PHYSICS

NCERT - FULL MARKS PHYSICS(TAMIL)

CURRENT ELECTRICITY

Example

1. (a) Esttimate the average drift speed of conduction electrons in a copper wite of cross-secttonal area $1.0 \times 10^{-7} m^2$ carrying a current of $1.5 A$. Assume the each copper atom contrbutes

roughly one conduction electron. The density of copper is $9.0 \times 10^3 kg/m^3$, and its atomic mass is $63.5u$. (b) Compare the drift speed obyained above with, (1) thermal speeds of copper atoms at ordinary temperaturtes. (ii) speed of propagation of electric field along the conductor which causes the drift motion.

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2. (a) The electron drift speed is estimated to be only a few mm s^{-1} for currents in the range of a few amperes? How then is current established

almost the instant a circuit is closed?

(b) The electron drift arises due to the force experienced by electrons in the electric field inside the conductor. But force should cause acceleration. Why then do the electrons acquire a steady average drift speed?

(c) If the electron drift speed is so small, and the electron's charge is small, how can we still obtain large amounts of current in a conductor?

(d) When electrons drift in a metal from lower to higher potential, does it mean that all the 'free' electrons of the metal are moving in the same direction?

(e) Are the paths of electrons straight lines

between successive collisions (with the positive ions of the metal) in the (i) absence of electric field, (ii) presence of electric field?

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3. An electric toaster uses nichrome for its heating element. When a negligibly small current passes through it. It resistance at room temperature $(27.0^{\circ}C)$ is found to be 75.3Ω. When the toaster is connected to a $230V$ supply, the current settles, after a few seconds, to a steady value of $2.68A$. What is steady temperature of the nichrome

element? The temperature coefficient of resistance of nichrome averaged over the temperature range involved , $1.70 \times 10^{-4} C^{-1}$

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4. The resistance of the platinum wire of a platinum resistance thermometer at the ice point is 5Ω and at steam point is 5.39Ω. When the thermometer is inserted in a hot bath, the resistance of the platinum wire is 5.795Ω. Calculate the temperature of the bath.

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5. A network of resistore is connected to a 16 V battery with internal resistance of $1\Omega,$ as shown in (a) Compute the equivalent resistance of the network. (b) Obtain the current in network. (c) obtain the voltage drops V_{AB}, V_{BC} and V_{CD}

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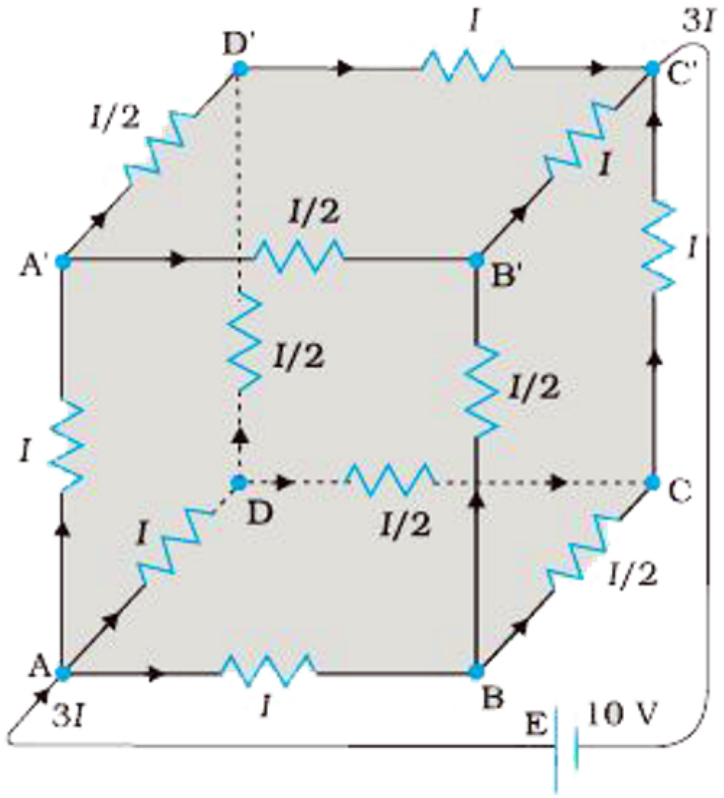
6. A bettery of 10 V and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting

of 12 resistors each of resistance 1Ω Determine the equivalent resistance of the network and the current along each edge of the cube.



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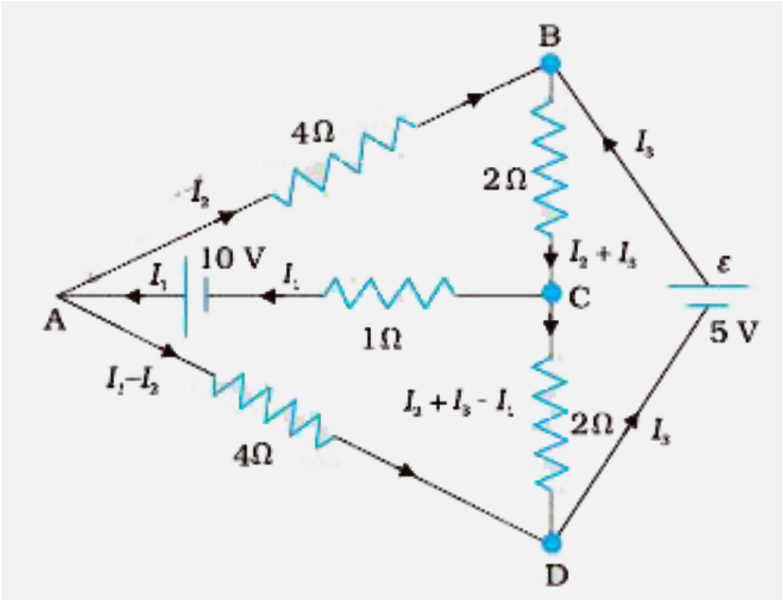
7. Determine the current in each brance of the network showin in



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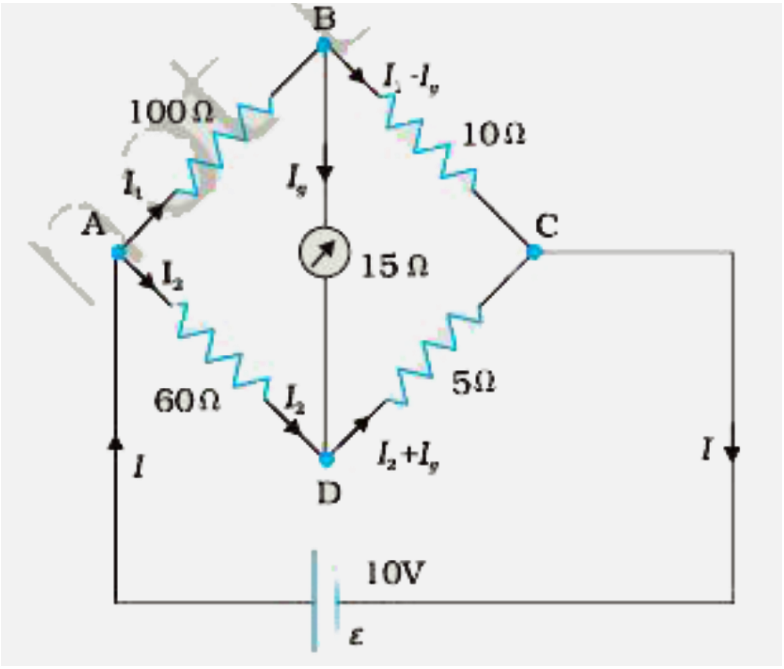
8. The four arms as a Wheatstone bridge have the following resistances:

$AB = 100\Omega, BC = 10\Omega, CD = 5\Omega$ and $DA = 60\Omega$



A galvanometer of 15Ω resistacne is connected across BD. Calculate the current through the galvanometer when a potential difference of 10 V is maintained across AC.

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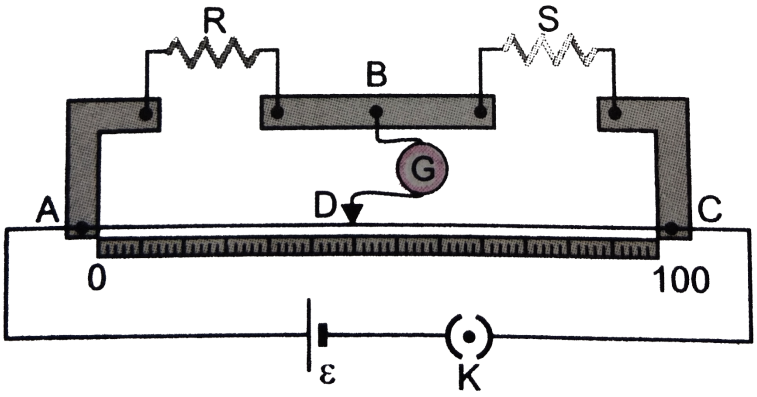
9. In a meter bridge,



the null points is found at a distance of 33.7 cm from A. If now a resistance of 12Ω is connected in parallel with S, the null point occurs at 51.9 cm. Determine the values of R and S.

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10. A resistance of R draws current from a potentiometer. The potentiometer has a total resistance R_0. A voltage V is supplied to the potentiometer. Derive an expression for the voltage across R when the sliding contact is in the middle of the potenttometer.

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Exercises

1. The storage battery of a car has an emf of 12 V. If the inernal resistance of the battery of 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 resistane 3Ω is connected to a resistor. If the current in the circuit is 0.5 A, what is the resistane of the resistors ? What is the terminal voltage of the battery when the circuit is closed ?

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

(b) If 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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4. (a) Three resistors $2\Omega, 4\Omega$ and 5Ω are combined in parallel. What is the total resistance

of the combination ?

(b) If 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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5. 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 $1.70 \times 10^{-4}.^{\circ} C^{-1}$.

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6. A negligbly small current is passed through a wire of length 15 cm 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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7. 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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8. 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 $27^{\circ}C$? Temperature coefficient of resistance of

nichrome averaged over the temperature range involved is $1.70 \times 10^{-4} C^{-1}$.

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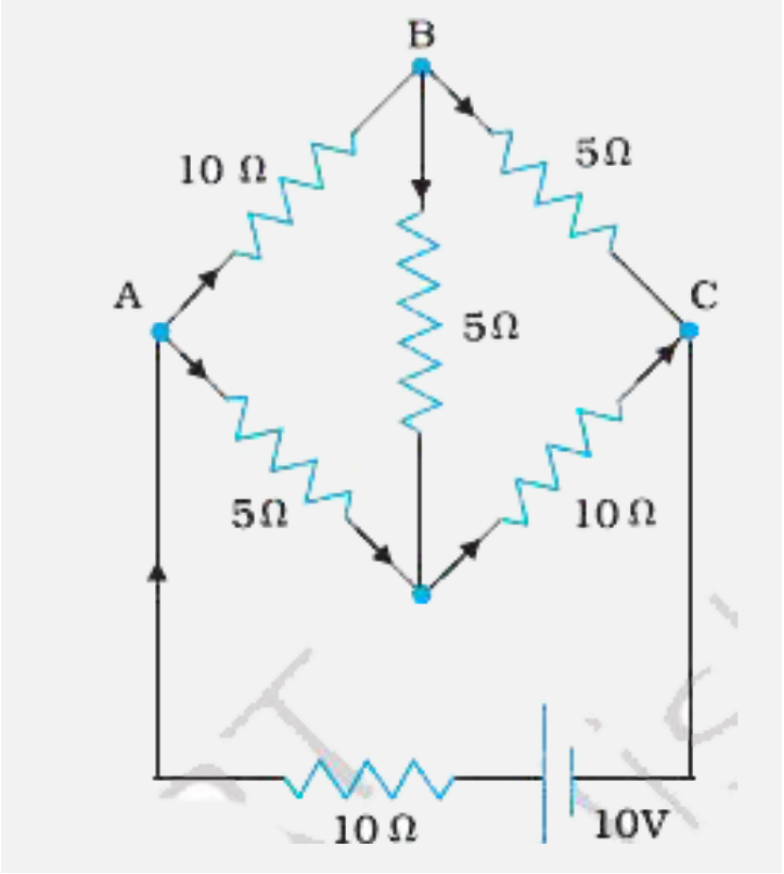
9. Determine the current in each branch of the network shown in



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10. (a) In a meter bridge the balance point is found to be at $39.5cm$ from the end A. when the resistor

S is of 12.5Ω. Determine the resistance of R. Way are the connections between resistors in a Wheatstone or meter bridge made of thick copper strips ?

(b) Determine the balance point of the bridge above if R and S are interchanged.

(c) 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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11. A storage battery of emf 8.0 V and internal resistance 0.5Ω is being charged by a 120V dc supply using a series resistor of 15.5Ω. what in 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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12. In a potentiometer arrangment, 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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13. The number density of free electrons in a copper conductor is estimated at $8.5 \times 10^{28} m^{-3}$. 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 3.0A.

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Additional Exercises

1. 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 low conductivity of the lower atmosphere) in a current of only 1800 A over the entire globe. If there were no mechanism of sustaining atmosphereic 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

thunder storms and lightning in different parts of the globe). Radius of the earth $= 6.37 \times 10^6 m$.

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

(b) A secondary cells 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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3. 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 perferred for overhead power cables. Given For $AI.\ p_1 = 2.63 \times 10^{-8}\Omega m,$ For $Cu, p_2 = 1.72 \times 10^{-8}\Omega m.$ Relative density of $AI = 2.7$ of $Cu = 8.9.$

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4. What conclusion can you draw from the follwing observation on a resistor made of alloy manganin ? `

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5. Answer the following questions : (a) A steady current flows in a metallic conductor of non-uniform cross-section. Explain which of these quantities is constant along the conductor :

current, current density, electric field and drift speed ?

(b) Is Ohm's law universally applicable for all conducting elements ? If not, give examples of elements which do not obey Ohm's law.

(c) A low voltage supply from which one needs high currents must have low internal resistance, why ?

(d) A high tension (HT) supply of say $6kV$ must have a very large internal resistance. why ?

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6. Choose the correct alternatives :

(a) Alloys of metals usually have (greater/less) resistivity than that of their constituent metals.

(b) Alloys usually have much (lower/higher) temperature coefficients of resistance than pure metals.

(c) The resistivity of the alloy manganin in (nearly independent of/ increase rapidly) with increase of temperature.

(d) The resistivity of a typical insulator (e.g. amber) is greater than that of a metal by a factor of the order of $\left(10^{22} \text{ or } 10^{3}\right)$.

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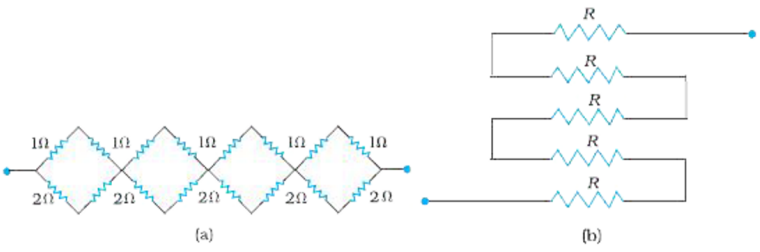
7. (a) Given n resistores each of resistance R. how will you combine them to get the (i) maximum (ii) minimum effective resistance?

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

(c) Determine the equivalent resistance of networks shown in



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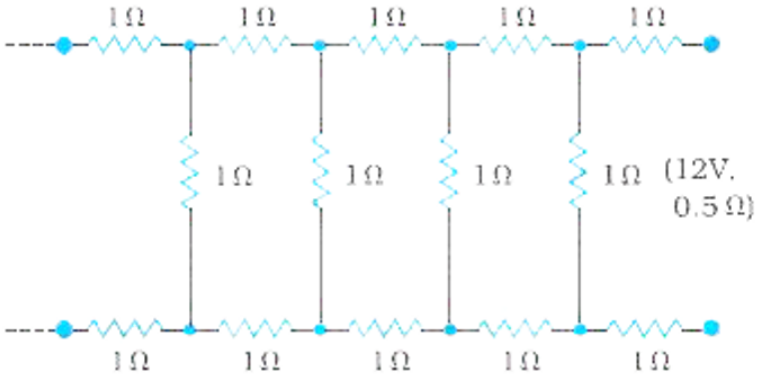
8. Determine the furrent drawn from a 12 V suly with internal resistacne 0.5Ω by the infinite network shown in Each rsistor has 1Ω resistance.



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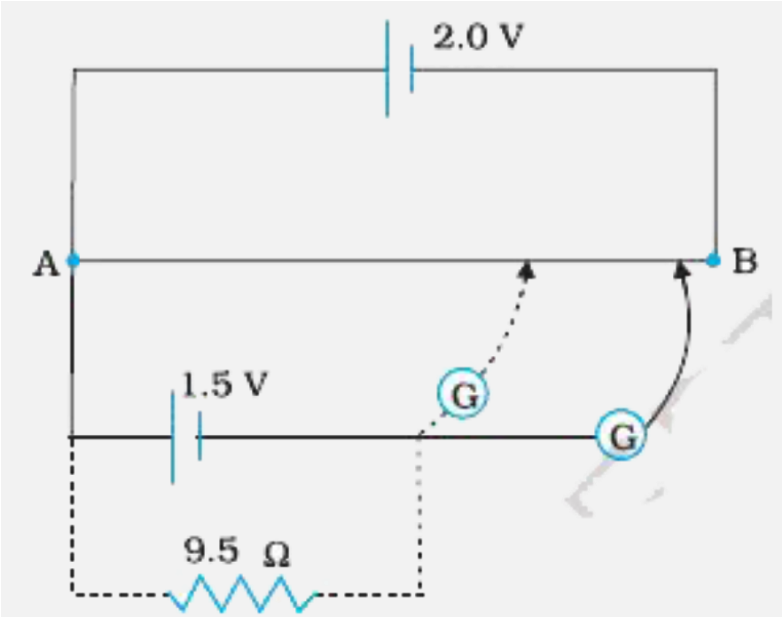
9. show a $2.0V$ potentiometer used for the determination of internal resistance of a $1.5V$ cell. The balance point of the cell in open circuit is 76.3 cm. When a resistor of 9.5Ω is used in the external circuit of the cell, the balance point shifts to $64.8cm$ length of the potentiometer wire. Determine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



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