PHYSICS

BOOKS - PSEB

CURRENT ELECTRICITY

Exercise

1. The storage battery of a car has an emf of 12 V. If the internal resistance of the battery is

0.4Ω , what is the maximum current that can be drawn from the battery?

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2. A battery of emf 10 V and internal resistance 3Ω is connected to a resistor. If the current in the circuit is 0.5 A, what is the resistance of the resistor? What is the terminal voltage of the battery when the circuit is closed?

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3. Three resistors $1\Omega, 2\Omega$ and 3Ω are combined in series. What Is the total resistance of the combination?

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4. Three resistors 1Ω, 2Ω and 3Ω are combined in series and the combination is connected to a battery of emf 12 V and negligible internal resistance, obtain the potential drop across each resistor.

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5. Three resistors $2\Omega, 4\Omega \text{ and } 5\Omega$ are combined in parallel. What is the total resistance of the combination?

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6. Three resistors 2 ohm ,4 ohm and 5 ohm are combined in parallel and the combination is connected to a battery of emf 20 V and negligible internal resistance, determine the current through each resistor, and the total current drawn from the battery.

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7. At room temperature $(27.0^{\circ} C)$ the resistance of a heating element is 100Ω . What is the temperature of the element if the resistance is found to be 117Ω . given that the temperature coefficient of the material of the resistor is 1.70×10^{-4} ^ $\circ C^{-1}$.

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8. A negligibly small current is passed through a wire of length 15 m and uniform cross-section $6.0 \times 10^{-7} m^2$, and its resistance is measured to be 5.0Ω . What is the resistivity of the material at the temperature of the experiment?

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9. A silver wire has a resistance of 2.1Ω at $27.5^\circ C$, and a resistance of 2.7Ω at $100^\circ C$.

Determine the temperature coefficient of resistivity of silver.

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10. A heating element using nichrome connected to a 230 V supply draws an initial current of 3.2 A which settles after a few seconds to a steady value of 2.8 A. What Is the steady temperature of the heating element If the room temperature is $27.0^\circ C$? Temperature coefficient of resistance of nichrome averaged over the temperature range involved is $1.70 \times 10^{-4} \circ C$.

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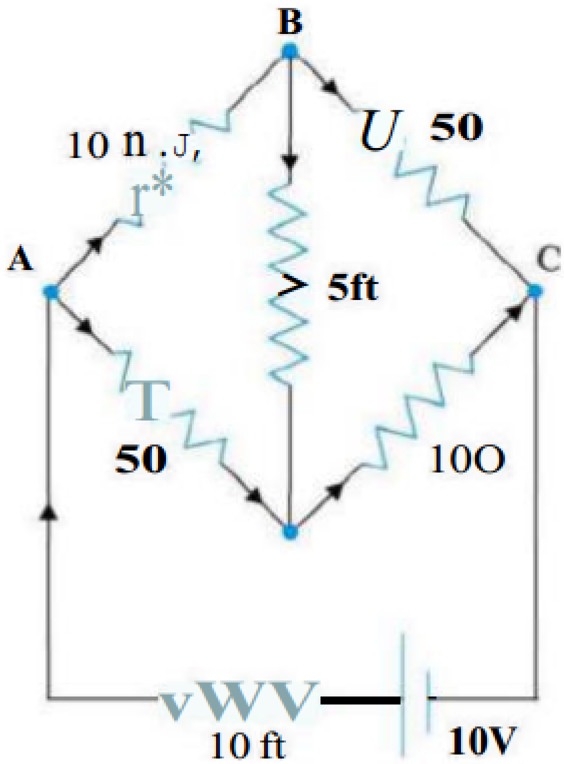
11. Determine the current in each branch of the network shown in Fig.



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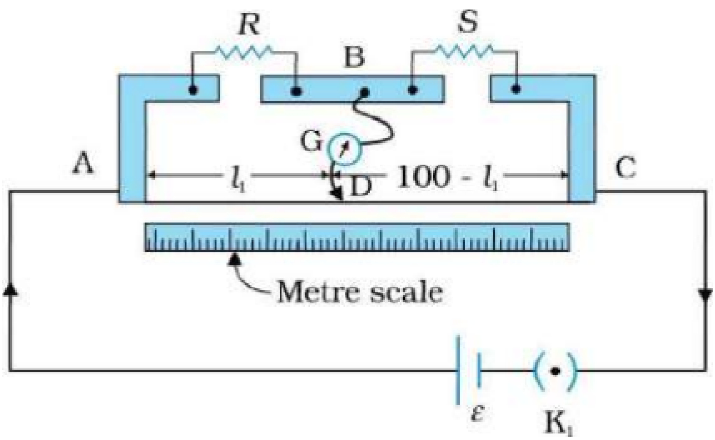
12. In a metre bridge [Fig. 3.27], the balance point is found to be at 39.5 cm from the end A, when the resistor Y is of 12.5Ω Determine the resistance of X. Why are the connections between resistors in a Wheatstone or meter bridge made of thick copper strips?:



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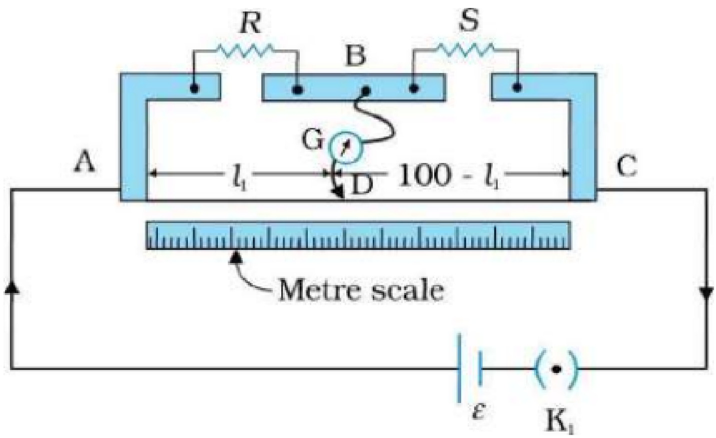
13. In a metre bridge [Fig. 3.27], the balance point is found to be at 39.5 cm from the end A, when the resistor R is of 12.5Ω. Determine the balance point of the bridge above if R and S are interchanged. :



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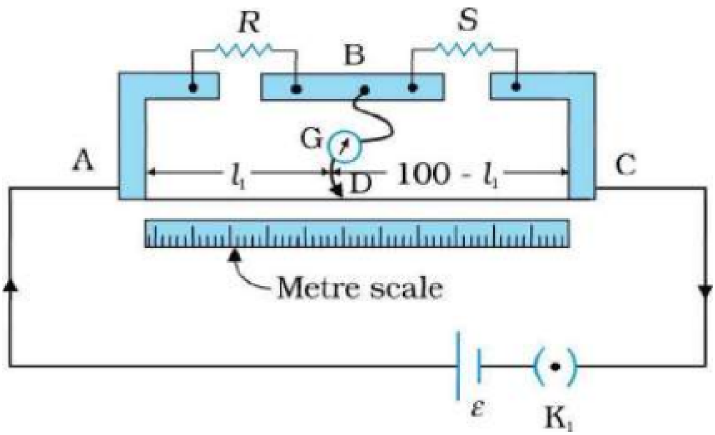
14. In a metre bridge [Fig. 3.27], the balance point is found to be at 39.5 cm from the end A, when the resistor R is of 12.5Ω. Determine the balance point of the bridge above if R and S are interchanged. :



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15. A storage battery of emf 8.0 V and internal resistance 0.5Ω is being charged by a 120 V dc supply using a series resistor of 15.5Ω . What is the terminal voltage of the battery during charging? What is the purpose of having a series resistor in the charging circuit?

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16. In a potentiometer arrangement, a cell of emf 1.25 V gives a balance point at 35.0 cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 63.0 cm, what is the emf of the second cell?

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17. The number density of free electrons in a copper conductor estimated in Example 3.1 is $8.5 \times 10^{28} m^{-3}$. How long does an electron take to drift from one end of a wire 3.0 m long to its other end? The area of cross-section of the wire is $2.0 \times 10^{-6} m^2$ and it is carrying a current of 3.0 A.

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18. The earth's surface has a negative surface charge density of $10^{-9} Cm^{-2}$. The potential difference of 400 kV between the top of the atmosphere and the surface results (due to the low conductivity of the lower atmosphere) in a current of only 1800 A over the entire globe. If there were no mechanism of sustaining atmospheric electric field, how much time (roughly) would be required to neutralise the earth's surface? (This never happens in practice because there is a mechanism to replenish electric charges, namely the continual thunderstorms and lightning in different parts of the globe). (Radius of earth = $6.37 \times 10^6 m$.)

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19. Six lead-acid type of secondary cells each of emf 2.0 V and internal resistance 0.015Ω are joined in series to provide a supply to a resistance of 8.5Ω . What are the current drawn from the supply and its terminal voltage?

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20. A secondary cell after long use has an emf of 1.9 V and a large internal resistance of 380Ω. What maximum current can be drawn from the cell? Could the cell drive the starting motor of a car?

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21. Two wires of equal length, one of aluminium and the other of copper have the same resistance. Which of the two wires is lighter? Hence explain why aluminium wires are preferred for overhead power cables. ($\rho_A l = 2.63 \times 10^{-8} \Omega m, \rho_C u = 1.72 \times 10^{-8} \Omega m$. Relative density of A1 = 2.7, of Cu = 8.9.)

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22. What conclusion can you draw from the following observations on a resistor made of alloy manganin? :

Current A	Voltage V	Current A	Voltage V
0.2	3.94	3.0	59.2
0.4	7.87	4.0	78.8
0.6	**11.8**	5.0	98.6
0.8	15.7	6.0	118.5
1.0	19.7	7.0	138.2
2.0	39.4	8.0	158.0

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23. Answer the following questions: A steady current flows in a metallic conductor of non-uniform cross-section. Which of these quantities is constant along the conductor: current, current density, electric field, drift speed?

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24. Answer the following questions: Is Ohm's law universally applicable for all conducting elements? If not, give examples of elements which do not obey Ohm's law.

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25. Answer the following questions: A low voltage supply from which one needs high currents must have very low internal resistance. Why?

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26. Answer the following questions: A high tension (HT) supply of, say, 6 kV must have a very large internal resistance. Why?

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27. Choose the correct alternative: Alloys of metals usually have $(greater / \leq ss)$ resistivity than that of their constituent metals.

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28. Choose the correct alternative: Alloys usually have much $(lower / higher)$ temperature coefficients of resistance than pure metals.

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29. Choose the correct alternative: The resistivity of the alloy manganin is nearly independent (of/ or increases) rapidly with increase of temperature.

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30. Choose the correct alternative: The resistivity of a typical insulator (e.g., amber) is greater than that of a metal by a factor of the order of $(10^{22} / 10^{3})$.

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31. Given n resistors each of resistance R. how will you combine them to get the maximum effective resistance? What is the ratio of the maximum to minimum resistance?

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33. Given the resistances of $1\Omega, 2\Omega, 3\Omega$, how will be combine them to get an equivalent resistance of (i) $(11/3)\Omega$ (ii) $(11/5)\Omega$, (iii) 6Ω, (iv) $(6/11)\Omega$?

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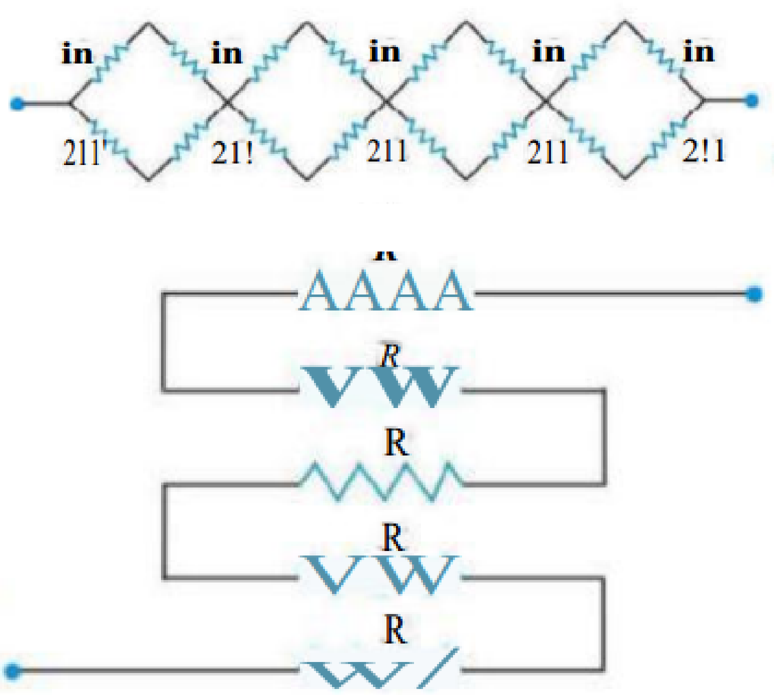
34. Determine the equivalent resistance of networks shown in Fig. 3.31. :



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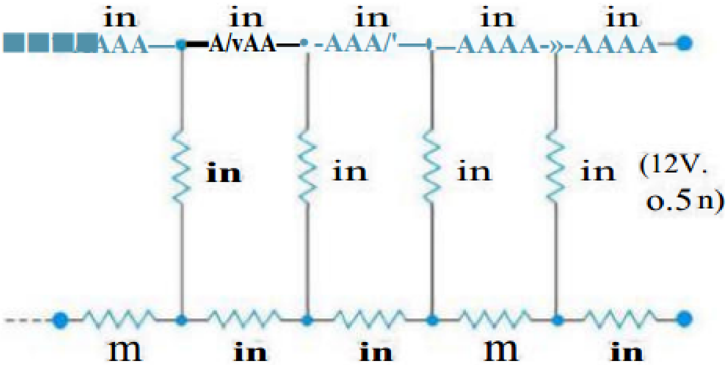
35. Determine the current drawn from a 12V supply with internal resistance 0.5Ω by the infinite network shown in Fig. Each resistor has 1Ω resistance. :



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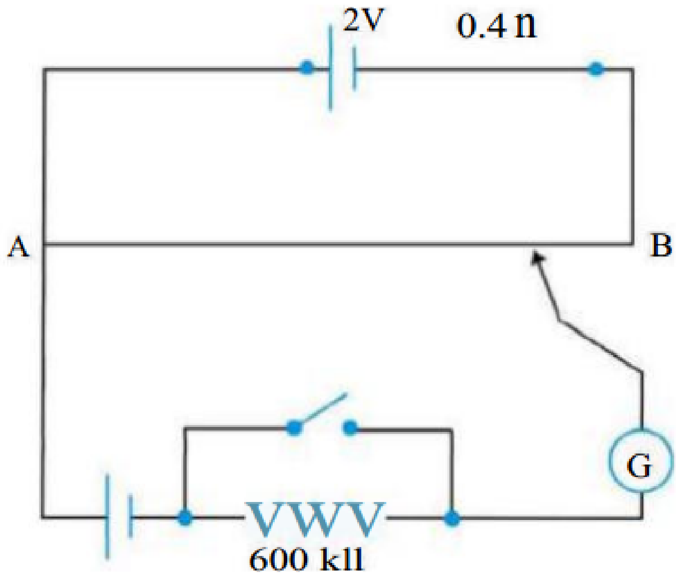
36. Figure shows a potentiometer with a cell of 2.0 V and internal resistance 0.40Ω maintaining a potential drop across the resistor wire AB. A standard cell which maintains a constant emf of 1.02 V (for very moderate currents upto a few mA) gives a balance point at 67.3 cm length of the wire. To ensure very low currents drawn from the standard cell, a very high resistance of $600k\Omega$ is put in series with it, which is shorted close to the balance point. The standard cell is then replaced by a cell of unknown $emf \varepsilon$ and the balance point found similarly, turns out to be at 82.3 cm length of the wire. What is the value ε ? :



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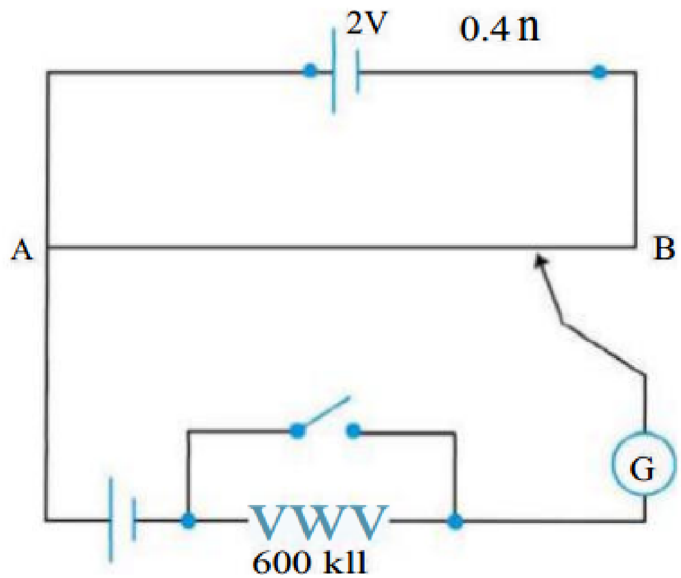
37. Figure shows a potentiometer with a cell of 2.0 V and internal resistance 0.40Ω maintaining a potential drop across the resistor wire AB. A standard cell which maintains a constant emf of 1.02 V (for very moderate currents upto a few mA) gives a balance point at 67.3 cm length of the wire. To ensure very low currents drawn from the standard cell, a very high resistance of $600k\Omega$ is put in series with it, which is shorted close to the balance point. The standard cell is then replaced by a cell of unknown $emf \varepsilon$ and the balance point found similarly, turns out to be at 82.3 cm length of the wire. What purpose does the high resistance of $600k\Omega$ have? :



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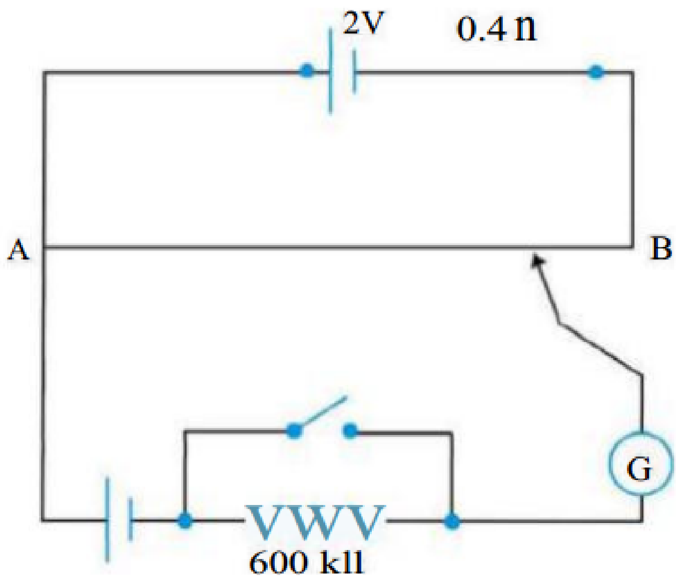

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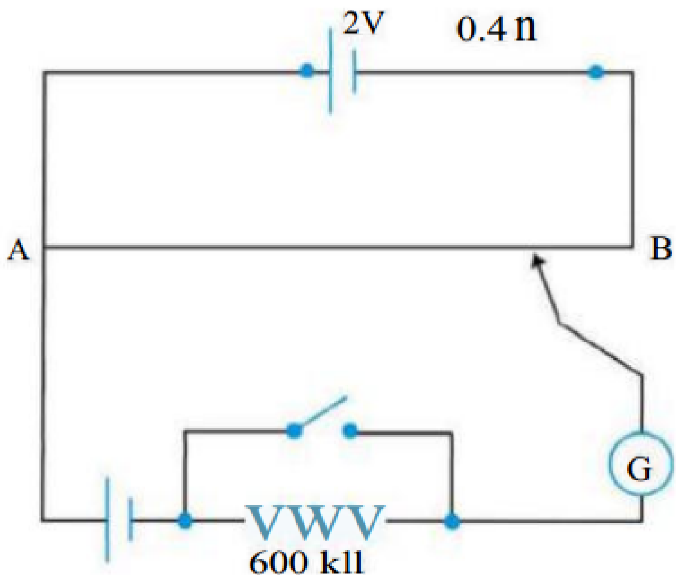

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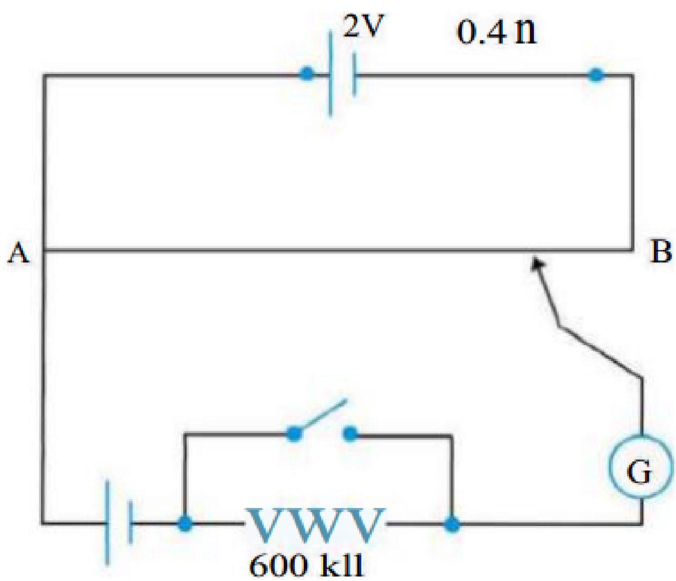

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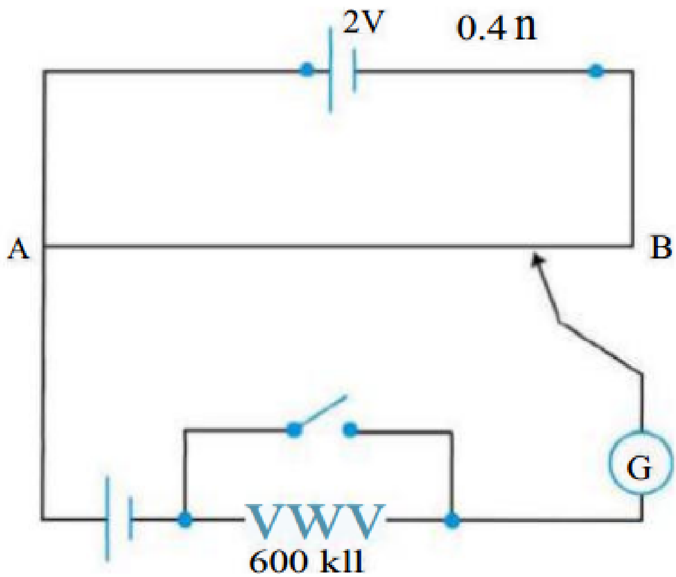

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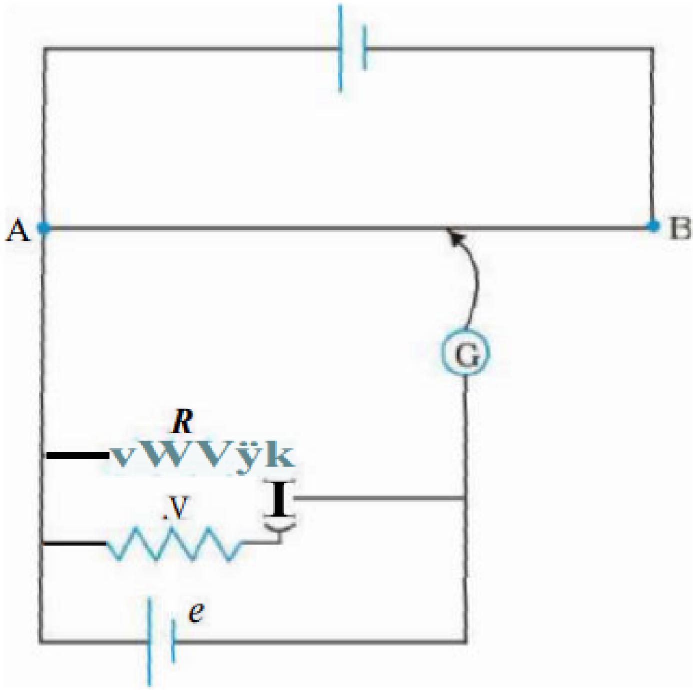
42. Figure 3.34 shows a potentiometer circuit for comparison of two resistances. The balance point with a standard resistor $R = 10.0\Omega$ is found to be 58.3 cm, while that with the unknown resistance X is 68.5 cm. Determine the value of X. What might you do if you failed to find a balance point with the given cell of $emf\varepsilon$? :



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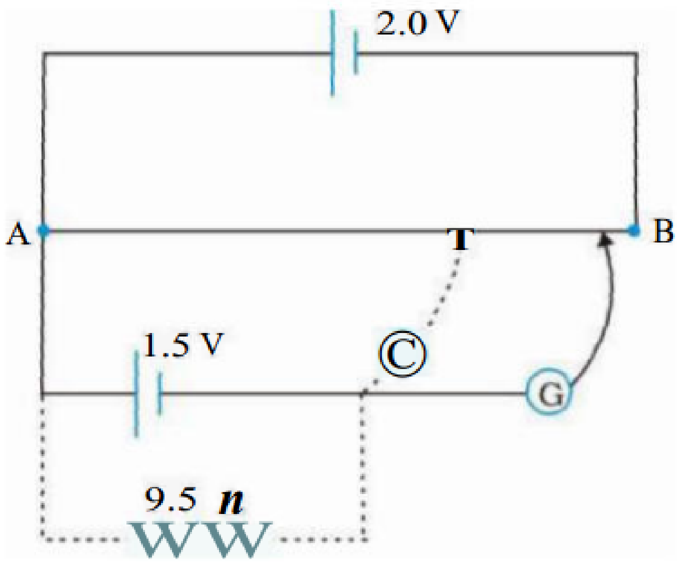
43. Figure 3.35 shows a 2.0 V potentiometer used for the determination of internal resistance of a 1.5 V cell. The balance point of the cell in open circuit is 76.3 cm. When a resistor of 9.5Ω is used in the external circuit of the cell, the balance point shifts to 64.8 cm length of the potentiometer wire. Determine the internal resistance of the cell. :



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