PHYSICS

BOOKS - MODERN PUBLICATION

ELECTRICAL MEASUREMENTS

Example

1. Two parallel resistors of 5 ohm nd 20 ohm are connected in left arm of a metre bridge. If the null point is at 40 cm from left end of the wire, calculate the value of resistance connected in right arm.

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2. A cell of e.m.f. 4 V and of negligible internal resistance is connected in series with a potentiometer wire of length 400 cm. The e.m.f. of a

Leelanche cell is found to be balacned at 150 cm from the positive end of the potentiometer wire. What is the e.m.f. of the Leclanche cell ?

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3. Two cells of emfs 1.5 V and 2.0V internall resistance 1Ω and $2\Omega$are connected in parallel so as to send current in the same direction through an external resistance of 5Ω.

Draw the circuit diagram.

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4. Two cells of emfs 1.5 V and 2.0V internall resistance 1Ω and $2\Omega$are connected in parallel so as to send current in the same direction through an external resistance of 5Ω.

Draw the circuit diagram.

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5. Two cells of emfs 1.5 V and 2.0V internall resistance 1Ω and $2\Omega$are connected in parallel so as to send current in the same direction through an external resistance of 5Ω.

Using Kirchhoff's rules, calculate.

potential difference across the 5Ω resistance.

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6. Three cells are connected in parallel with their like poles connected together with wires of negligible resistance. If the emfs of the cells are 2, 1 an 4 V respectively and their internal resistances are 4,3 and 2Ω respectively, find the current through each cell.

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7. Two cells of emf 2V and 4V and internal resistance 1Ω and 2Ω respectively are connected in parallel so as to send the current in the

same direction through an external resistance of 10Ω. Find the potential difference across 10Ω resistor.

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8. Twelve wire, each having resistance r, are joined to form a cube.Find the equivalent resistance between the end of a face diagonal such as a and c.

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9. 12 wires each of resistance r ohm are connected in the form of a skelton cube. Find the equivalent resistance of the cube, when a cell is joined across any one of the 12 wires forming the cube.

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10. Four resistors of 15ohm, 12ohm, 4ohm and 10ohm given in cyclic order to form a wheat stone bridge. What resistance (in ohm) should be

connected in parallel across the 10ohm resistor to balance the wheat stone bridge .

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11. 4 resistance P= 5ohm, Q= 6 ohm,R=50 ohm & S= 60 ohm are connected in Four Arms of a wheatstone bridge. If a cell of EMF 1.5 v and negligible internal resistance is connected across the bridge, calculate he current in the arms of the Wheat stone bridge and the cell.

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12. A wire connected in the left gap of a meter bridge balance a $10\Omega r$ esistance in the right gap to a point, which divides the bridge wire in the ratio 3:2. If the length of the wire is 1m. Calculate the length of one ohm wire.

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13. In a metre bridge, 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. Made of thick copper strips? Determine the balance point of the bridge above if X and Y are interchanged. What happens if the galvanometer and cell are interchanged at the balance point of the bridge ? Would the galvanometer show any current?

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14. With two resistance R_1 and $R_2(>R_1)$ in the two gaps of a metre bridge the balance was found to be 1/3 m from the zero end. When a 6Ω resistance is connected in series with the smaller of the two resistance, the point is shifted to 2/3 m from the same end, then R_1 and R_2 Find the resistance of the two wires.

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15. A potentiometer wire of length 1 m has a resistance 10 ohm. It is connected to 6 V battery in series with a resistance of 5 ohm. Determine the emf of the primary cell which gives a balance point at 40 cm.

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16. The resistance of a potentiometer wire of length 10 m is 25Ω. A resistance box and a 2 volt accumulator are connected in series with it. What resistance should be introduced in the box to have a potential drop of one microvolt per millimetre of the potentiometer wire ?

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17. A 10 meter long wire of uniform cross section of 20Ωresistance is used as a potentiometer wire. This wire is connected in series with a battery of 5V along with an external resistance of 480 Omega if an unknown emf epsilon is balanced at 600 cm of this wire , calculate the potential gradient of the potentiometer wire.

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18. A 10 meter long wire of uniform cross section of 20Ωresistance is used as a potentiometer wire. This wire is connected in series with a battery of 5V along with an external resistance of 480 Omega if an unknown emf epsilon is balanced at 600 cm of this wire , calculate the value of the unknown emf.

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19. With a certain cell, the balance point is obtained at 65 cm from the zero end of a potentiometer wire. With another cell, whose e.m.f. is less than that of the first by 0.1 V, the balance point is obtained at 60 cm. What is the e.m.f. of the first cell ?

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20. A potentiometer has 10 wires each of 1 meter length and the total resistance is 20Ω. Find the resistance to be connected to the driving battery of emf 2 volts to produce a potential drop of $1\mu V$ per millimeter.

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21. Three resistors are connected to form the sides of a triangle ABC , the resistance of the sides AB, BC and CA are 40 ohms , 60 ohms and 100 ohms respectively. Find the effective resistance between the points A and B in ohms .

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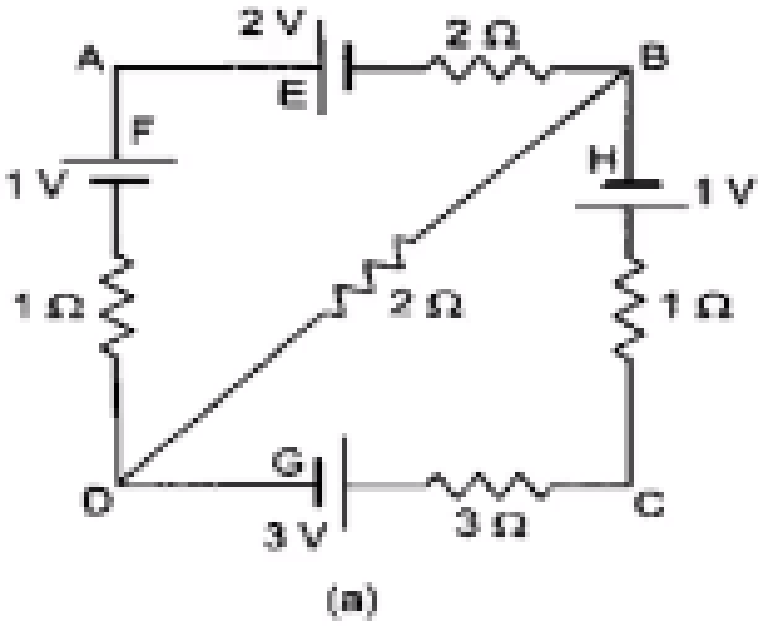
22. In the circuit show in the figure E,F,G and H are cells of e.m.f. 2,1,3 and 1 V and their internal resistances are 2,1,3 and 1Ω respectively. Calculate the

potential difference across the terminals of each of the cells G and H.



(a)

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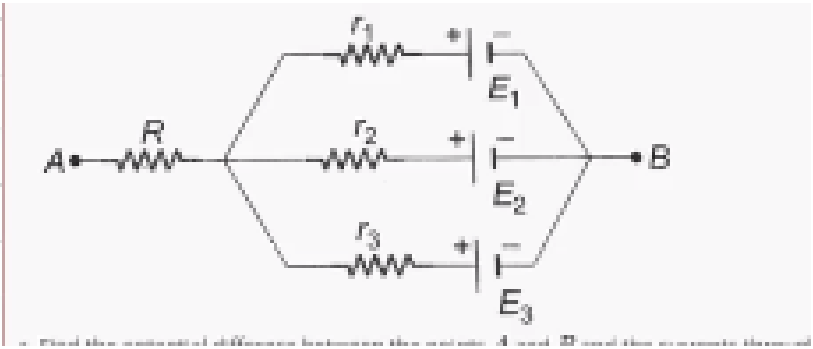
23. In the circit show in the figure $E_1 = 3V$, $E_2 = 2V$, $E_3 = 1V$ and the resistances $R = r_1 = r_2 = r_3 = 1\Omega$. Find the potential difference

between the points A and B and the current through each branch.



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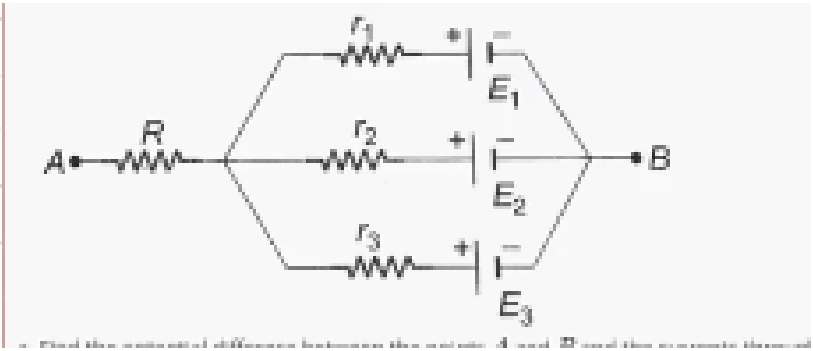
24. In the circit show in the figure $E_1 = 3V$, $E_2 = 2V$, $E_3 = 1V$ and the resistances $R = r_1 = r_2 = r_3 = 1\Omega$. If r_2 is short circuited and the point A is conneted to the point B, find the currents through E_1, E_2 and E_3 and the resistor R



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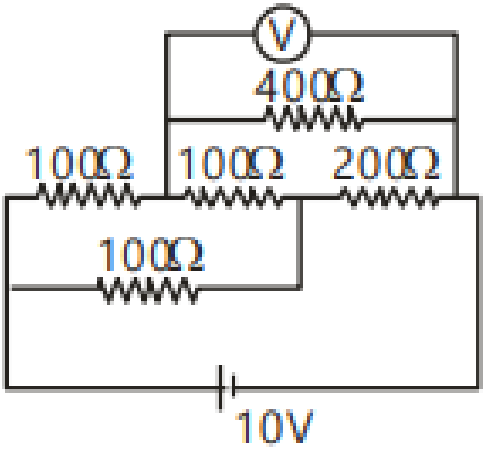
25. An electrical circuit is shown in the Fig. Calculate the potential difference across the resistance of 400 ohm, as will be measured by the voltmeter V of resistance 400 ohm, either by applying Kirchhoff's rules or otherwise.



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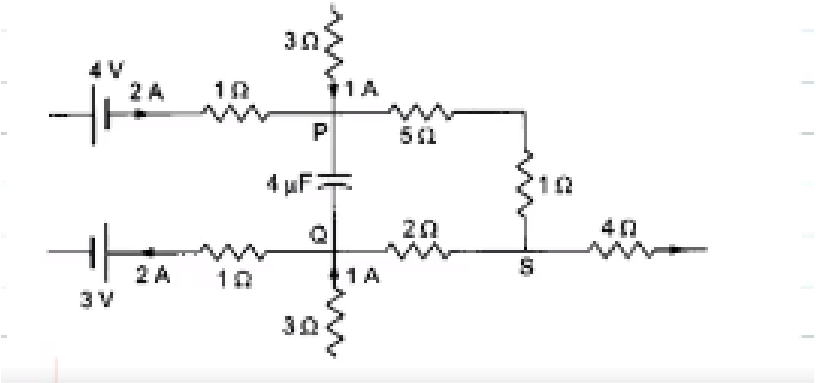
26. A part of a circuit in steady state along with the currents flowing in the branches,the values of resistances,etc, is shown in figure.Calculate the

energy stored in the capacitor.



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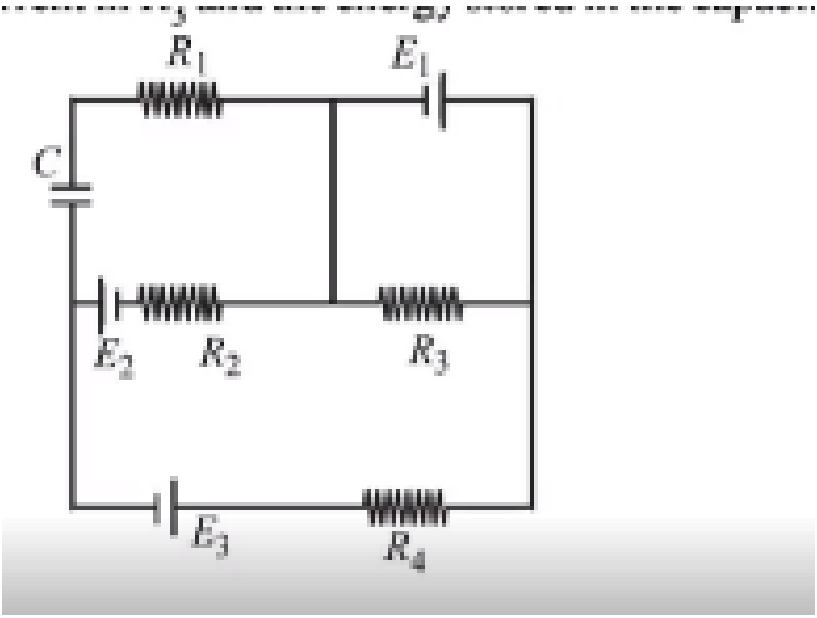
27. In the circuit show in figure

$E_2 = 2V, E_1 = 3E_3 = 6V, C = 5\mu F, R_1 = 2R_2 = 6Oega, R_3 = 2R_4 = 4\Omega$

. Find the current in R_3 and the energy stored in the capacitor.



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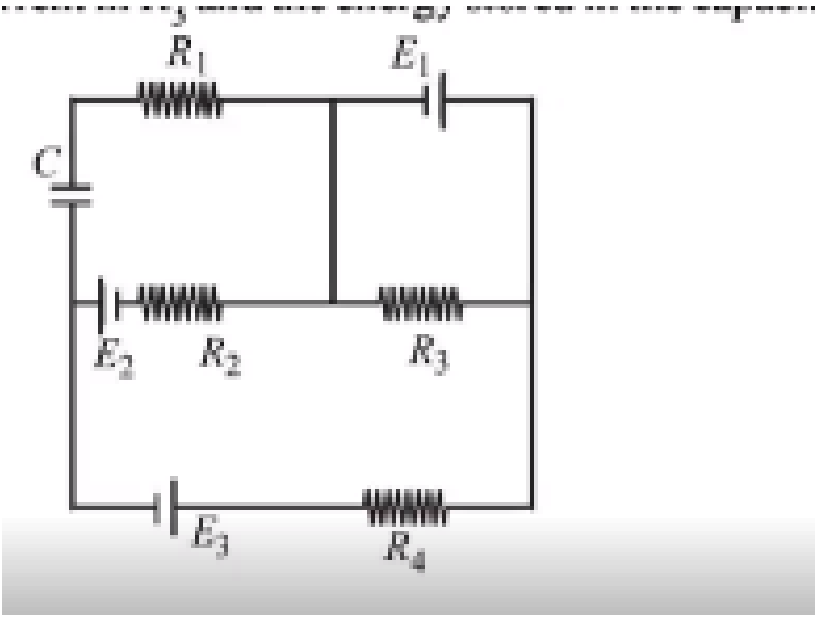
28. In the circuit show in figure

$E_2 = 2V, E_1 = 3E_3 = 6V, C = 5\mu F, R_1 = 2R_2 = 6Oega, R_3 = 2R_4 = 4$

. Find the current in R_3 and the energy stored in the capacitor.



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29. In a wheatstone bridge, the resistance of the arms of the bridge are $AB = 2\Omega, BC = 4\Omega, AD = 1\Omega$ and $DC = 3\Omega$. a cell of emf 2volt the terminals of negligible resistance to A and C is connected. If a galvanometer of resistance $10\Omega$is connected between B and D, find the current in the galvanometer.

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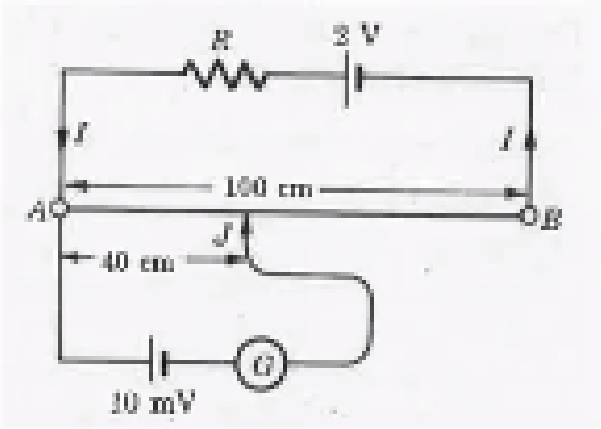
30. A potentiometer wire of length 100 cm has a resistance of 10Ω. It is connected in series with a resistance and an accumulator of emf 2V and negligible internal resistance. A source of emf 10 mV is balanced against a length of 40 cm of the potentiometer wire. what is the value of the external resistance?



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31. State the basic concept on which Kirchhoff's first law is based?

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32. What is the loop rule?

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33. Draw the circuit diagram of Wheatstone bridge. Under what condtion, no current flows through its galvanometer (balanced condition)?

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34. Name two practical applications of Wheatstone bridge?

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35. What is principle of a metre bridge?

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36. Why is a slide wire bridge also called a metre bridge?

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37. Why are the connections between the resistors in a meter bridge made of thick copper strips?

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38. In a meter bridge, two unknown resistances R and S when connected in two gaps, give a null point at 40 cm from one end. What is the ratio of R and S?

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39. The resistance in the left gap of a metre bridge is 10Ω and the balance point is 40 cm form the left end. Calculate the value of the unknown resistance.

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40. Name the device used for measuring the e.m.f. of a cell.

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41. Why is a potentiometer named as potentiometer?

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42. State the principle of a potentiometer.

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43. Why should the potentionmeter wire be of uniform cross-section and composition?

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44. By which material is a potentiometer wire normally made and why?

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45. Of which material is a potentionmeter wire normally made and why?

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46. What type of cell should be used in the main circuit of the potentiometer and why?

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47. Why electric current should not be passed through potentiometer wire for a long time continuously?

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48. Sometmes balance point may not be obtained on the potentiometer wire. Why?

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49. The e.m.f. of the cell used in the main circuit of the potentiomter should be more than the potential diference to be measured. Why?

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50. Name the device used for measuring the internal resistance of a secondfary cell.

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51. Write down the relation between the e.m.f. of a cell and its internal resitance.

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52. Define junction and loop. State Kirchoff's laws.

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53. Explain the significance of Kirchhoff's law.

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54. Using meter bridge, it is advised to obtain the null point in the middle of the wire. why?

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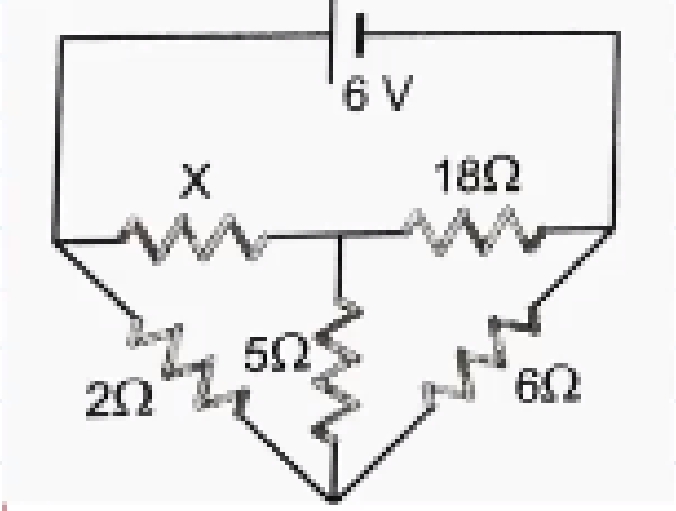
55. Find out the magntude of resistance X in the circuit shown in the figure, when no current flows through the 5Ω resistor.



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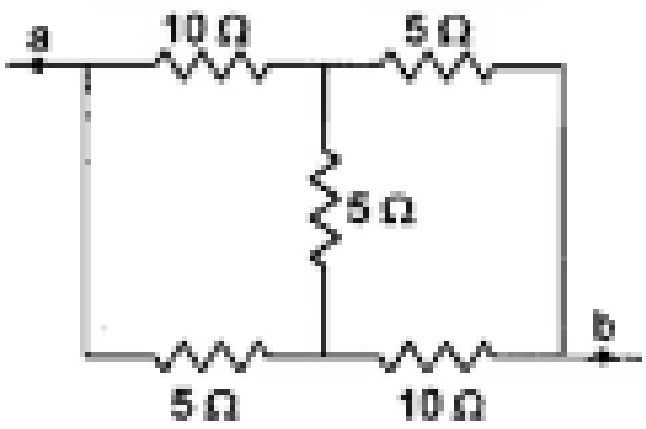
56. What is the resistance between points A and B in the circuit shown in the figure.



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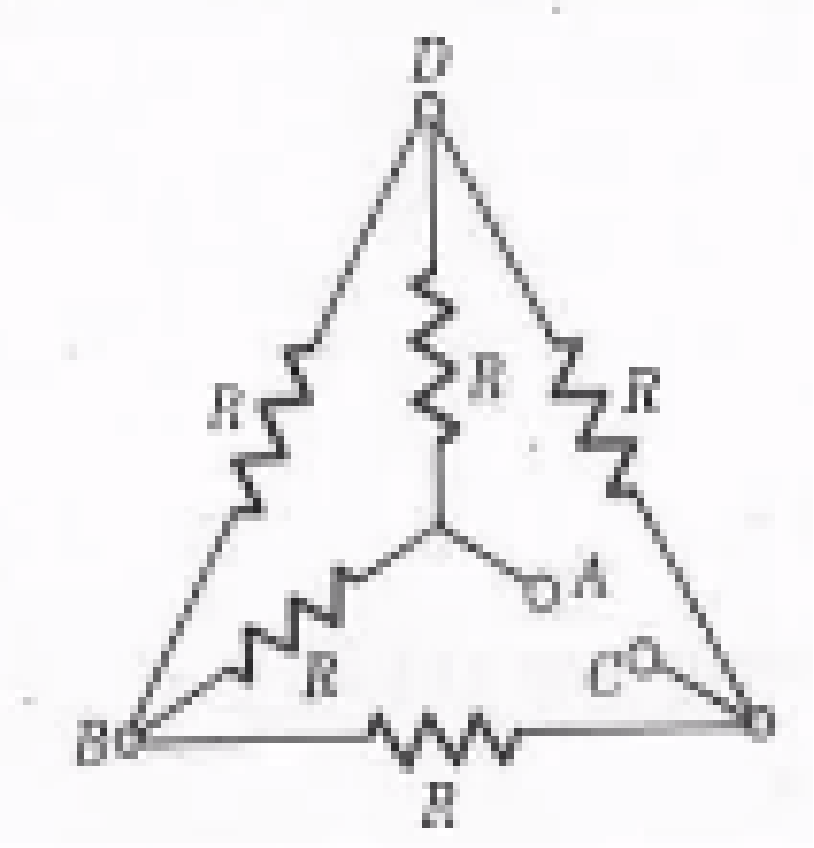
57. If each of the resistances in network shown in the figure is R, what is the resistance between terminals A and C?



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58. Draw a circuit diagram for determining the unknown resistance R using meter bridge. Explain briefly its working, giving the necessary formula used.

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59. Why is a potentiometer preferred over a voltmeter for determining the e.m.f. of a cell?

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60. The variation of potential difference V with length l in the case of two potentiometers, P and Q is as shown in the figure. Which of these two will

you prefer for comparing the emf's of the two primary cells?

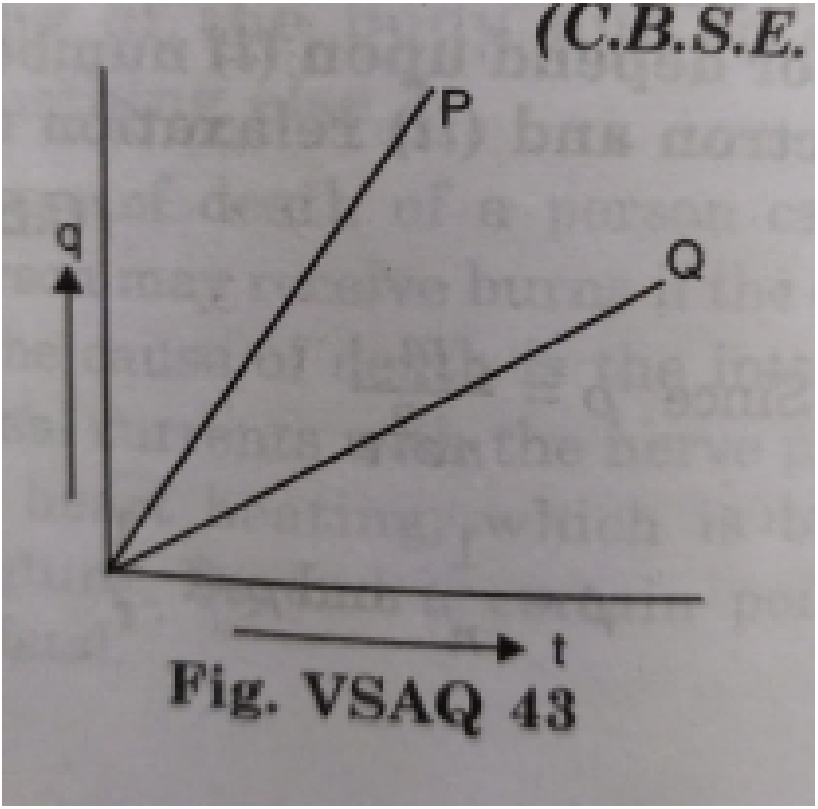

Fig. VSAQ 43

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61. How can you make a potentiometer of given wire length more sensitive using resistance box?

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62. Draw circuit diagram for the comparison of e.m.fs of two cells with the help of a potentiometer.

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63. How will you use potentiometer to determine internal resistances of a cell?

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64. In a potentiometer experiment , the balancing with a cell is at length 240 cm. On shunting the cell with a resistance of 2Ω, the balancing length becomes 120 cm. Find the internal resistasnce of the cell.

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65. In the circuit shown in the figure, AB is a resistance wire of uniform cross-section in which a potential gradient of $0.01V^{-1}$ exists.

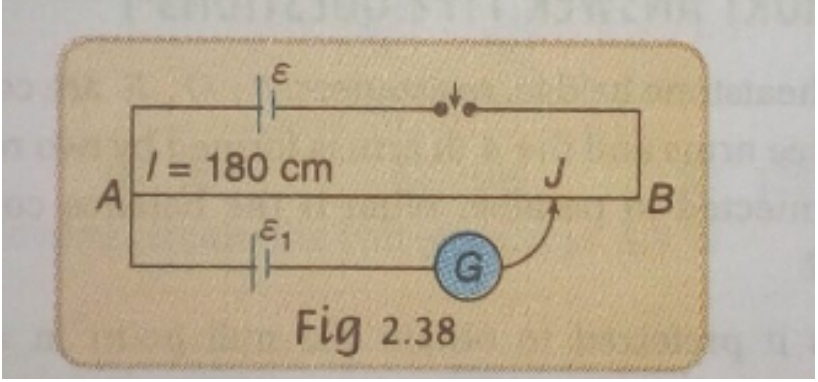

Fig 2.38

If the galvanometer G shows zero deflection what is the e.m.f. E_1 of the cell used?

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66. In the circuit shown in the figure, AB is a resistance wire of uniform cross-section in which a potential gradient of $0.01 V cm^{-1}$ exists.

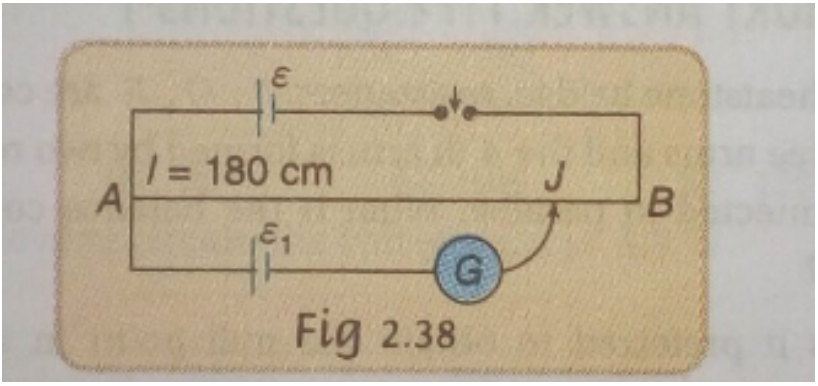

Fig 2.38

If the internal resistance of the deriver cell increases on some account, how will it change the balance point in the experiment?

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67. A cell of e.m.f. 1 V gives a balance point at 40 cm length of a potentioeter wire. For another cell, the balance point shifts to 60 cm. Find the e.m.f. of the second cell.

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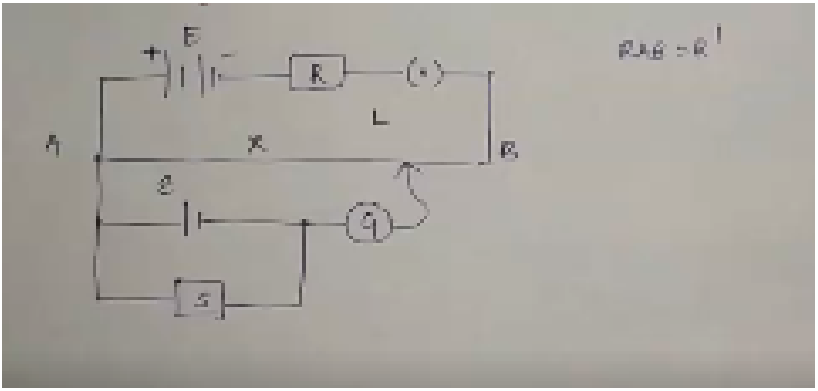
68. Two students X and Y performs an experiment on potentiometer separately using the ciruit diagram shown in the fig keeping other things unchanged

X increases the value of resistance R.

How would these changes affect the position of null point in each case

and why?



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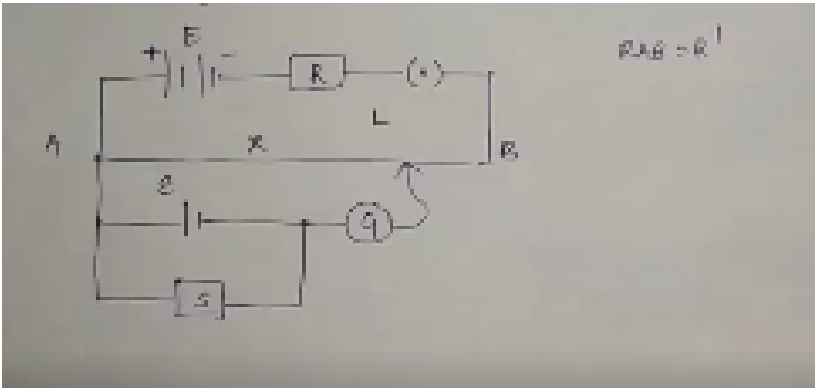
69. Two students X and Y performs an experiment on potentiometer separately using the ciruit diagram shown in the fig keeping other things unchanged

Y decreases the value of resistance S in the set up.

How would these changes affect the position of null point in each case

and why?



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70. Why do we prefer potentiometer of longer length for sensitive measurements?

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71. Explain the principle on which the working of a potentiometer is based. Why is the use of potentiometer preferred over that of a voltmeter for measuring the e.m.f. of a cell.

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72. Why is a potentiometer preferred over a voltmeter for determining the e.m.f. of a cell?

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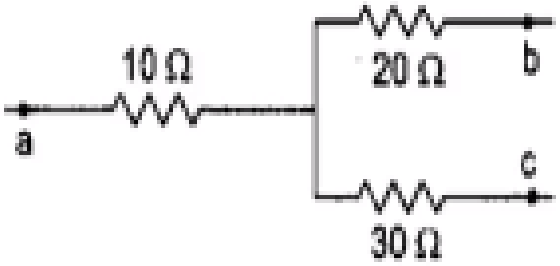
73. Figure shows a part of an electric circuit.The potentials at the points a,b and c are 30V,12V and 2V respectively.Find the currents through the three resistors.



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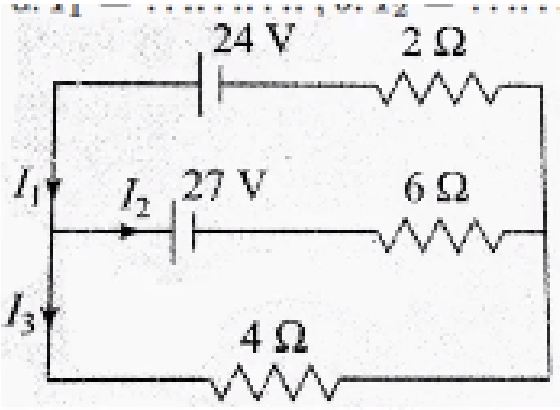
74. Determine the values of currents I_1, I_2 and I_3 in the network shown in the figure.



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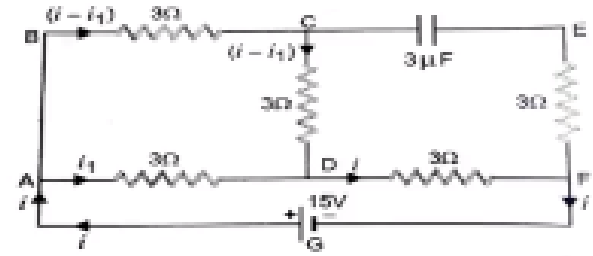
75. In the circuit shown in the figure, calculate the potential difference across the capacitor C.



Find the potential difference across capacitor.

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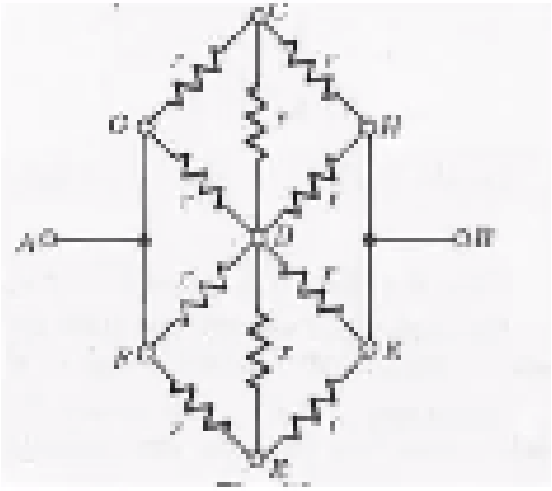
76. Find the equivalent resistance between points A and B of the network of resistors shown in the figure. Each resistor is of resistance r.



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77. Eight equal resistors, each of resistance r are connected along the edge of a pyramid OABCD having square base ABCD . Calculate the equivalent resistance of the network between the points A and D.

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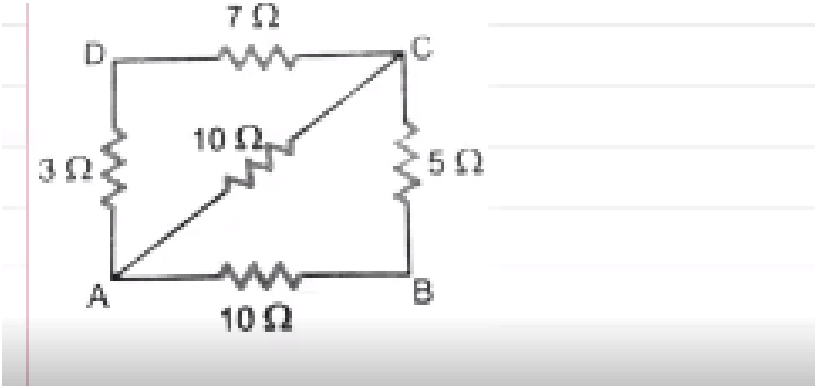
78. Find the equivalent resistance of the network of resistors shown in the figure between the points A and B.



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79. A short circuit occurs in a telephone cable having a resistance of $0.45\Omega m^{-1}$. The circuit is tested with a Wheat stone bridge network have values of $100\Omega \text{ and } 1,110\Omega$ respectively. A balance condition is found when the variable resistor has a value of400Ω. Calculate the distance down the cable, where the short has occured.

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80. Two cells, $E_1 \text{ and } E_2$ of emfs 4 V and 8 V having internal resistances $0.5\Omega \text{ and } 1.0\Omega$ respectively are connected in opposition to each other. This combination is connected in opposition to with resistance of $4.5\Omega \text{ and } 3.0\Omega$. Another resistance of$6\Omega$ is connected in parallel across the 3Ω resistor. Draw the circuit diagram

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81. Two cells of e.m.f.6V and 12V and internal resisatnce lohm and 2ohm respectively are connecetd in parallel so as to send current in the same

direction through an external resistance of 15ohm. Draw the circuit diagram.

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82. Two cells of e.m.f.6V and 12V and internal resisatnce lohm and 2ohm respectively are connecetd in parallel so as to send current in the same direction through an external resistance of 15ohm. calculate current in each branch of the circuit (c) potential difference across the 15 ohm resistor.

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83. Two cells of e.m.f. of 1.6 V and 2.4 V have internal resistance 2 and 4 respectively. The two resistance wires positive poles are connected to resistance of 6 and negative poles connected to 8 ohm. If another wire of 10 is connected between the mid-points of these wires, what is the potential difference across it.

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84. A battery of 10V and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 resistors each of resistance 1Ω. Determine equivalent resistance of the network and the current through the battery.

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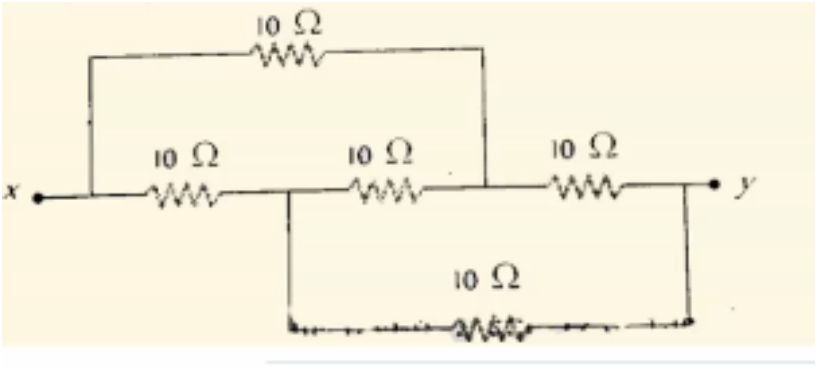
85. Calculate the resistance between points X and Y in the circuit shown in the figure



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86. In a Wheatstone's network, $P = 2\Omega$, $Q = 2\Omega$, $R = 2\Omega$ and $S = 3\Omega$. The resistance with which S is to be shunted in order that the bridge may be balanced .

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87. In a meter bridge when the resistance in the left gap is $2\Omega$and an unknown resistance in the right gap the balance point is obtained at 40 cm from the zero end. On shunting the unknown resistance with 2Ω, find the shift of the balance point on the bridge wire

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88. In a meter-bridge experiment with a resistanceR_1 in left gap and a resistance X in a right gap. null point is obtained at 40 cm from the left emf. With a resistance R_2 in the left gap, the null point is obtainned at 50 cm from left hand. Find the position of the left gap is containing R_1 and R_2 in series.

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89. In a meter-bridge experiment with a resistance R_1 in left gap and a resistance X in a right gap. null point is obtained at 40 cm from the left emf. With a resistance R_2 in the left gap, the null point is obtainned at 50 cm from left hand. Find the position of the left gap is containing R_1 and R_2 in parallel.

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90. In comparing the resistance of two cells P and Q with a sides wire bridge, a balance point is obtained when the sliding contact is 30 cm from the zero end of the wire. The resistances P and Q are interchanged and the balance is obtained at 120 cm from the same emf. Find the ratio of the resistance P and Q and the length of the bridge wire

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91. A cell gives a balance with 85 cm of a potentiometer wire. When the terminals of the cell are shorted through a resistance of 7.5Ω, the balance is obtained at 75 cm. Find the internal resistance of the cell.

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92. It is found that 125 cm length of a potentiometer wire is required to balance the e.m.f. of a Daniel cell but that only 100 cm of the wire is required for the balance, if the poles of the ell are joined to a resistance of 2 ohm. Calculate the internal resistance of the cell.

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93. A cell can be balanced against 110 cm and 100 cm of potentiometer wire respectively, when open icrcuited and when short circuited through a resistance of 10 ohm. Find the internal resistance of the cell.

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94. The potentiometer wire of length 100cm has a resistance of 10Ω. It is connected in series with a resistance of$5\Omega$and an accumulat or emf 3V having negligible resistance. A source 1.2V is balanced against a length 'L' of the potentionmeter wire. find the value of L.

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95. In an experiment to determine the internal resistance of a cell, the null point is obtained at 2 cm, when the cell is shnted by a resistance of 5Ω. When the cell is shunted by a resistance of 20Ω, the null point is obtained at 3 cm. Find the internal resistance of the cell.

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96. In a potentiometer, a standard cell of emf 5V and of negligible resistance maintains a steady current through the galvanometer wire of length 5 m. Two primary cells of emfs ε_1 and ε_2 are joined in series with (i) same polarity and (ii) apposite polarity.The combination is connected

through it galvanometer and a joined to the potentiometer. The balancing length is the two cases are found to be 350 cm and 50 cm respectively

Draw the necessary circuit diagram.

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97. In a potentiometer, a standard cell of emf 5V and of negligible resistance maintains a steady current through the galvanometer wire of length 5 m. Two primary cells of emfs ε_1 and ε_2 are joined in series with (i) same polarity and (ii) apposite polarity.The combination is connected through it galvanometer and a joined to the potentiometer. The balancing length is the two cases are found to be 350 cm and 50 cm respectively

Find the value of emfs of the two cells

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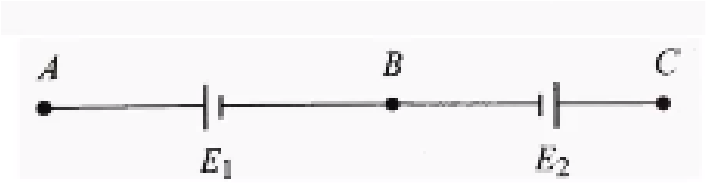
98. Two cells of emfs E_1 and $(E_2(E_1 > E_2)$ are connected as shows in figure

When a potentiometer is connected between A and B, the balancing length of the potentiometer wire is 300 cm. On connecting the same potentiometer between A and C, the balancing length is 100 cm. The ratio E_1 / E_2



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99. A cell of e.m.f. 2 V and negligible internal resistance is connected to a potentiometer wire of resistance 10 Omega and length 4 m. The potential difference per unit length (potential gradient) of the wire is

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100. A standerd cell emf 1.08 V is balance by the potential difference across 91 cm of a meter long wire applied by a cell of emf 2 V through a series resistor of resistance 2Ω. The internal resistance of the cell is zero. Find the resistance per unit length of the potentiometer wire.

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101. A potentiometer wire carries current. The potential difference across 70 cm of its balances the potential difference across a 2 ohm coil supllied by a cell of e.m.f. 2 volt. When a 1 ohm coil is placed in parallel with the 2 ohm coil, a length equal to 50 cm of the potentiometer wire is required to balance the potential difference across the parallel combination. What is the internal resistance of the 2 V cell?

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102. A certain unknown resistance is connected in the left gap and a resistance box in the right gap of a metre bridge. By introducing a

resistance of 10Ω with the help of resistance box, the balance point is determined. If the balance point shift by 20 cm on increasing the resistance from the resistance box by12.5Ω Find the value of unknown resistance.

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103. A standerd cell emf 1.08 V is balance by the potential difference across 91 cm of a meter long wire applied by a cell of emf 2 V through a series resistor of resistance 2Ω. The internal resistance of the cell is zero. Find the resistance per unit length of the potentiometer wire.

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104. There is a potentiometer wire of length 1200 cm and 60 mA current is flowing in it. A battery of emf 5V and internal resistance of 20 ohm is balanced on potentiometer wire with balancing length 1000 cm. find the resistance of the potentiometer wire

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105. There is a potentiometer wire of length 1200 cm and 60 mA current is flowing in it. A battery of emf 5V and internal resistance of 20 ohm is balanced on potentiometer wire with balancing length 1000 cm. if a voltmeter is connected across the cell, the balancing length decreasing by 20 cm find reading of the voltmeter

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106. There is a potentiometer wire of length 1200 cm and 60 mA current is flowing in it. A battery of emf 5V and internal resistance of 20 ohm is balanced on potentiometer wire with balancing length 1000 cm. if a voltmeter is connected across the cell, the balancing length decreasing by 20 cm find reading of the voltmeter

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107. Derive the expression for internal resistance of a cell.

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108. What is the principle of a potentiometer? With the help pf circuit diagram, explain the use of potentiometer to measure internal resistance of a given primary cell.

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109. Using Kirchoff's law, derive the condition for the balance of a Wheatstone bridge circuit.

Watch Video Solution

110. Using Kirchoff's law, derive the condition for the balance of a Wheatstone bridge circuit.

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111. State and explain Kirchhoff's laws.

Watch Video Solution

112. State Wheatstone bridge principle. Use kirchoff'slaws to obtain the relation bteween the resistance in four arms of the Wheatstone bridge by drawing circuit diagram.

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113. What is the principle of a metre bridge ? With a circuit diagram, explain how a metre bridge can be used to determine an unknown resistance of a given wire.

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114. Deduce the conditions for balance in a wheatstone bridge. Using the principle of Wheatstone bridge, describe the method to determine the specific resistane of a wire in the laboratory. Draw the circuit diagram and write the formula used. Write any two important precautions you would observe, while performing the experiment.

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115. What is Wheatstone bridge? Deduce the condition for which Wheatstone bridge is balanced.

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Exercise

1. State and explain Kirchhoff's laws.

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2. State and explain Kirchhoff's laws.

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3. State and explain Kirchhoff's laws.

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4. Derieve condition of a balanced wheatstone's bridge.

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5. Using Kirchoff's law, derive the condition for the balance of a Wheatstone bridge circuit.

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6. Using Kirchoff's law, derive the condition for the balance of a Wheatstone bridge circuit.

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7. State Wheatstone bridge principle. Use kirchoff'slaws to obtain the relation bteween the resistance in four arms of the Wheatstone bridge by drawing circuit diagram.

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8. State Wheatstone bridge principle. Use kirchoff'slaws to obtain the relation bteween the resistance in four arms of the Wheatstone bridge by drawing circuit diagram.

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9. Draw the circuit diagram of Wheatstone bridge. Under what condtion, no current flows through its galvanometer (balanced condition)?

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10. Draw the circuit diagram of Wheatstone bridge. Under what condtion, no current flows through its galvanometer (balanced condition)?

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11. With help of circuit diagram, explain how a meter bridge can be used to find unknown resistance of a given wire.

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12. Explain the principle of Wheatstone bridge for determining and unknown resistance. How is it realised in actual practice in the

laboratory?

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13. What is a slide wire bridge? How can you find unknown resistance by it?

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14. With help of circuit diagram, explain how a meter bridge can be used to find unknown resistance of a given wire.

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15. Draw a circuit diagram for determining the unknown resistance R using meter bridge. Explain briefly its working, giving the necessary formula used.

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16. Draw a circuit diagram of a meter bridge and write the necessary mathematical relation used to determine the value of unknown resistance. Why cannot such arrangement be used for measuring very low resistances?

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17. Draw a cricuit diagram of a metre bridge arranged to find the value of an unknown resistance. Write the formula used.

Watch Video Solution

18. Draw a cricuit diagram of a metre bridge arranged to find the value of an unknown resistance. Write the formula used.

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19. Draw a neatly labelled diagram of a potentionmeter and explain its principle.

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20. Explain the principle on which the working of a potentiometer is based. Why is the use of potentiometer preferred over that of a voltmeter for measuring the e.m.f. of a cell.

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21. What is potentiometer? With the help of circuit diagram, explain how a potentiometer can be used to compare the emf of two primary cells.

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22. Define e.m.f of a cell. How can you compare the e.m.f of the cells using potentiometer.

Watch Video Solution

23. State the principle of a potentiometer.

Watch Video Solution

24. What is potentiometer? With the help of circuit diagram, explain how a potentiometer can be used to compare the emf of two primary cells.

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25. Explain the principle of a potentiometer. How will you compare the e.m.f. of two primary cells by using potentiometer? Explain with proper circuit diagram.

Watch Video Solution

26. Define e.m.f of a cell. How can you compare the e.m.f of the cells using potentiometer.

Watch Video Solution

27. Define internal resistances of a cell. explain how the internal resistance of a aprimary celle can be determined using a Potentiometer.

Watch Video Solution

28. What is the principle of a potentiometer? With the help pf circuit diagram, explain the use of potentiometer to measure internal resistance of a given primary cell.

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29. What is the principle of a potentiometer? With the help pf circuit diagram, explain the use of potentiometer to measure internal resistance of a given primary cell.

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30. How will you use potentiometer to determine internal resistances of a cell?

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41. Explain the principle of a potentiometer. How will you compare the e.m.f. of two primary cells by using potentiometer? Explain with proper circuit diagram.

Watch Video Solution

42. Draw circuit diagram for the comparison of e.m.fs of two cells with the help of a potentiometer.

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43. How will you use potentiometer to determine internal resistances of a cell?

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44. Explain the principle of a potentiometer. How will you compare the e.m.f. of two primary cells by using potentiometer? Explain with proper circuit diagram.

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