. $12\ \Omega$

D. $18\ \Omega$

From the figure, Bulbs 2 and 3 are in series and both consume same power.

Therefore , $R_2 = R_3$

Further, $V_1 = V_{23}$ and $V_2 = V_3$

Thus, $V_2 = V_3 = \dfrac{V_1}{2}$

Since, Power $(P) = \dfrac{V^2}{R}$

We can say, resistance should becomes $\left(\dfrac{1}{4}\right)^{th}$.

Hence, $R_2 = R_3 = \dfrac{R_1}{4} = 9\ \Omega$

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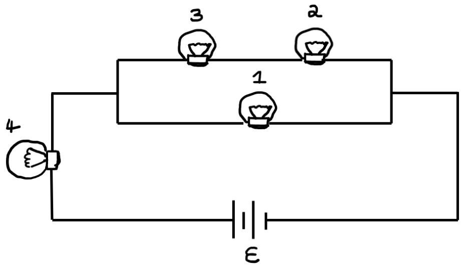
20. All bulbs consume same power. The resistance of bulb 1 is $36\ \Omega$.



(ii) What is the voltage output of the battery , if the power of each bulb is $4\ \mathrm{W}$?

A. $12\ \mathrm{V}$

B. $16\ \mathrm{V}$ ✔

C. $24\ \mathrm{V}$

D. $32\ \mathrm{V}$

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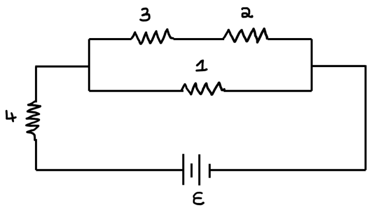
From the figure, Bulbs 2 and 3 are in series and both consume same power.



Therefore , $R_2 = R_3$

Further, $V_1 = V_{23}$ and $V_2 = V_3$

Thus, $V_2 = V_3 = \frac{V_1}{2}$

Since, Power $(P) = \frac{V^2}{R}$

We can say, resistance should becomes .

Hence, $R_2 = R_3 = \frac{R_1}{4} = 9\ \Omega$

Now, $R_{23} = 9 + 9 = 18\ \Omega$ and $R_1 = 36\ \Omega$

$\therefore i_{23} = 2i_1$, also $i_4 = i_{23} + i_1 = 3i_1$ (Which means current passing through 4 become 3 times)

That implies, resistance of 4 should be $\left(\frac{1}{9}\right)^{th}$ of resistance 1.

$R_4 = \frac{R_1}{9} = 4\ \Omega$

For the equivalent resistance, $R_{net} = \frac{R_1 \times R_{23}}{R_1 + R_{23}} + R_4 = \frac{18 \times 36}{18 + 36} + 4 = 16\ \Omega$

Given, power of each bulb becomes $4\ \mathrm{W}$

Therefore , $P_{net} = 4 \times (4\ \mathrm{W}) = 16\ \mathrm{W}$

Voltage output of battery , $\mathcal{E} = \sqrt{P_{net} R_{net}} = 16\ \mathrm{V}$