PHYSICS

BOOKS - NN GHOSH PHYSICS (HINGLISH)

FUNDAMENTAL OF CURRENT ELECTRICITY

Examples

1. A cell of emf 2V produces 0.3A current when connected to a resistor of 5Ω. Calculate the terminal voltage and internal resistance of the cell.

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2. Two batteries of emfs 12V and 6V and intenal resistance 0.2Ω and 0.1Ω, respectively are connected in opposition through a

resistor 3.7Ω. Calculate the terminal voltage of the first battery following either path.

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3. Two cells of emfs 1.5 V and 2.0V internall resistance 2Ω and 1Ω respectively have their negative terminals joined by a wire of 6Ω and positive terminals by another wire of 4Ω. A third wire of 8Ω connects the mid points of these two wires. Find the current through 8Ω

and the potential difference at the ends of the third wire.

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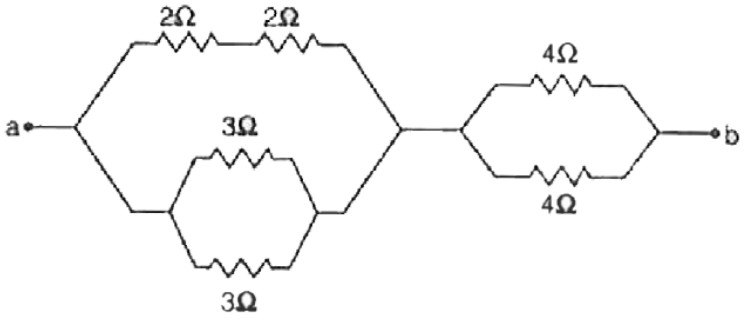
4. Calculate the equivalent resistance between the points a and b of the following network of conductors.



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5. A regular hexagon is formed by six wires each of resistance $r\Omega$ and the corners are joined to the center by wires of the same resistance. If the current enters at one corner and leaves at the opposite corner, find the equivalent resistance of the conductor.

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6. A nicrome wire of length 100cm and radius 0.36 mm has a resistance of 1.5Ω. Calculate

the resistivity of nicrome and also its conductivity.

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7. The resistance of a wire at 0° C and 100° C is 5.2Ω and 7.85Ω, respectively. Calcualte the mean temperature coefficient of resistance of the material of the wire.

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8. Calculate the drif velocity of electrons in an aluminium wire of radius 2mm when a current of 5A passes through it. (Atomic weight of aluminium = 27, Avogardo number = 6×10^{26} kg mol^(-1) and $densityofalu \min ium = 2710kg$ m^(-3)`

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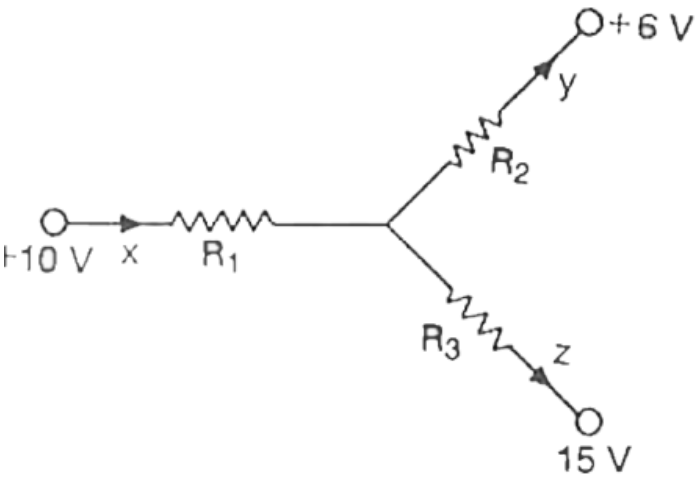
9. Find the currents in the Y connection of 3 resistances $R_1 = 10\Omega$, $R_2 = 20\Omega$ and $R_3 = 30\Omega$. When the terminals of R_1 , R_3 and R_3 are maintained at potentials V_1 = 10V, V_2 =6V and V_3 = 15V.



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Exercises

1. A wire carries a constant current of 10A. How many coulombs and how many charge carriers pass a cross-rection of the wire in 20 seconds? (charge of electron = 1.6×10^{-19}C

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2. Two batteries of emf ε_1 and ε_2 produce a current of 1.5 A when they are in opposition

and 2.5A when they are in series. Find the ratio of the two emf's.

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3. In a battery of 10 cell supposed to be in series some are wrongly connected. The cells are sealed in a box. When a similar cell is connected in opposition to the battery, the current produced by the combination through an external resistor of 14.5Ω is 0.075 A. How many cells are wrongly connected? What is the

emf of the battery and what is its internal resistance if emf of each cell is 1.5V and internal resistance 0.5Ω?

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4. How you would arrange 24 cells, each of emf 1.5V and internal resistance 0.5Ω, to deliver maximum current to a resistor of 4Ω? What is the maximum current?

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5. A letter A is constructed as a uniform wire of resistance 1 ohm/cm. The sides of the letter are 20 cm long and the cross piece in the middle is 10 cm long while the vertex angle is 60° the resistance of the letter between the two ends of the legs is

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6. Calculate the the resistivity of the material of a wire whose resistance is 5Ω, length 1m and radius 0.6mm.

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7. The resistance of 100m of copper wire of diameter 0.056×10^{-2} m is 6.62Ω. Calculate (i) resistivity, (ii) Electrical conductivity of copper.

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8. Calcualte the resistance of a steel wire of length 10m and diameter 0.6mm at $0^{\circ}C$ and

$100^{\circ}C$. (Electrical resistivity of steel $0^{\circ}C$ is $15 \times 10^{-8}\Omega$m and mean temperature coefficient of resistance of steel is $50 \times 10i^{-4}K^{-1}$

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9. Three wires whose lengths are in the ratio $3:8:18$ and radii in the ratio $1:2:3$ are connected in parallel. Find the ratio of the currents through them.

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10. A moving coil galvanometer of resistance 50Ω is connected in series with a fixed resistance 50Ω and the combination to a cell of steady emf and negligible internal resistance. What is the shunt required to halve the current through the galvanometer?

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11. A resistance box, a battery and a galvanometer of resistance G ohm are

connected in series. the galvanometer is shunted by resistance of S ohm, find the change in resistance in the resistance box be required to maintain the current from the battery unchanged.

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12. A shunt is to be applied to a galvanometer of 99Ω so that only 10% of the total current passes through it. Find the shunt required. What additional shunt will be required to send

1% of the total current through the galvanometer?

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13. Two identical cells of emf 1.5V and internal resistance 1Ω are joined in series and the combination is connected in parallel with a third cell of the same emf and internal resistance. Calculalte the terminal voltage of the cells.

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14. A battery of emf 6V internal resistance 5Ω is joined in parallel with another cell of emf of 10V and internal resistance 1Ω and the combination is used to send current through a resistor of 12Ω. Calculate the current through each battery.

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15. A battery of emf 6 volts and internal resistance 1Ω is connected in parallel to

another battery of emf 8V and internal resistance 2Ω. The combination is then used to send current through an external resistance of 10Ω. Find the current through the external resistance.

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16. Two batteries of emfs 24V and 6V and internal resistance 2Ω and 1Ω respectively are joined in parallel, negative to negarive by a resistor of 2Ω and positive to positive by

another resistor of 4Ω. Calculate the terminal voltages of the two batteries.

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17. The sides of a square ABCD are formed of wires, each of resistance r and B is joined to D by a wire of resistance 2r. Find the equivalent resistance of the skelton

(i) between B and D, (ii) between A and C and (iii) between A and B.

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18. In a wheatstone bridge, the resistance of the arms of the bridge are AB = 2Ω, BC = 4Ω ,AD = 1Ω and DC = 3Ω. The terminals of negligible resistance to A and C. If a galvanometer of resistance 100Ω is connected between B and D, find the current in the galvanometer.

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19. ABCD is a square of side a meters and is mae up of wires of resistance $x\Omega/m$. Similar wires are connected across the diagonals AC and BD. Show that the effective resistance of the frame-work between the corners A and C is $\left(2-2\sqrt{2}\right.$ ax Ω.

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20. A battery of 2V and internal resistance 2Ω is used in wheatstone bridge. Find the current

through the galvanometer in the unbalanced position of the bridge when $P = 1\Omega, Q = 2\Omega$, $R = 2\Omega$,$S = 3\Omega$ and $G = 4\Omega$.

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21. When one mole of zinc combines with sulphuric acid 445 kJ of heat is liberated and when a mole of copper is liberated from blue vitriol 235 kj of heat is absorbed. Avogadro number = 6.023×10^{23}, electronic charge = 1.6×10^{-19} C and zinc or copper is divalent.

Use these data to find the emf of a Daniell cell. [Hint: Energy liberated in the form of heat is converted into elecrical energy in a Daniel cell]`

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22. Two resistors with temperature coefficients of resistance α_1 and α_2 have resistances R_{01} and R_{02} at $0^\circ C$. Find the temperature coefficient of the compound resistor consisting of the two resistors connected.

a.. In series and

b. in paralllel

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23. Show that if E is the electric intensity inside a conductor of electrical conductivity σ, Ohm's law may be coveniently put in the form, $\vec{J} = \sigma \vec{E}$ where J = current density in the conductor.

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24. Show that drift velocity of electrons in a conductor is given by u = $\frac{J}{\neq}$ where J is the current density, n is the number of mobile electrons per unit volume and e is the charge carried by each electron. Calculate the same in a copper wire of radius of 0.6mm when a current of 1A flows through it assuming that one mobile electron is available from one atom of copper. Atomic weight of copper = 63.55, density of copper = 8930 kgm^(-3) , $Avogadrovmber = 6.01$ xx 10^(26)Kg mol^(-1) $\text{and } e = 1.6$ xx 10^(-19)`C

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25. A spherical silver electrode of radius 8cm is concentric with a spherical metal shell of radius 10cm. The inter space contains an insulating material of resistivity $10^6 \Omega$m. Compute the resistance of the insulator.

[Hint: Resistance of a shell of radius z = $\rho \frac{dz}{4\pi z^2}$

. Integrate from z = 8 to z=100

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26. Two batteries of emf 12V and 6V and internal resistance 2Ω and 1Ω are connected in parallel and the combination is connected to a resisor of 2Ω through a key. Find the potential difference between the positive and negative terminals of the batteries (a) When key is open, b) when key is closed. Find the emf and internal resistance of a single cell which would be equivalent to the combination.

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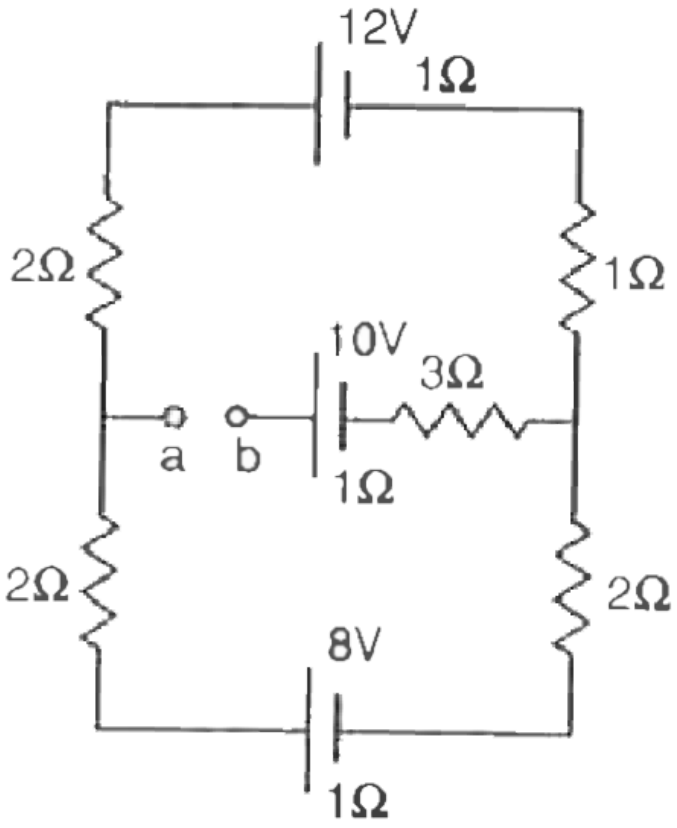
27. Find the potential difference the points a and b of the circuit(figure). If a and b are joined by a wire what is the current through the 12-V cell?



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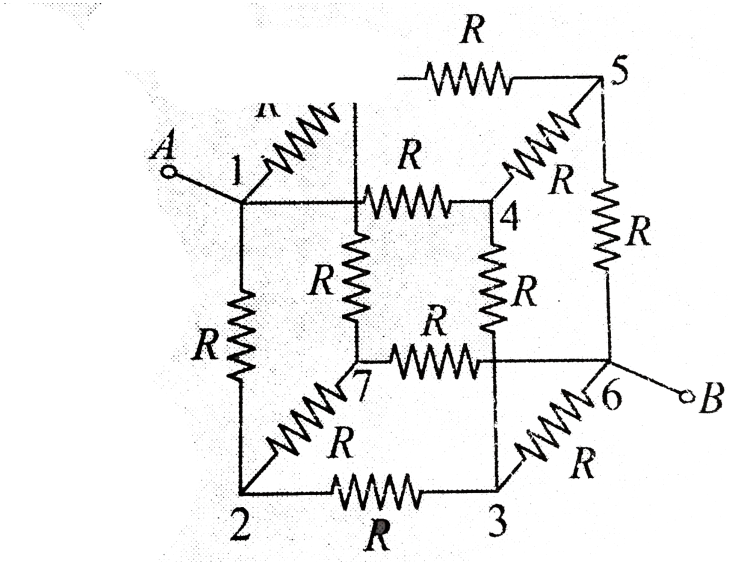
28. Twelve identical resistor are arranged on all edges of a cube. Then find the equivalent resistance between the corners 1 and 6 as shown in fig 5.126(use nodal method) .



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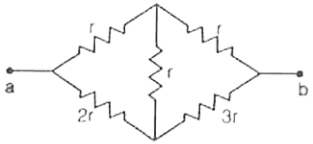
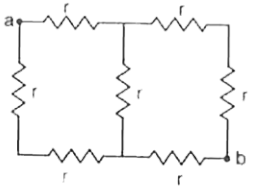
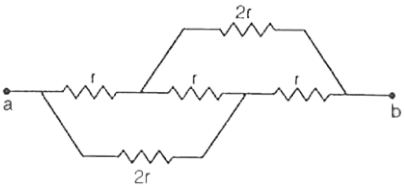
29. Find the equivalent resistance between the terminal points a and b of the circuits 1, 2,3 and 4.



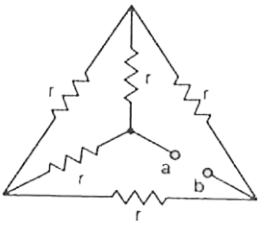
circuit 1



circuit 2



circuit 3



circuit 4

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30. A newtwork of conductors is in the form of a triangle ABC in which AB = 1Ω, BC=2Ω and CA = 3Ω and the angular points A, B and C are joined to any point O inside the triangle by resistance 1Ω, 2Ω and 3Ω, respectively. Find the equivalent resistance between A and B.

[Hing: Assume current at the entrance and exit points].

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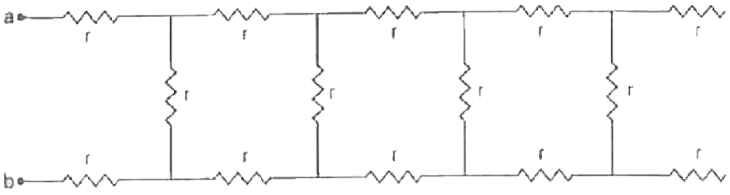
31. Find the resistance of the infinite series of the circuit in figure between the points a and b.

[Hint: From an infinite series if we separate out the first unit, the remaining circuit will still be an infinite series and hence will have the same equivalent resistance]



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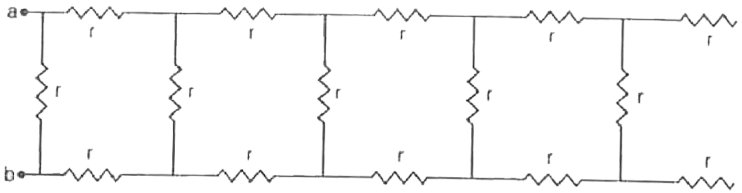
32. Calculate the equivalent resistance of the circuit shown in figure between the points a and b.



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33. A current of 8A is to be sent through a resistor of 5Ω Calcualte the least number of cells required for the purpose when each cell has emf 2V and internal resistance 0.5Ω.

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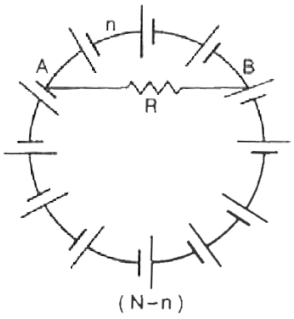
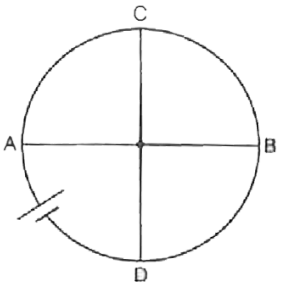
34. N cells, each of emf ε and internal resistance r, are arranged in a ring in series. Two points including n cells on one side and N-n cells on the other side are connected to a resistor R. Calcualte the current through R (figure)





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35. Calcualte the equivalent resistance between the terminals of the cell (figure) The resistance of each equivalent is 1Ω and the intersecting diameters have resistance 2Ω each.

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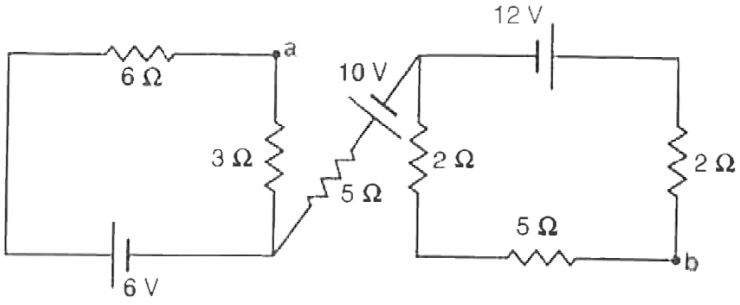
36. Find the potential difference between the point a,b of the given circuit figure. [Hint:

$V_{ab} = \sum ir - \sum \varepsilon]$



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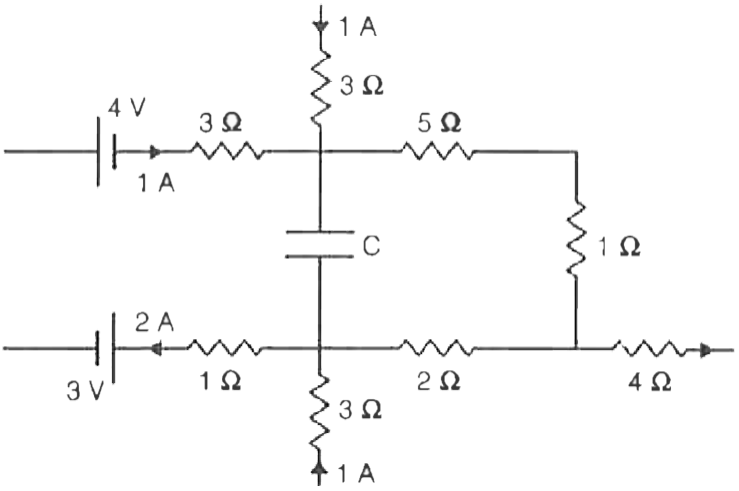
37. A part of a circuit in the steady state with the currents flowing in the branches and the values of resistance are shown in figure. Calculate the energy stored in the capacitor

$C = 4\mu F.$



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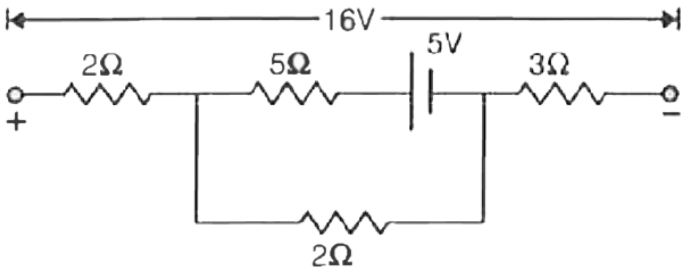
38. Calculate the current through the 5-V cell of the figure.



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39. In the circuit in figure there are n repetitions of the same loop. What resistance should be connected across the end points so that the equivalent resistance between a and b may be independent of n? What is this equal to?

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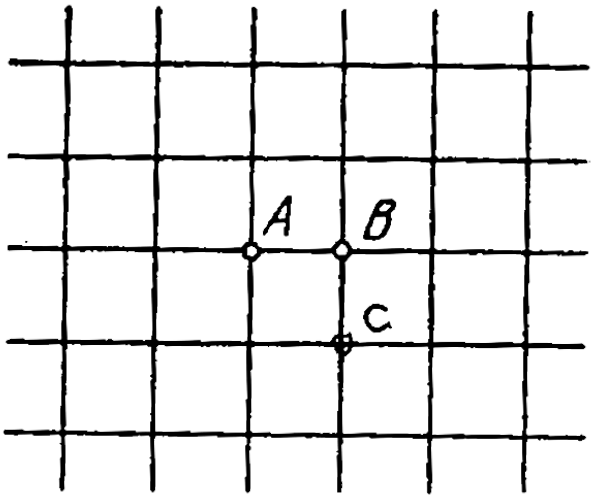
40. There is an infinite wire grid with square cells (Fig). The resistance of each wire between neighbouring joint connections is equal to R_0 . Find the resistance R of the whole grid between points A and B.

Instruction. Make use of principles of

symmetry and superposition.



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41. Two metals balls of the same radius a are placed in a homogenous poorly conducting media with resistivity ρ. Find the resistance if

they are separated by a large distance.

[Hint: Use $j = \sigma E$ to evaluate total current through mid-plane and then use V=IR]

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42. Show that if one collision takes place in every τ seconds then the resistivity is given by $\rho = \frac{m}{\neq^2 \rho}$, where all the terms have their usual meaning.

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43. A straight copper-wire of length $100m$ and cross-sectional area $1.0mm^2$ carries a current $4.5A$. Assuming that one free electron corresponds to each copper atom, find

(a) The time it takes an electron to displace from one end of the wire to the other.

(b) The sum of electrostatic forces acting on all free electrons in the given wire. Given resistivity of copper is $1.72 \times 10^{-8}\Omega - m$ and density of copper is $8.96g/cm^3$.

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44. A constant voltage is applied to n groups of resistors in siries where each group has m identical resistros in parallel. One resistor burns out in one group. Find the percentage increase of current in each resistor of the faulty group, and the percentage decrease of current in each resistor of the second group.

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45. If α_1 is the temperature coefficient of resistance at $t_1^\circ C$ find α_2 at $t_2^\circ C$

[hint: α=1/R(dR)/dt) and R=R_(0) (1+at+btp^(2))]`

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