PHYSICS

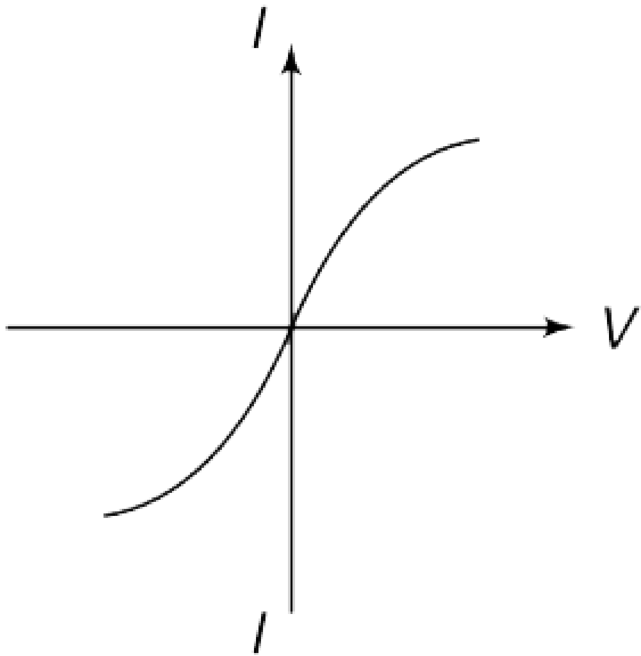
BOOKS - ARIHANT PHYSICS (HINGLISH)

CURRENT ELECTRICITY

Current Electricity

1. The current-voltage graph for a resistor is as shown in the figure. Is it right to say that resistance decreases as the current through it increases

?



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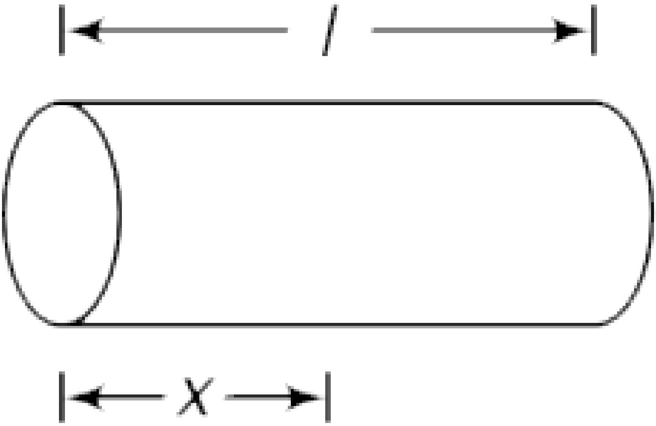
2. A cylindrical conductor has length l and area of cross section A. Its conductivity changes with distance (x) from one of its ends as $\sigma = \sigma_0 \frac{l}{x}$. $[\sigma_0 \text{is a constant}]$. Calculate electric field inside the conductor as a function of x, when a cell of emf V is connected across the ends.



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3. A conductor has density d and molar mass M. A wire made of this conductor has cross sectional radius r. Calculate the drift speed of electrons in this conductor when current through it is I. Assume that each atom contributes one free electron.

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4. A conducting wire of length l and cross sectional area A is used to short the terminals of a cell having emf of ε and internal resistance r. The resistively, density and Molar mass of the material of the wire are r, d and M respectively. Calculate the average time needed for a free electron to travel from positive terminal of the cell to its negative terminal.

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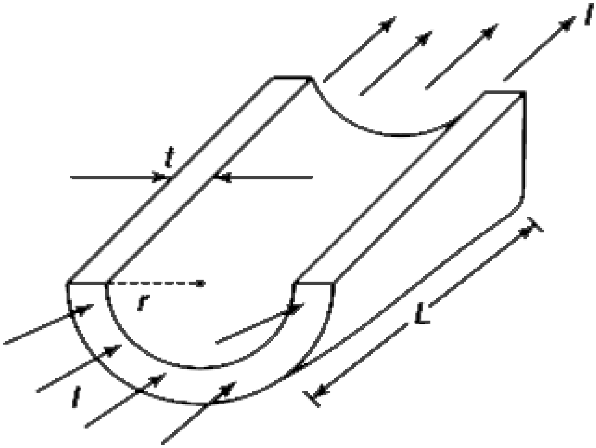
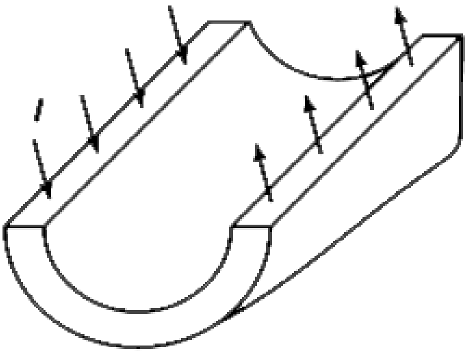
5. A conducting open pipe has shape of a half cylinder of length L. Its semicircular cross section has radius r and thickness of the conducting wall is $t(< \ < r)$. The resistance of the conductor when the current enters and leaves as shown in figure (a) is R_1 and its resistance is R_2

when the current is as shown in figure (b). find $\frac{R_1}{R_2}$



(a)



(b)

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6. It was found that resistance of a cylindrical specimen of a wire does not change with small change in temperature. If its temperature

coefficient of resistivity is α_R then find its thermal expansion coefficient (α).

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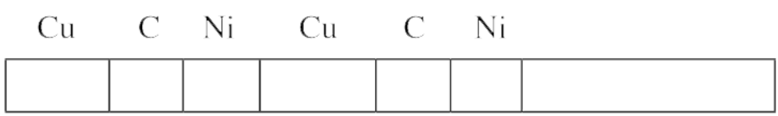
7. A cylindrical conductor is made so that its resistance is independent of temperature. It is done by stacking layers of copper, carbon and nichrome as shown in figure. The length of each copper layer is 1 cm and sum of lengths of consecutive carbon and Nichrome Leyers is also 1 cm. find the length of each Nichrome segment. Given [$\rho =$ resistivity, $\alpha =$ temperature coefficient of resistivity]

$\rho_{Cu} = 1.7 \times 10^{-8} \Omega m^{-1}, \rho_C = 5 \times 10^{-5} \Omega m^{-1}$

$\rho_{Ni} = 1 \times 10^{-6} \Omega m^{-1}, \alpha_{Cu} = 3.9 \times 10^{-3} . ^\circ C^{-1}$

$\alpha_C = -5 \times 10^{-4} . ^\circ C^{-1}, \alpha_{Ni} = 4 \times 10^{-4} . ^\circ C^{-1}$



Assume no change in dimensions of the segment due to temperature change.

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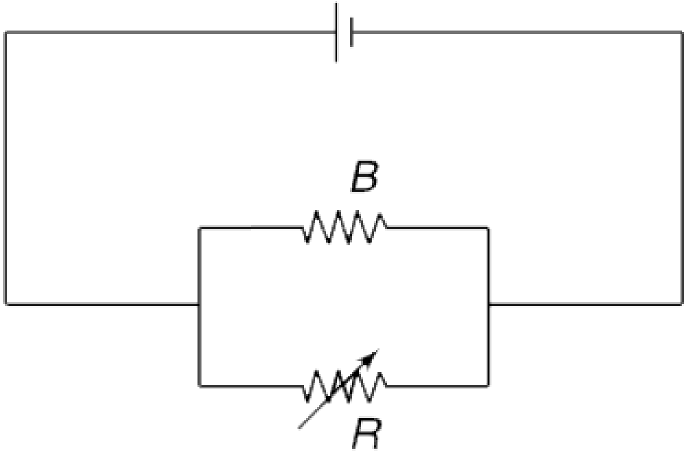
8. A bulb B is connected to a source having constant emf and some internal resistance. A variable resistance R is connected in parallel to the bulb. If the resistance R is increased, how will it affect the-

(a) Brightness of the bulb?

(b) Power spent by the source ?



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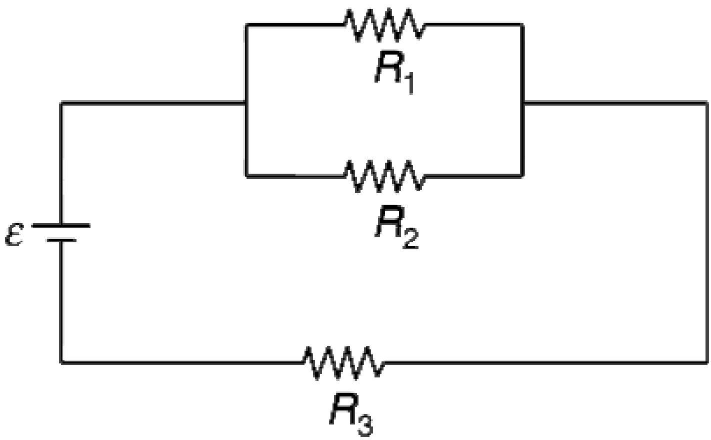
9. In the circuit shown in the figure $R_1 = 3\Omega$, $R_2 = 2\Omega$ and $R_3 = 5\Omega$ Emf of the cell $\varepsilon = 6$ Volt.

(a) Infinitely many 1Ω resistors are added in parallel to R_1 and R_2. Find current through R_2 and potential drop across it.

(b) Infinitely many 1Ω resistors are added in series to R_3. Find the potential drop across R_3 and current through it.



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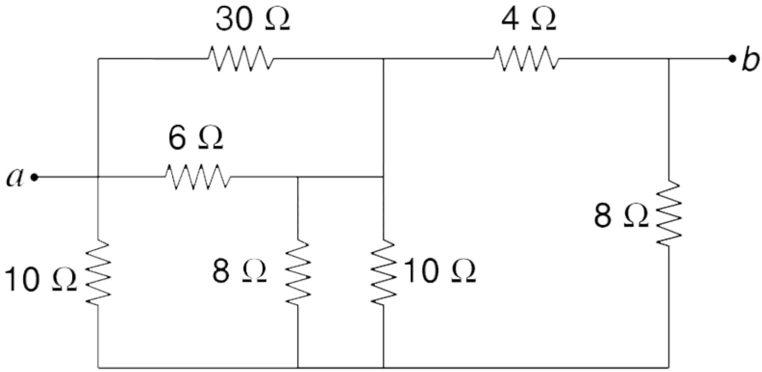
10. Find the equivalent resistance between point a and b in the network shown in figure.



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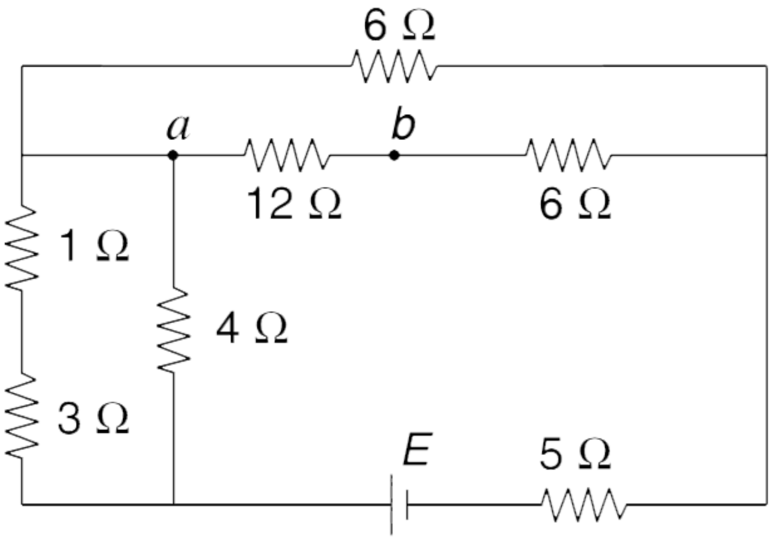
11. In the circuit shown in the figure, the potential difference between points a and b is $V_a - V_b = 4V$. Find the emf, E of the battery.



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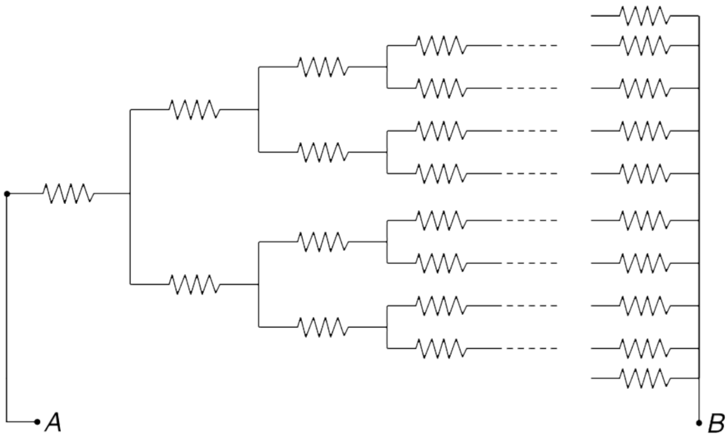
12. An infinite network of resistances has been made as shown in the figure. Each resistance is R. find the equivalent resistance between A and B.



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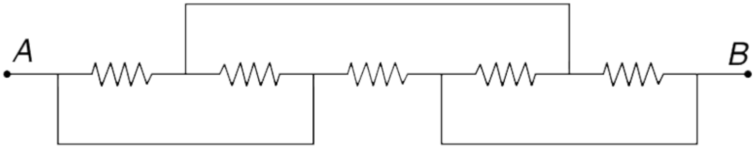
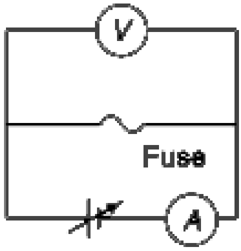
13. Find equivalent resistance between points A and B in the figure. Each resistance is R.



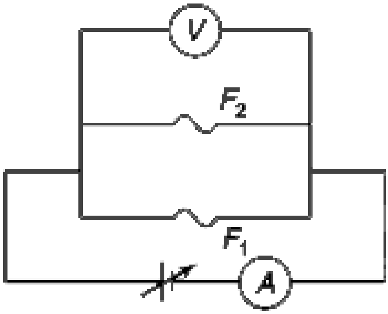
14. A fuse F_1 is connected across a source of variable voltage and the voltage is increased gradually. The fuse blows out just when the reading of the voltmeter and ammeter reaches $1.0V$ and $1.0A$ respectively (see figure (i)). The experiment is repeated with another fuse F_2 and the reading of the voltmeter and ammeter when it blows out is $2.4V$ and $1.2A$ respectively.

(a) The two fuses are connected in parallel as shown in figure (ii). Voltage is increased gradually. find the reading of the ammeter when any one of the fuses blows out.

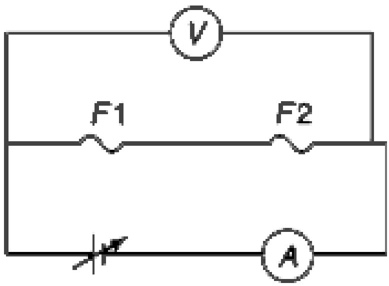
(b) The two fuses are connected in series as shown in figure (iii). find the reading of the voltmeter at the point one of the fuses blows out.



(i)



(ii)



(iii)

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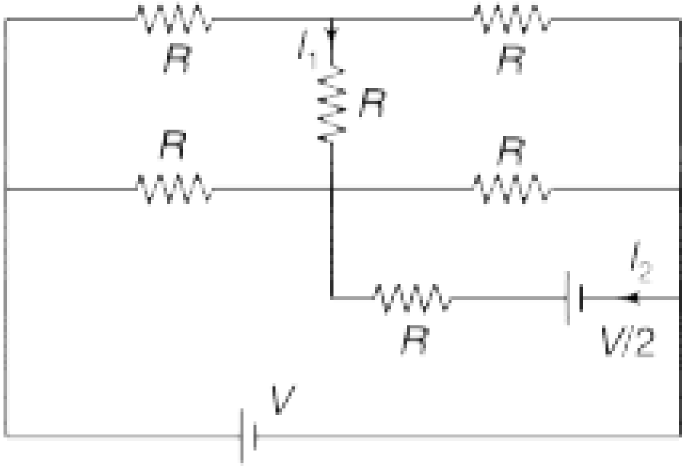
15. In the circuit shown in the figure. find I_1 and I_2.



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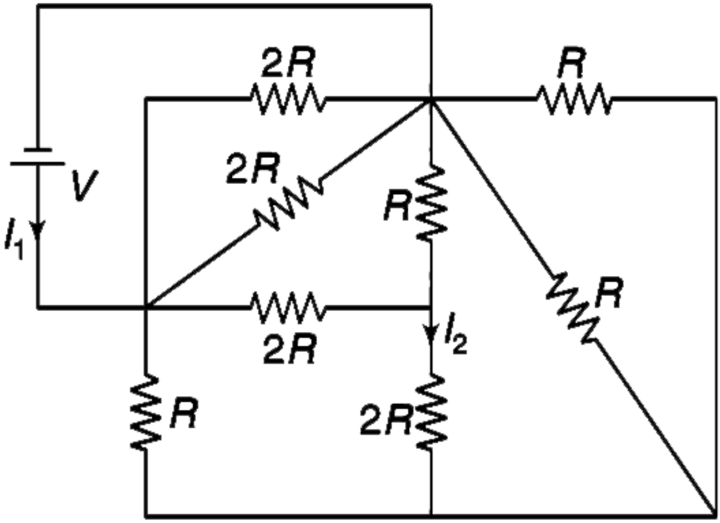
16. In the network shown calculate current through the cell (I_1) and the current I_2 through the $2R$ resistance.



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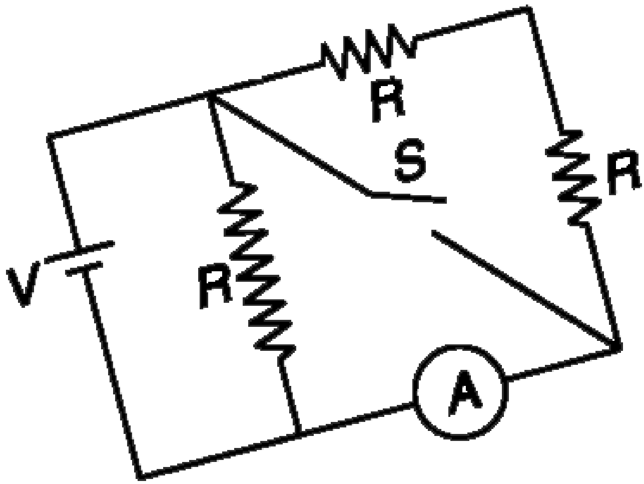
17. In the circuit shown, $R = 2\Omega$ and $V = 20$ volt. With switch S open the reading of ammeter is half its reading when 'S' is closed. Calculate the resistance of the ammeter.



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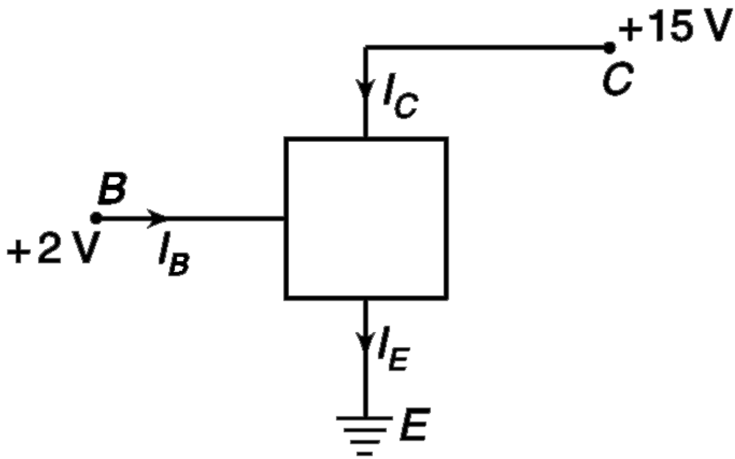
18. The box shown in the figure has a device which ensures that

$I_C = 0.9 I_E$.

If a small change (ΔI_B) is made in I_B, calculate the corresponding change in I_C.



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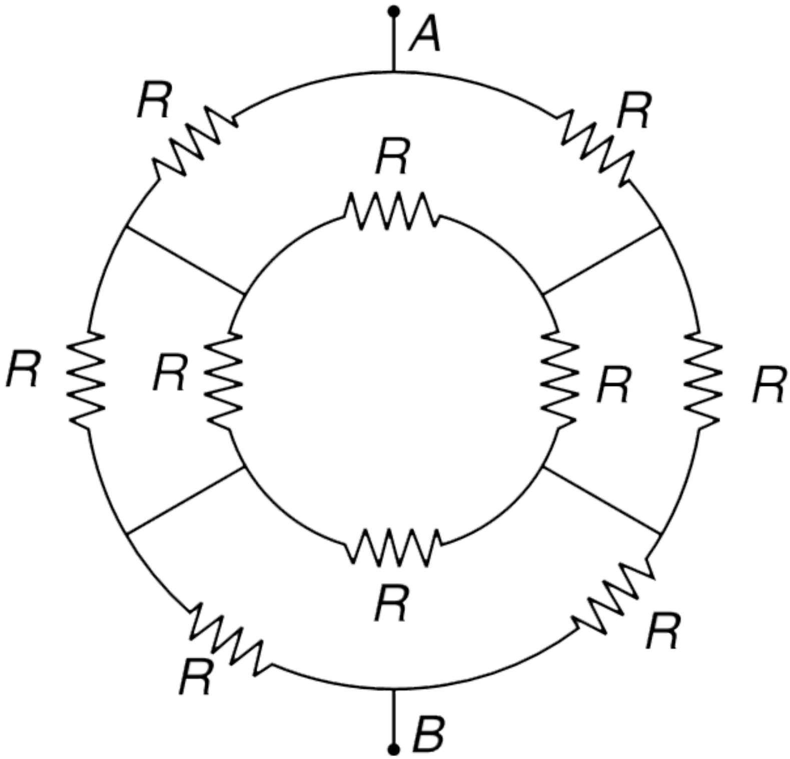
19. In the circuit shown in figure find the equivalent resistance across points A and B.



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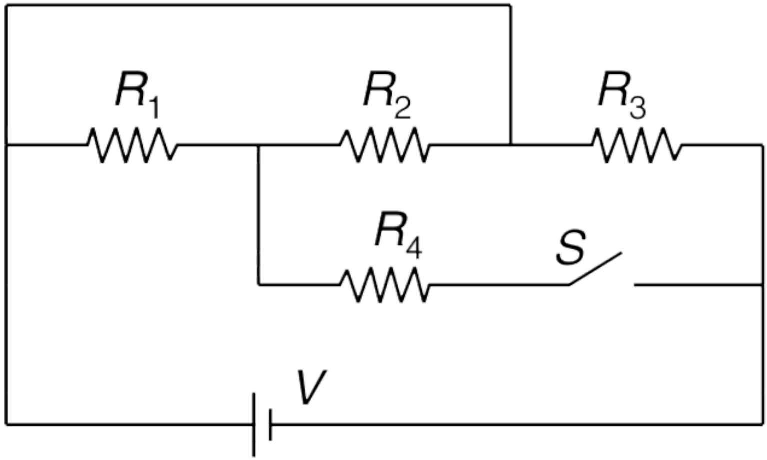
20. Find the percentage change in power supplied by the cell after the switch 'S' is closed in the circuit shown below. All resistances are identical



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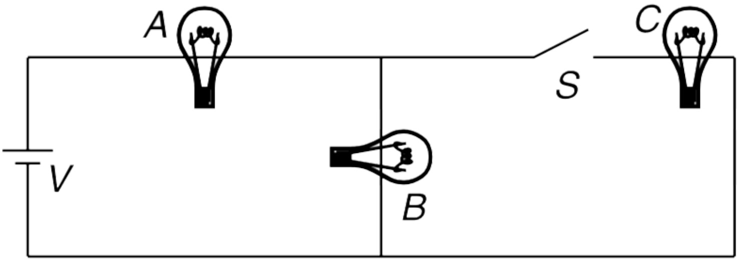
21. A and B are two identical bulbs of $40W$ connected to a $V = 12$ volt cell. Switch S is closed to connect a third bulb C in the circuit. What happens to brightness of bulb A? Answer for two cases:

(i) Bulb C is a very high wattage bulb.

(ii) Bulb C is a very low wattage bulb.

All the three bulbs have rated voltage of 12 volt.



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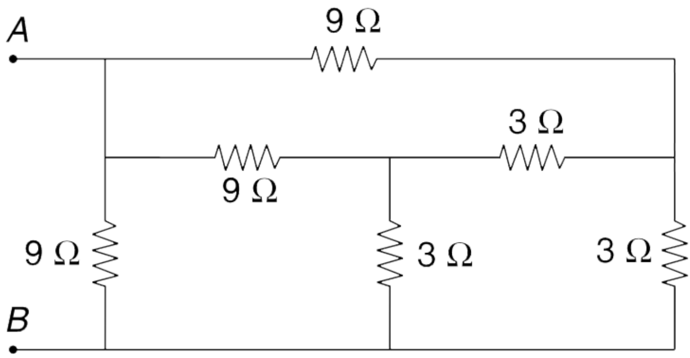
22. Find equivalent resistance between points A and B in the circuit shown.



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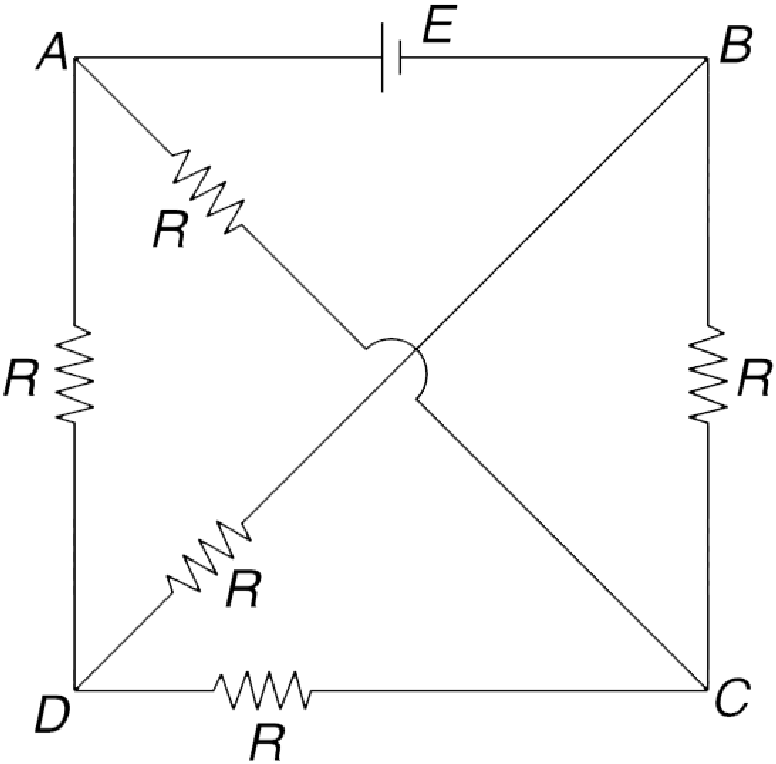
23. Find current through the cell and potential difference between A and D in the circuit shown in the figure



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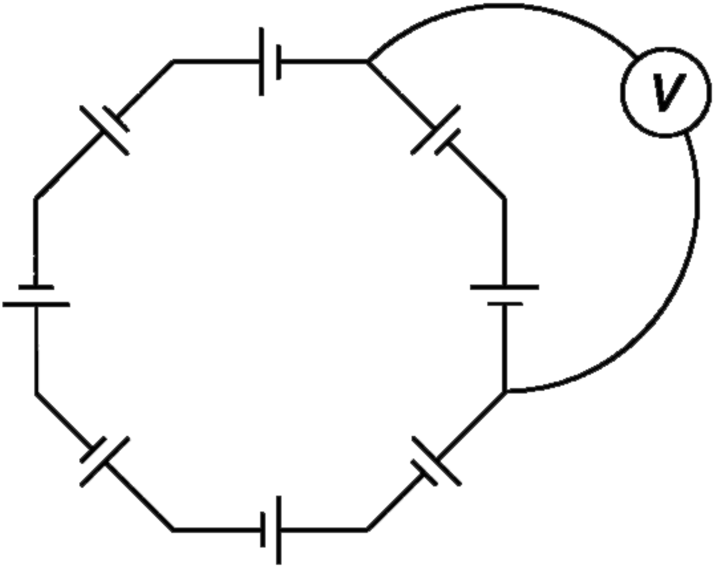
24. Eight identical 1 volt cells are connected to make a ring as shown in the figure. An ideal voltmeter is connected as shown. What will be its reading ?



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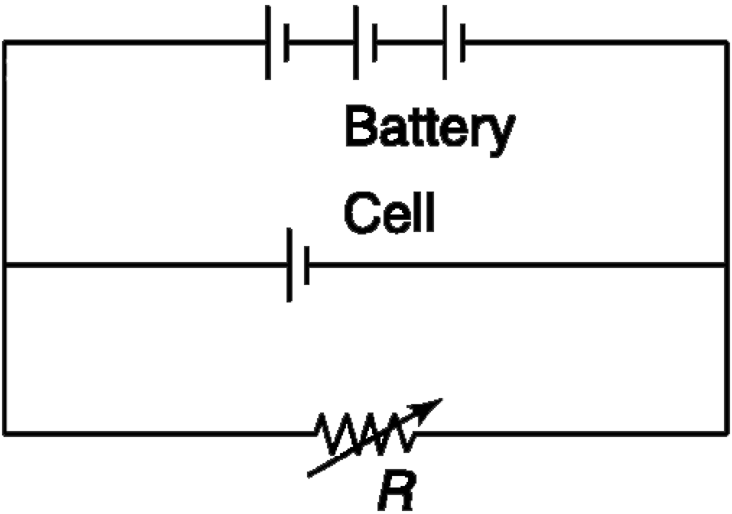
25. A battery of $120V$ and internal resistance $r = 0.5\Omega$ is used to charge a $110V$ cell in the circuit shown in the figure. find the range of values of R for which the cell will never get charged.



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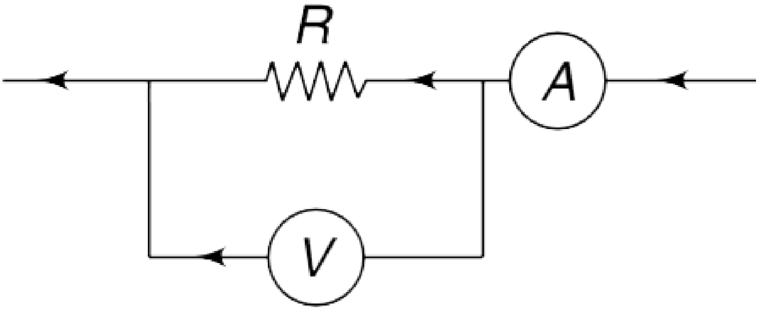
26. A voltmeter of resistance R_V and an ammeter of resistance R_A are connected as shown in an attempt to measure the resistance R. The measured value of the resistance is $R_M = \frac{V}{I_0}$ where V is reading of voltmeter and I_0 is reading of the ammeter. find the true value of the

resistance in terms of R_M, R_V and R_A.



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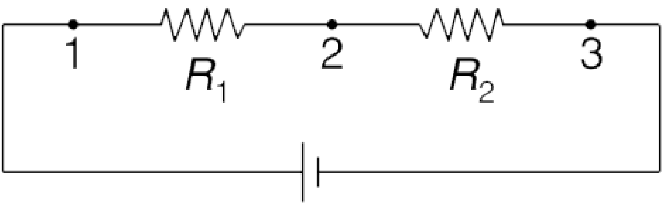
27. In the circuit shown in the figure, cell is ideal and $R_2 = 100\Omega$. A voltmeter of internal resistance 200Ω reads $V_{12} = 4V$ and $V_{23} = 6V$ between the pair of points $1 - 2$ and $2 - 3$ respectively. What will be the reading of the voltmeter between the points $1 - 3$.



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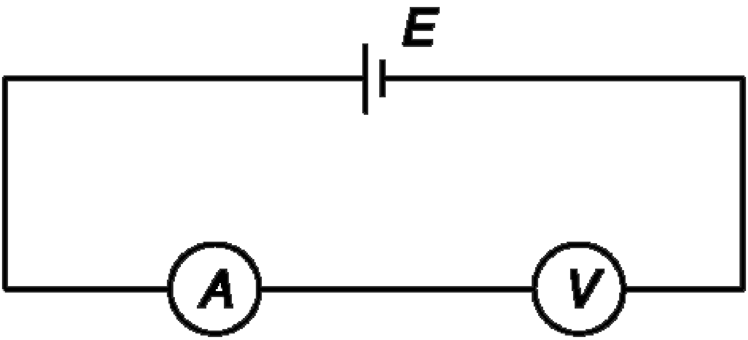
28. In the circuit shown, an ideal cell of emf E is connected in series to a non-ideal ammeter and voltmeter. Reading of the voltmeter is V_0. When a resistance is added in parallel to the voltmeter its reading becomes $\frac{V_0}{10}$ and the reading of the ammeter becomes 10 times the earlier value. find V_0 in terms of E.



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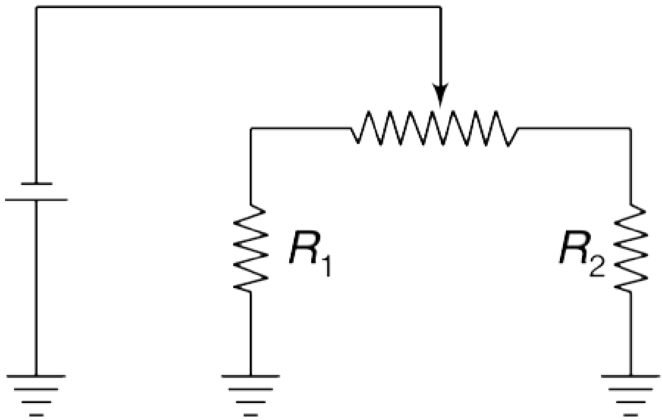
29. In the circuit shown, which way would you move the sliding contact, to the left or to the right, in order to increase current through resistance

R_1 ? What will happen to current through R_2 as you move the contact?



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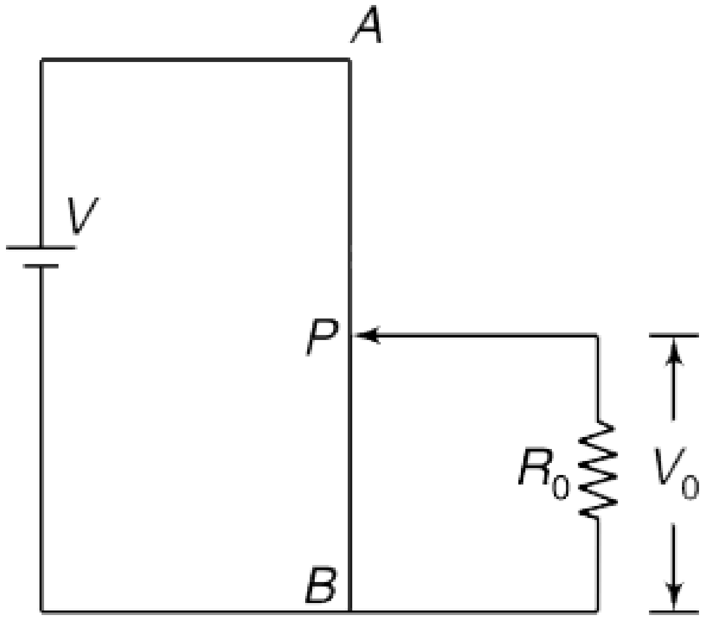
30. In the circuit shown in figure. AB is a uniform wire of length L and resistance R. P is a sliding contact. Take the ratio of lengths PB to AB as α.

(a) Find the ratio $\frac{V_0}{V}$ in terms of R_0, R and α

(b) Predict the value of $\frac{V_0}{V}$ when $R_0 rar \infty$. Use the result obtained in (a) to show that your prediction is correct.

(c) Find the ratio $\frac{V_0}{V}$ when $R_0 = 2R$ and $\alpha = \frac{1}{2}$



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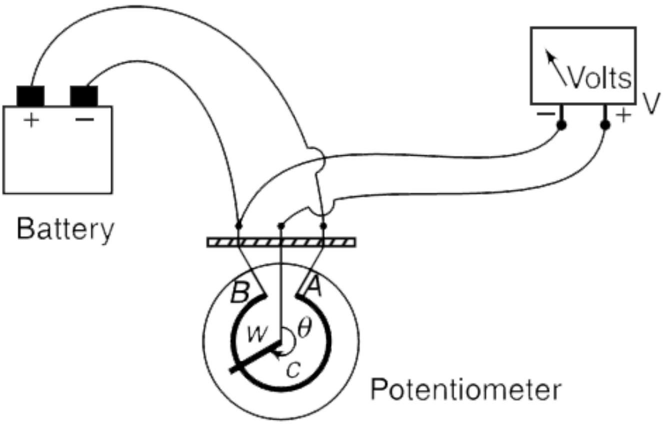
31. A rotary potentiometer has a circular resistance (C) and a conducting wiper (W) can rotate over it. An ideal battery and an ideal voltmeter are connected to it as shown in the figure. As the wiper is rotated on the circular resistance the reading of the voltmeter changes from zero to $20V$. What is reading of the voltmeter when wiper is at angular position $\theta = 120^\circ$? Assume that resistance C is almost a complete circle and resistance of all connecting wires and knobs in the circuit is zero.



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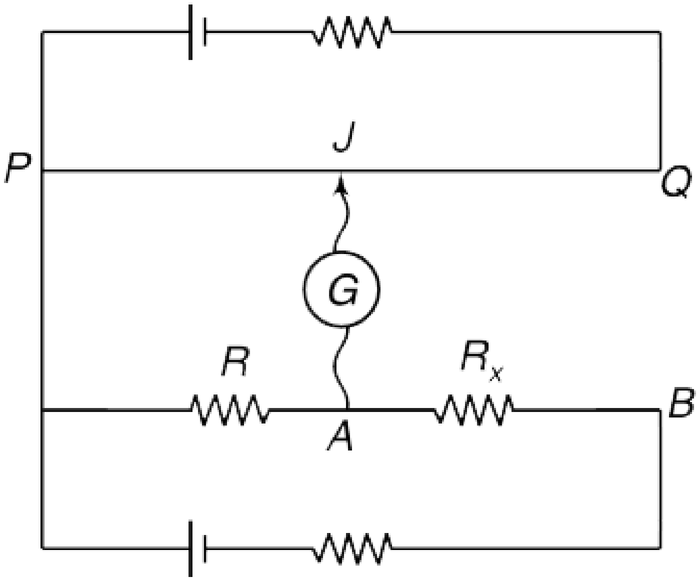
32. In the figure shown PQ is a potentiometer wire. When galvanometer is connected at A, it shows zero deflection when $PJ = x$. Now the galvanometer is connected to B and it shows zero deflection when

$PJ = 3x$. find the value of unknown resistance R_X in term of R.



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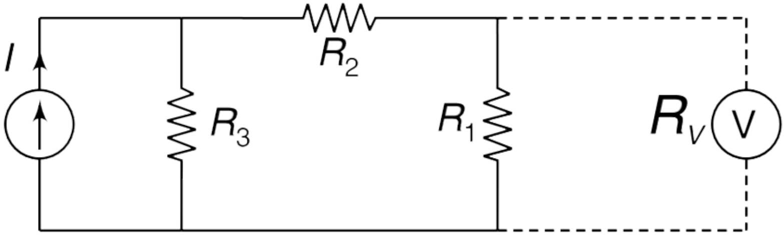
33. Three resistors $R_1 = 3k\Omega, R_2 = 2k\Omega$ and $R_3 = 5k\Omega$ have been connected to a constant current source as shown in figure. The current source supplies current $I = 2mA$ to the circuit. A voltmeter with $R_V = 6k\Omega$ internal resistance is connected, as shown, to measure the potential difference across R_1.

(a) Find the percentage error in the measurement of potential difference (V_1) across. R_1 caused due to finite resistance of the voltmeter.

(b) If positions of R_2 and R_3 are interchanged will the percentage error in measurement of V_1 increase or decrease ?



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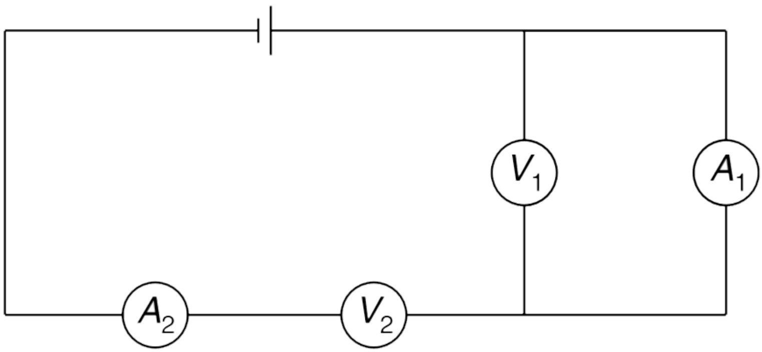
34. In the circuit shown in figure the voltmeters $V_1 \& V_2$ are identical. If readings of ammeter A_2, Voltmeter V_2 and V_1 are $400 \mu A$, $100 V$ and $2 V$ respectively, find the resistance of ammeter A_1. Is the value realistic ?



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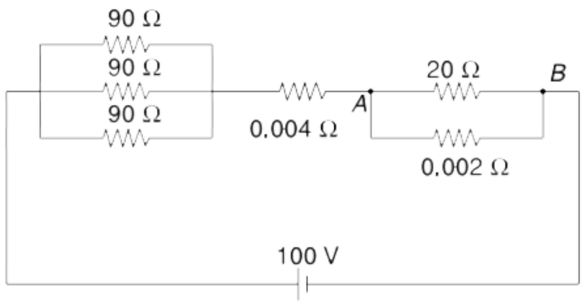
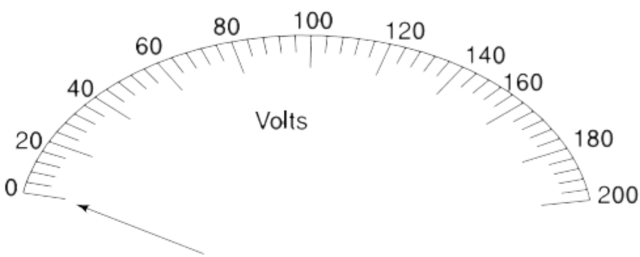
35. A lab voltmeter has scale as shown in figure. A student uses this nearly ideal voltmeter to record potential difference between points A and B in the circuit shown. He could not see any deflection in the pointer and thinks that the voltmeter must be faulty. He replaces the voltmeter with another similar one. What reading will he record this time? Can you give some suggestion to record the potential difference across A and B ?





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36. A 10 wire potentiometer has first five wires of cross sectional radius r and next five wires of radius $2r$. The wires are uniform and made of same material. An ideal cell of emf $2V$ is connected across the potentiometer wire. What length of the potentiometer wire will balance the emf of–

(a) a Daniell cell (emf = 1.0 V)

(b) a Lechlanche cell (emf = 1.5 V)

(c) a cell of emf 1.8 V ?

Length of each wire is 100 cm.

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37. A water heater has a well insulated vertical cylindrical container of radius a in which water is filled to a height h. A resistor made of an allow is used to heat the water in the tank from a temperature θ_1 to $\theta_2(> \theta_1)$ in a time interval Δt. The resistor wire has cross sectional radius b and its alloy material has resistivity ρ. Calculate the length of the resistor wire. Density and specific heat capacity of water are d and s respectively. The power source connected to the resistor has emf ε.

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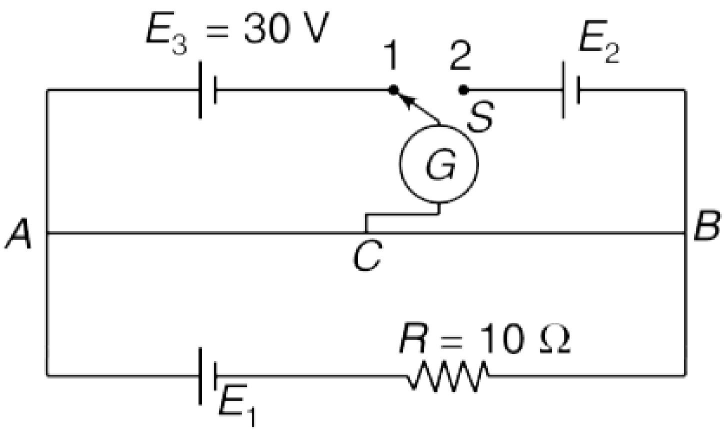
38. In the circuit shown in figure AB is a uniform wire of length $L = 5m$. It has a resistance of $2\Omega/m$. When $AC = 2.0m$, it was found that the galvanometer shows zero reading when switch s is placed in either of the two positions 1 or 2. find the emf E_1.



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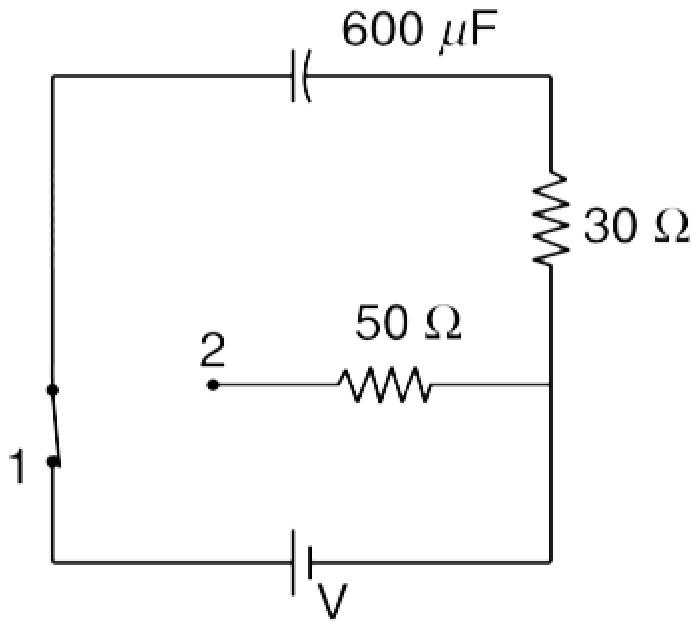
39. In the circuit shown, after the switch is shifted to position 2 the heat generated in 50Ω resistance is $6J$. find the emf (V) of the cell.



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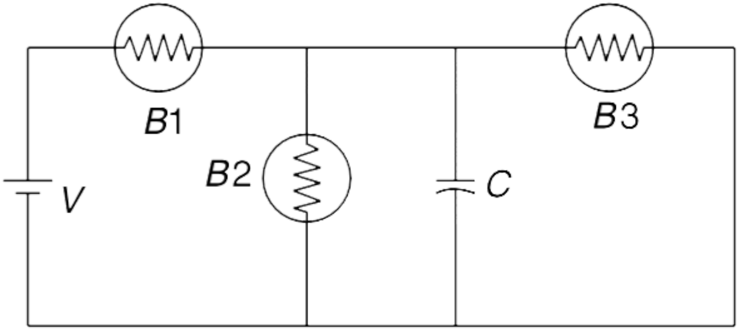
40. In the circuit shown in figure B_1, B_2 and B_3 are identical bulbs and C is a parallel plate capacitor.

(a) Which bulb is brightest?

(b) If separation between the plates of the capacitor is increased very slowly to double its value, how does the brightness of each of the bulbs change ?



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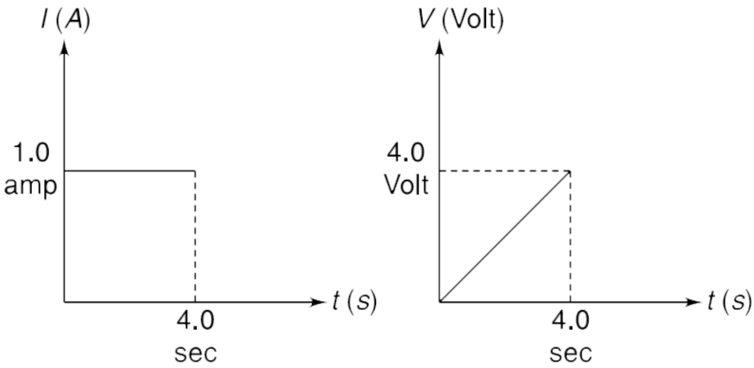
41. When the applied potential difference across a circuit element is increased linearly with time as shown in the second figure, the current in the circuit remains constant with time as shown in the first figure. At $t = 4s$ the lead wire connecting the element to the source breaks. What will be the voltage across the element after $t = 4s$? Can you identify the element?



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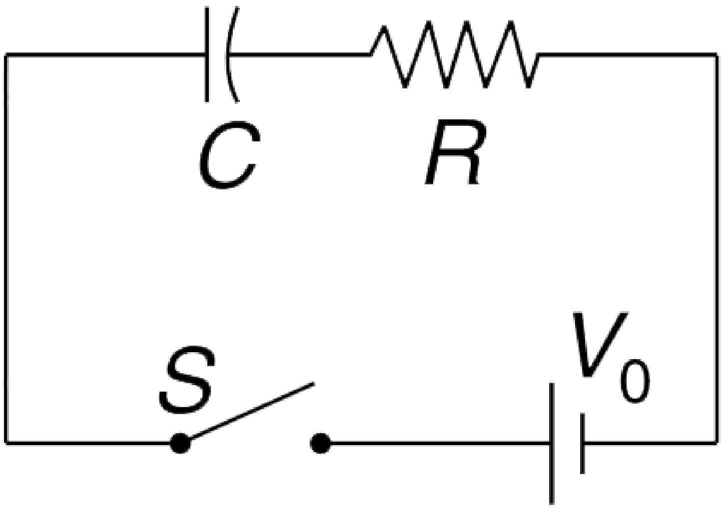
42. In the circuit shown the switch is closed at time $t = 0$. Plot the following graphs:

(i) current (I) in the circuit V_s time (t)

(ii) voltage across the capacitor (V_C) Vs 't'

(iii) power absorbed by the capacitor V_s 't'.



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43. A capacitor having initial change q_0 and capacitance C is connected to a variable resistance R. The resistance R can have values ranging from O to R_0. How should we vary R with time (t) such that the discharging current remains constant with time?

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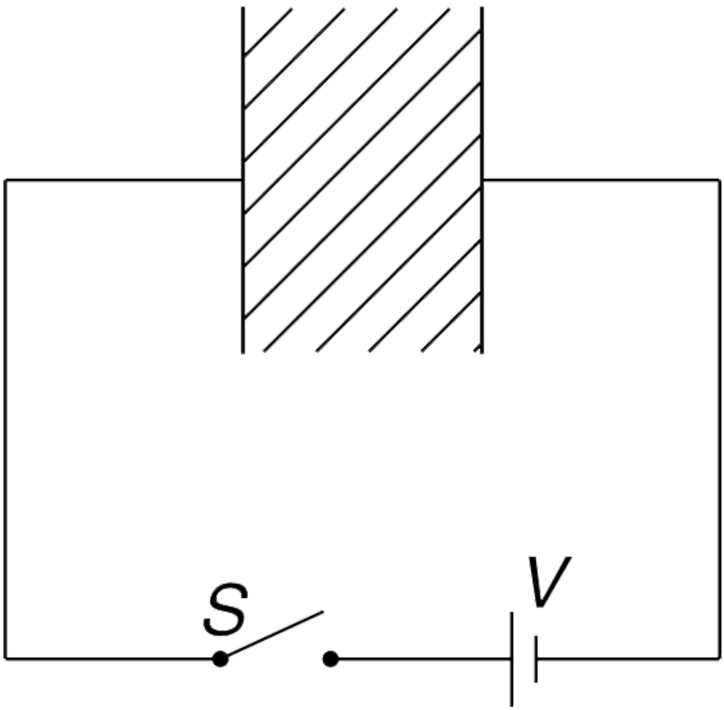
44. A parallel plate capacitor has plate area A and separation between the plates equal to d. A material of dielectric constant K and resistivity ρ is filled between the plates. The switch is closed to connect the capacitor to a cell of emf V.

(a) Write the steady state current in the circuit and charge on the capacitor.

(b) When the circuit is in steady state, switch s is opened (at t = 0). Write charge on the capacitor as function of time (t) after this



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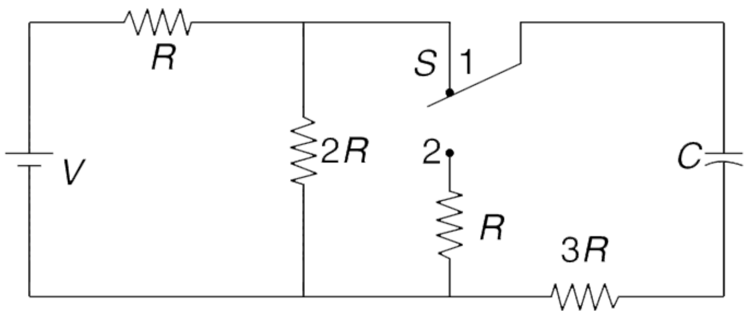
45. Consider the circuit shown in the figure. The switch has been in position 1 for a long time. Answer following questions:

(a) find current through 2R.

(b) find potential difference across the capacitor.

(c) At $t = 0$ the switch is moved to position 2. What current flows through the capacitor immediately after the switch is placed to position 2?

(d) Draw a graph of current Vs time for the current through the capacitor after the switch is moved to position 2. Indicate the time on the graph when the current becomes 37% of its value immediately after the switch is put to position 2.



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46. An electric bulb has a solid cylindrical filament of length l and radius r and it consumes power P when connected to a power source. Another bulb having cylindrical filament of same material, operating at same voltage and emitting the same spectrum of light consumes $8P$ power. find length and radius of the new filament. Assume that the filaments do not radiate from the flat ends and radiation is the only source of heat loss from the filaments.

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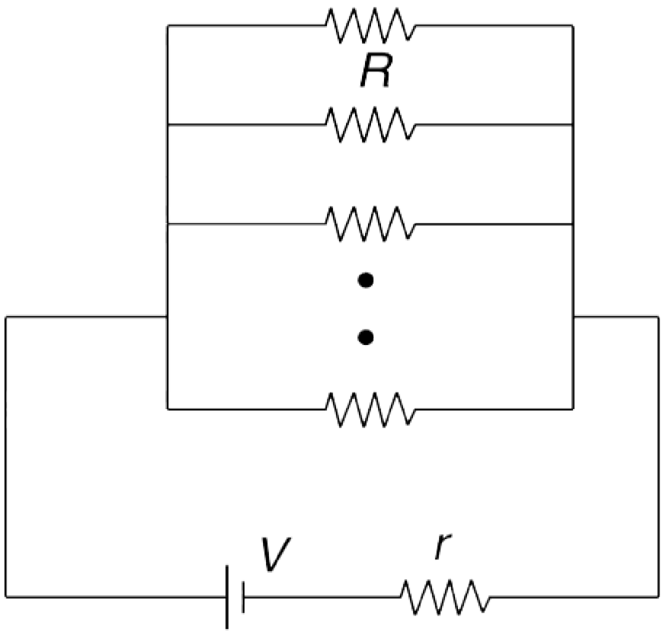
47. A battery of emf V and internal resistance r is connected to N identical bulbs, all in parallel. Resistance of each bulb is R. It is observed that maximum cumulative power is dissipated in the bulbs if $N = 10$.

Can we say that $r = \frac{R}{10}$



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48. A copper wire of length 5 cm carries a current of density $j = 1A(mm)^{-2}$. The density and molar mass of copper are $9000Kgm^{-3}$ and $63gmol^{-1}$. Each copper atom contributes one free electron. The temperature of the wire is $27^{\circ}C$. Estimate the (average) distance travelled by a free electron during the time it moves from one end of the copper wire to the other end. Assume that thermal motion of electrons are similar to that of molecules of an ideal gas.

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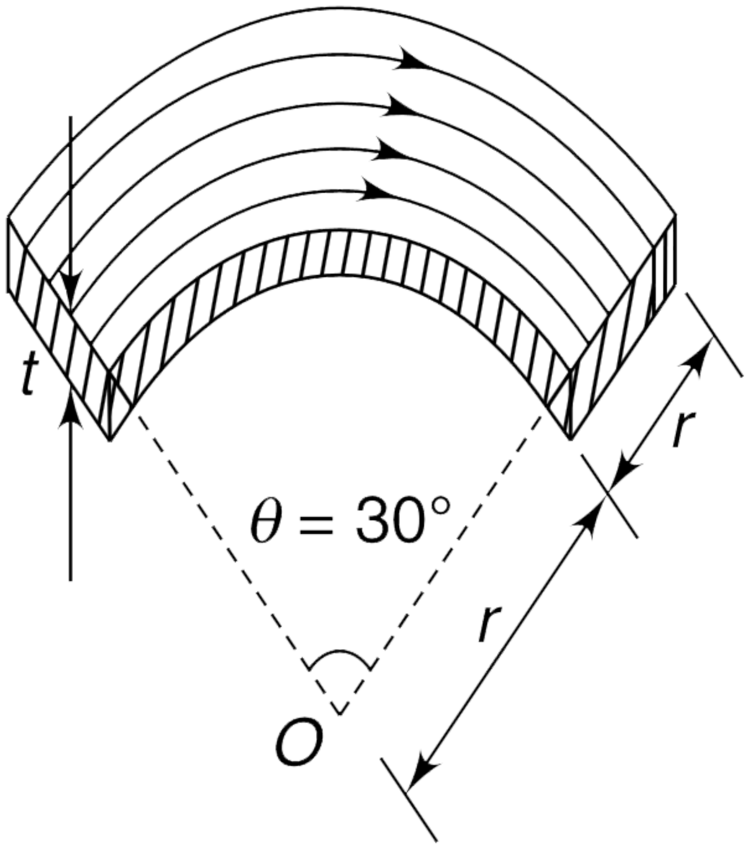
49. A conducting plate of thickness t is in the shape of an arc. Its inner and outer rim form a 30° arc of radius r and $2r$ respectively at point O (see figure). Electric current flows through the strip along circular arcs as indicated in the diagram. find resistance of the plate if its material has conductivity σ.



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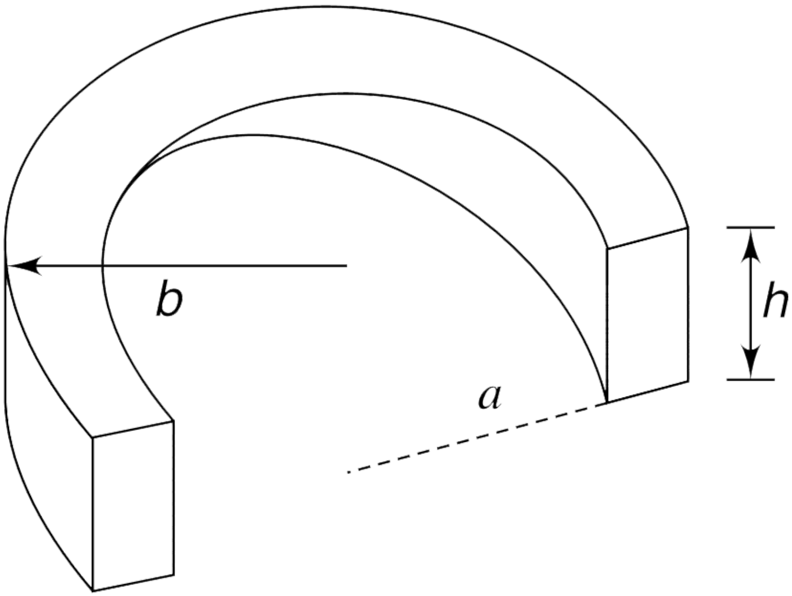
50. A conductor having resistivity ρ is bent in the shape of a half cylinder as shown in the figure. The inner and outer radii of the cylinder are a and b respectively and the height of the cylinder is h. A potential difference is applied across the two rectangular faces of the conductor. Calculate the resistance offered by the conductor.



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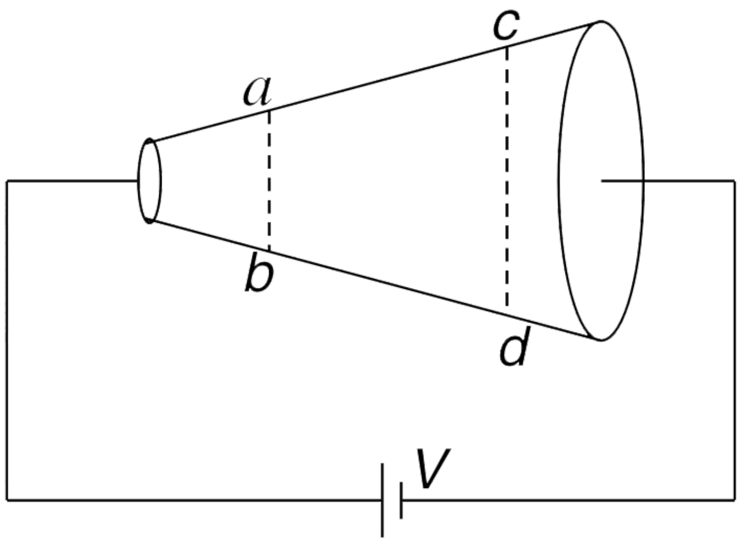
51. A metallic wire has variable cross sectional area. Cross sectional area at cd is twice the area at ab. The wire is connected to a cell as shown. find the ratio of heat dissipated per unit volume at section cd to that at section ab.



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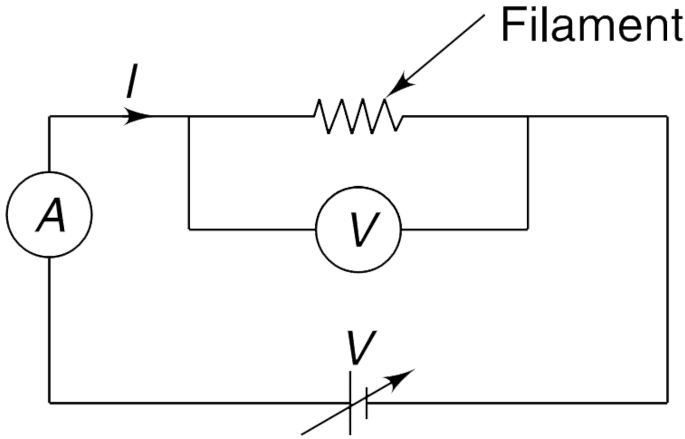
52. A tungsten filament bulb is connected to a variable voltage supply. The potential difference, V is varied and the current, I and steady temperature T of the filament is recorded. A graph is plotted for ln $(VI)V_s \ln(T)$. Find the slope of the graph. Assume that temperature of filament $T >> T_0 =$ atmospheric temperature



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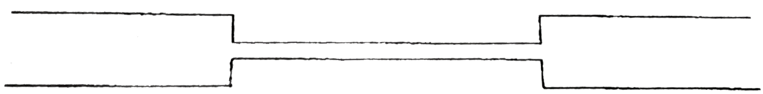
53. The figure shows the tungsten filament with constant diameter except a piece of it which has half the diameter of the resy of the wire. Assume the the temperature is constant with in each part and charges suddenly between the parts. If the temperature of thick part is 2000 K, the temperature of the thin part of the filament is



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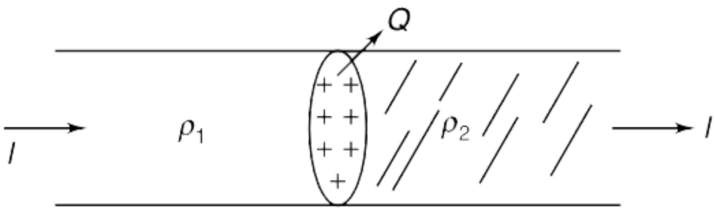
54. Two cylindrical rods, of different material, are joined as shown. The rods have same cross section (A) and their electrical resistivities are ρ_1 and ρ_2. When a current I is passed through the rods, a charge (Q) gets piled up at the junction boundary. Assuming the current density to be uniform throughout the cross section, calculate Q.



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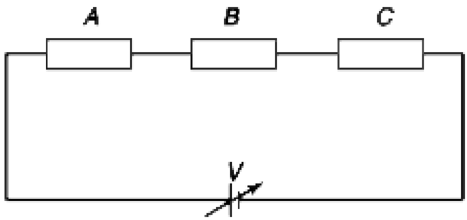
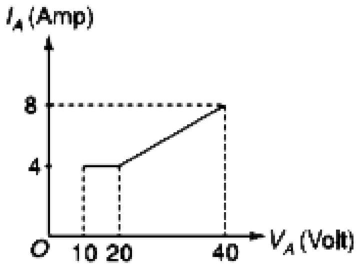
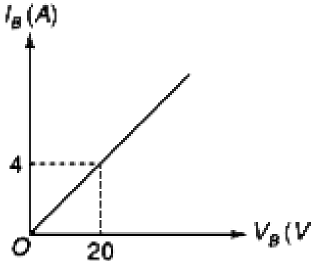
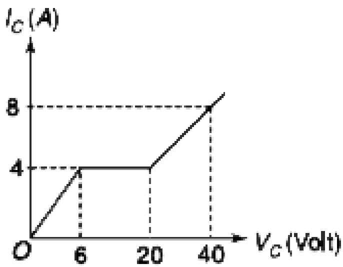
55. The current (I) – voltage (V) characteristic of three devices A, B and C connected in the circuit is as shown below.









Plot the variation of current through the cell when its emf is changed from 0 and 90 V.

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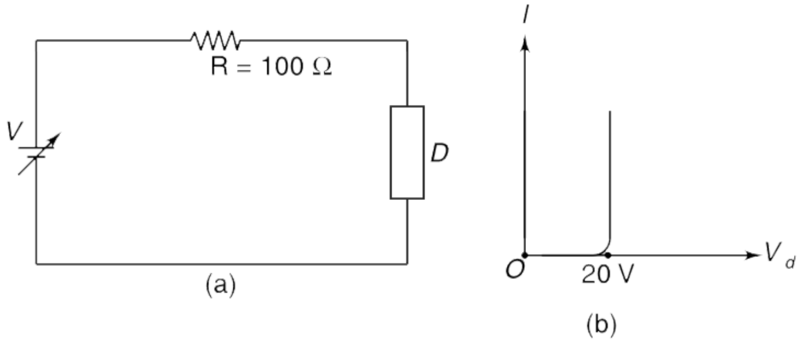
56. The current – voltage characteristic of an electric device is as shown in figure (b). The device gets damaged if power dissipated in it exceeds 1 Watt. This device is connected to a dc source of variable emf (V) and a resistance $(R = 100\Omega)$ in series. What is possible range of V for which the device remains operational (i.e. consumes some power) and safe.



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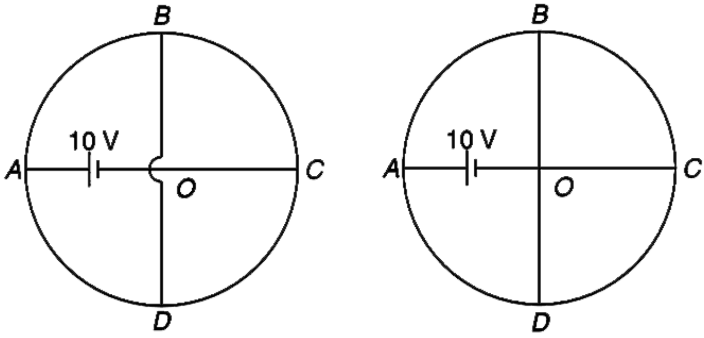
57. ABCD is a uniform circular wire of resistance 16Ω and AOC and BD are two uniform wires forming diameters at right angles, each of resistance 2Ω. The two straight wires do not touch each other at O. A battery of emf $10V$ is placed in AO as shown.

(a) Find the current through the battery (figure a)

(b) If the straight wires are tied at O so as to form a junction, find the current through the battery (figure b)



(a) (b)

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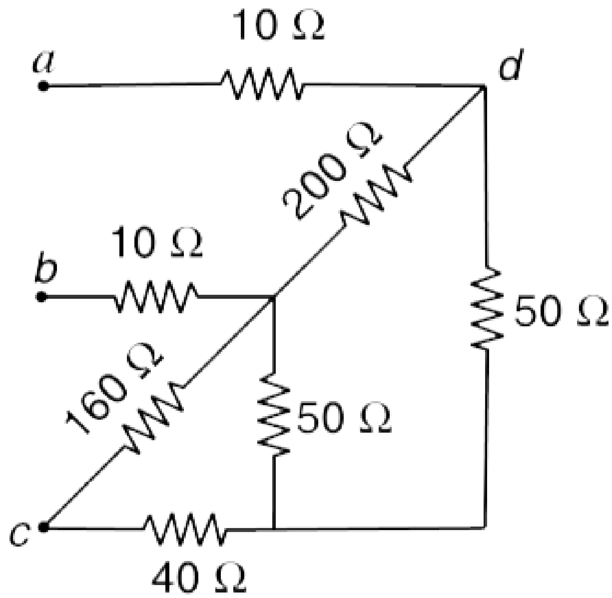
58. In the circuit shown in the fig the equivalent resistance between a and b is R_{ab} and the equivalent between a and c is R_{ac}. find the ratio

$R_{ab} : R_{ac}$.



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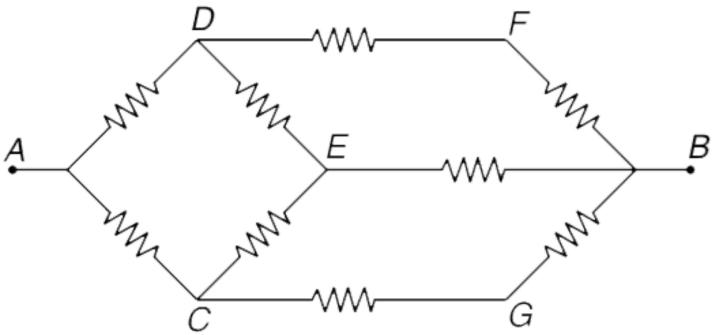
59. (a) In the circuit shown in figure, all resistances are identical when a $5V$ supply is connected across AB the current in branch CG is 3 mA. Find the effective resistancce if the circuit between A and B



(b) Twelve equal resistances, each equal to R, are placed along the sides of a cube. Find equivalent resistance across.

(i) Diagonally opposite points of the cube

(ii) Diagonally opposite point on one face of the cube

(iii) End points of a side of the cube.

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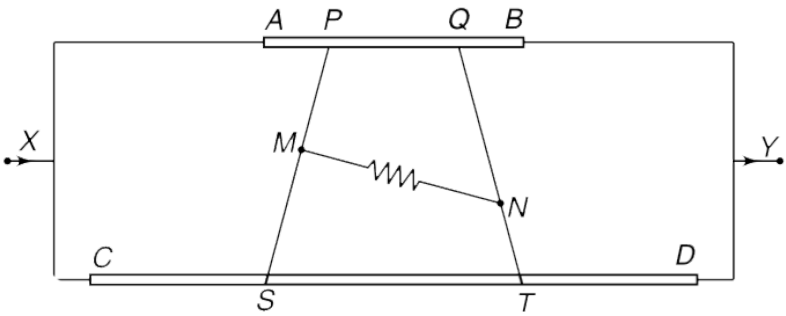
60. AB and CD are two resistance wires cut from a uniform long wire. Lengths of AB and CD are L and $2L$ respectively and resistance of AB is R. The two resistances are connected in parallel to a supply. P and Q are two points on the resistance AB such that $AP = QB = \frac{L}{3}$. Two conductors PS and QT are connected between two resistors such that no current flows through both the conductors. A resistance R is connected between points M and N as shown. Neglect resistance of PS and QT.

(a) find the equivalent resistance of the circuit between X and Y.

(b) Will there be any current in resistance connected across MN ?



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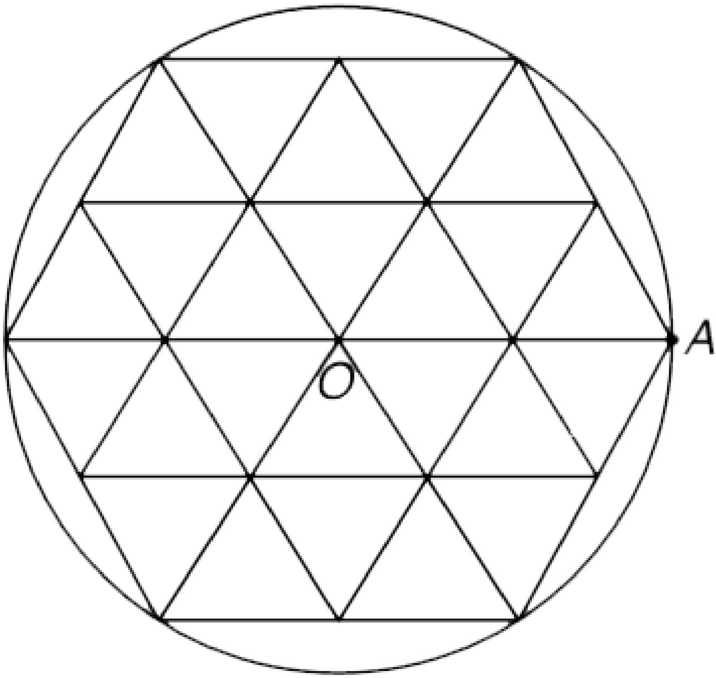
61. In the figure, each segment (side of small triangle) has resistance R and the wire used in the circumference of the circle has negligible resistance. find equivalent resistance between point O and A.



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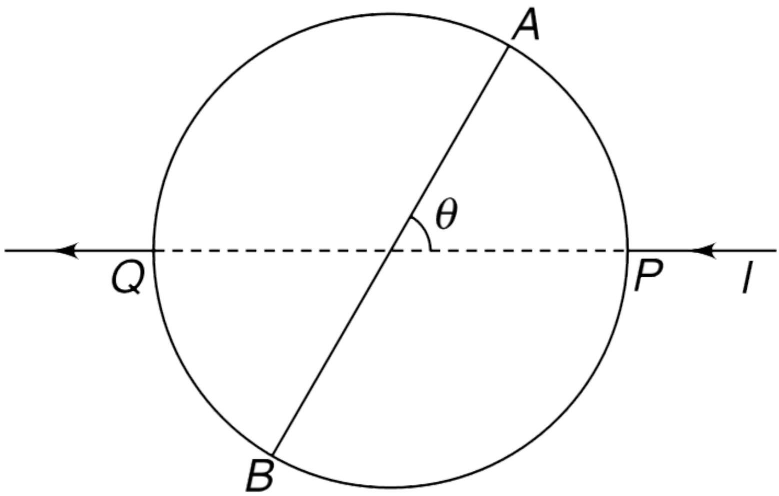
62. A uniform conducting wire is in the shape of a circle. The same wire has been used to make its diagonal AB. A current I enters at point P and leaves at the diagonally opposite point Q. AB makes an angle θ with the line PQ. find current (i), through AB as a function of θ. Plot a graph showing variation of i with $\theta \quad (0^\circ \leq \theta \leq 90^\circ)$



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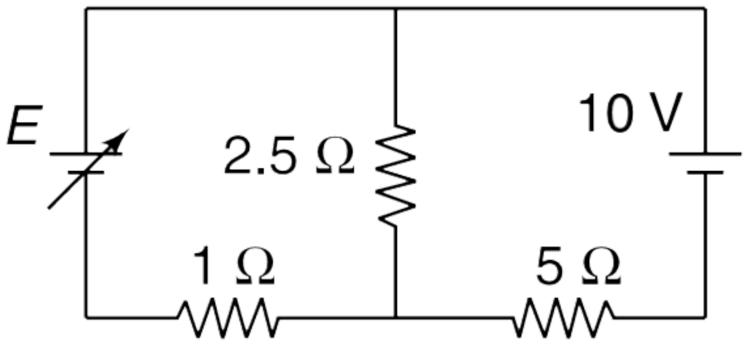
63. In the circuit shown in figure the emf E of the battery is increased linearly from zero to 28 V in the interval $0 \leq t \leq 14s$.

(a) find the energy gained by the $10V$ cell in the interval $0 \leq t \leq 14s$.

(b) At what time the $10V$ cell begin to charge?



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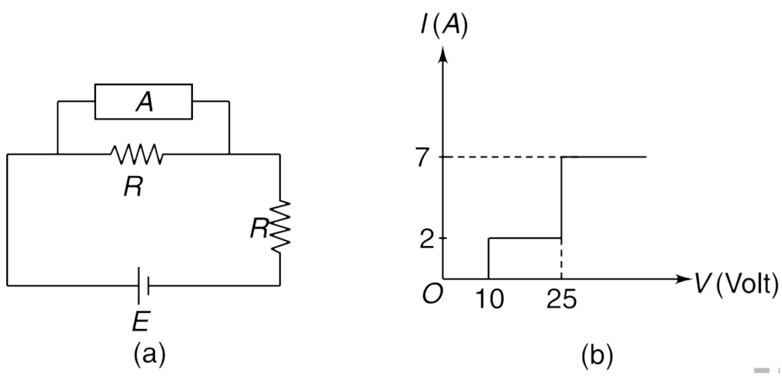
64. In the circuit shown in figure (a), the emf of the ideal cell is $E = 100V$ and resistance R is 10Ω. The current (I) – Voltage (V) characteristic of the circuit contained in box A is as shown in figure (b). find the potential difference across the box A.



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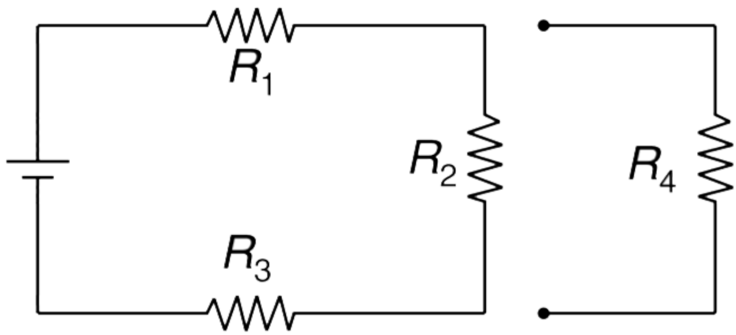
65. In the circuit shown in the fig., $R_1 : R_2 : R_3 = 4 : 1 : 2$.

(a) Will the current through R_1 increase or decrease when a new resistance R_4 is added in parallel to R_2 ?

(b) Change in current through R_1 when R_4 is added is found to be $0.2A$. Calculate the current through R_4.



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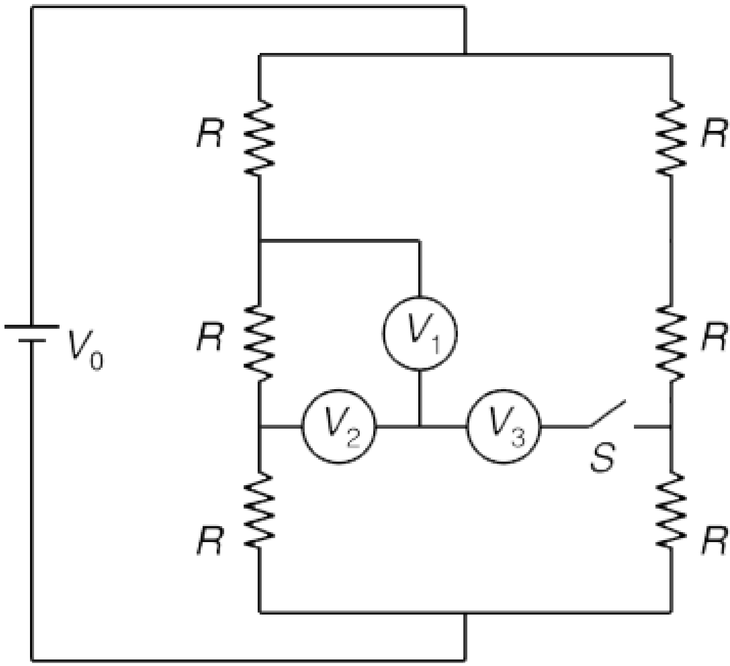
66. In the circuit shown in figure all resistances are identical (each equal to R) and the cell has an emf of V_0. The three voltmeters V_1, V_2 and V_3 are identical and are nearly ideal.

(a) find the reading of the voltmeter V_1 when switch 'S' is open.

(b) find the reading of the voltmeter V_1 after the switch is closed



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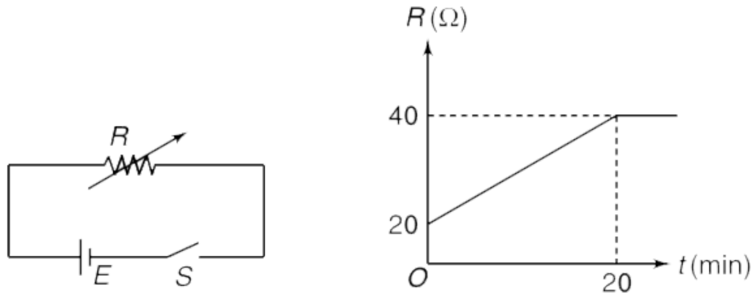
67. A chemical cell of emf E has negligible internal resistance. It is connected to a variable resistance (R) which changes linearly from 20Ω to 40Ω in 20 minute and thereafter becomes constant. It was found that the cell lost 10% of its total chemical energy in first 20 minute after the switch was closed. How long will the energy in the cell last?



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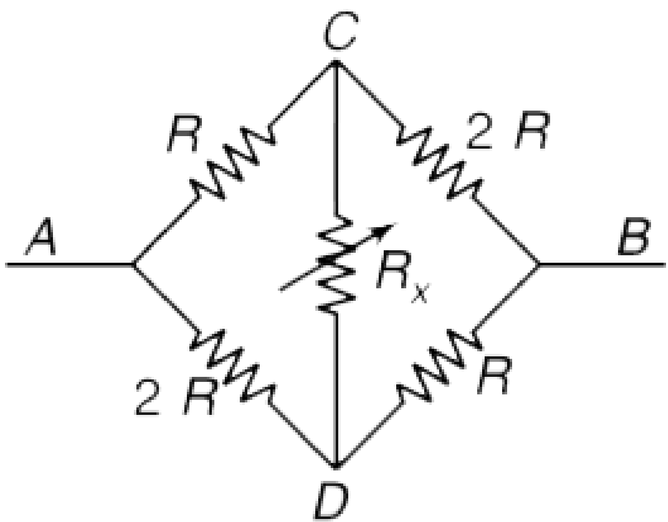
68. In the circuit shown in the figure R_X is a variable resistance. find the equivalent resistance (R_{AB}) between A and B in terms of R and R_X. What are the possible range of values of R_{AB} ?



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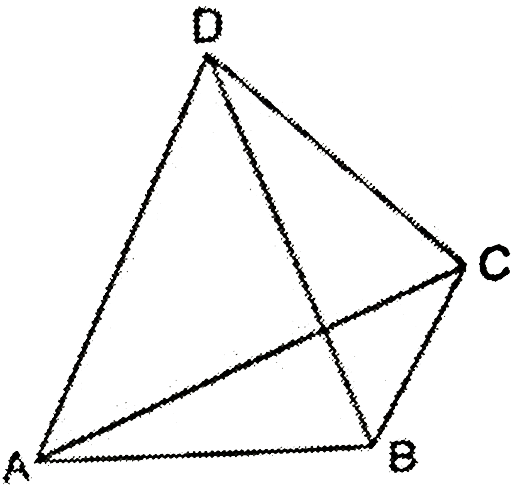

69.

Six identical wires of resistance R each are joined to form a pyramid, as shown in the figure above

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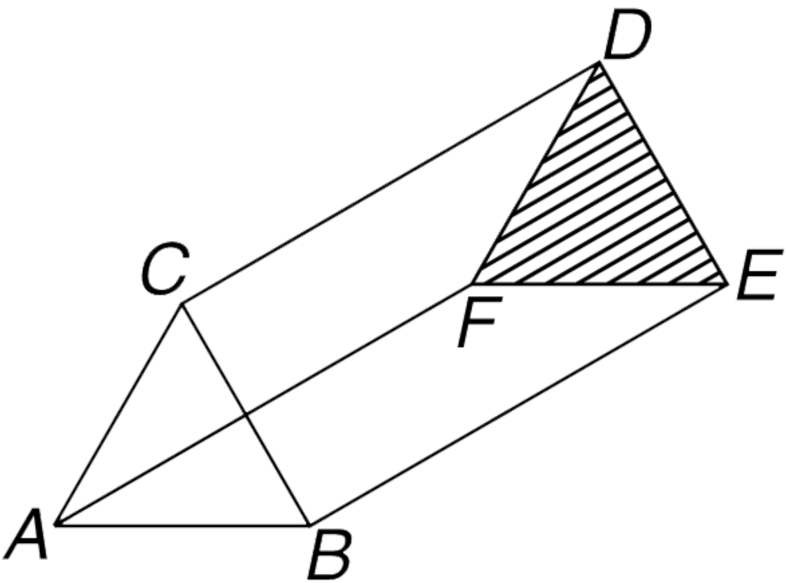
70. A prism shaped network of resistors has been shown in the figure. Each arm (like AB, AC, CD, DF ...) has resistance R. Find the equivalent resistance of the network between

(a) A and B

(b) C and D



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71. A cylindrical conductor has a resistance R. When the conductor is at a temperature (T) above its surrounding temperature (T_0), the ratio of thermal power dissipated by the conductor to its excess temperature $(\Delta T = T - T_0)$ above surrounding is a known constant k. The conductor is connected to a cell of emf V. Initially, the conductor was at room temperature T_0. Mass and specific heat capacity of the conductor are m and s respectively.

(i) find the time (t) dependence of the temperature (T) of the conductor after it is connected to the cell. Assume no change in resistance due to temperature.

(ii) find the temperature of the conductor after a long time.

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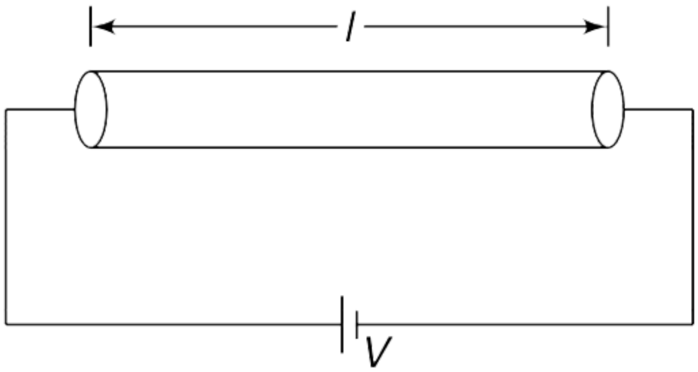
72. A conductor in the shape of a cylinder of length l and cross sectional radius r is connected to a cell of emf V. The resistivity of the material of the conductor is ρ and does not change much with temperature. The emissivity of the curved surface of the conductor is e. [Take emissivity of the flat circular surfaces to be zero]. In steady state the temperature of the conductor is T when the environmental temperature is T_0. The difference between T and T_0 is much smaller than the environmental temperature. Stefan's Constant is σ.

Find the steady state temperature T for the conductor.



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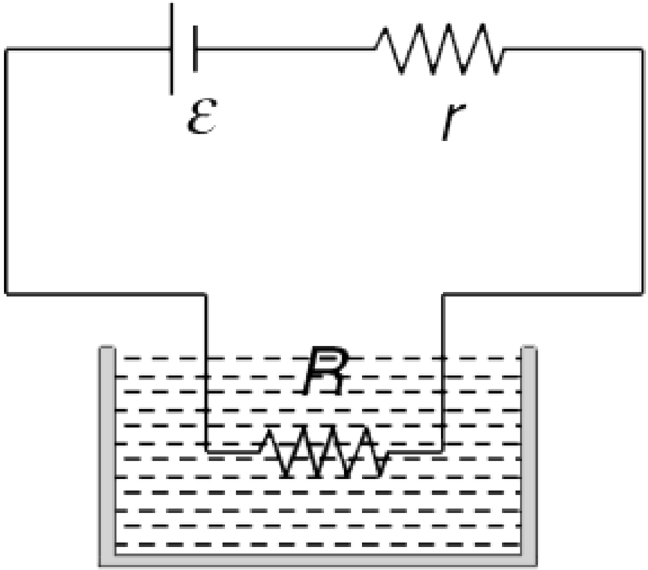
73. In order to heat a liquid an electric heating coil is connected is to a cell of emf $E = 12V$ and internal resistance $r = 1\Omega$. There are three options for selecting the resistance (R) of the heating coil. R can be chosen as $1\Omega, 2\Omega \text{ or } 4\Omega$. The cell has a rating of $2000mAh$ (milli Ampere hour) and it is to be used to heat the liquid till it expires. [The cell maintains constant emf till it lasts]

(a) Which value of R will you chose so that maximum heat (H_0) is transferred to the liquid before the cell expires? Calculate H_0.

(b) Which value of R will chose so that heat is transferred to the liquid at fastest possible rate? What percentage of H_0 (as obtained in (a)) is transferred to the liquid in this case by the time the cell expires ?



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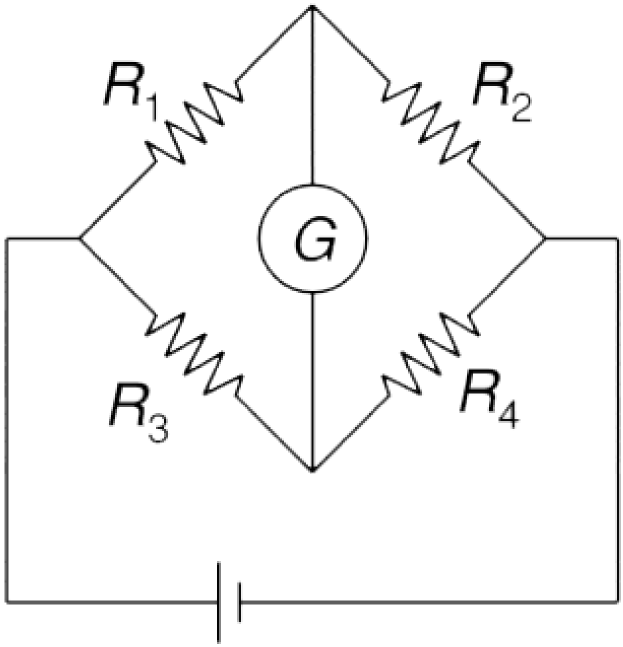
74. In a wheat stone bridge experiment to determine the unknown resistance R_4, the values of R_1 and R_2 were taken to be 10Ω and 1Ω respectively. It was found that the galvanometer will show exact zero deflection when value of R_3 is taken as $643\Omega < R_3 < 644\Omega$.

Now R_1 is changed to 100Ω (R_2 remains unchanged).

(a) If you have been asked to obtain a balanced bridge, which values of R_3 will you try with?

(b) If balance is obtained for $6432\Omega < R_3 k < 6433\Omega$ write the measured value of unknown resistance R_4.



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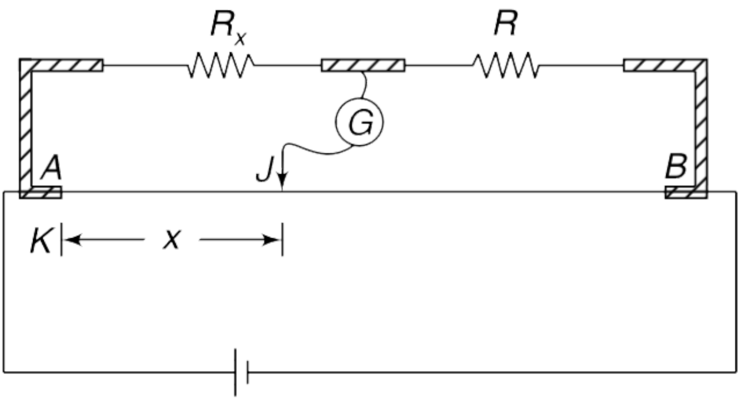
75. Figure shows an experimental set up to find the value of an unknown resistance (R_x) using a meter bridge. AB is the uniform meter bridge wire of length $L = 100 cm$. When the sliding jockey is placed at $J(AJ = x)$, the galvanometer shows zero deflection. $AJ = x$ is known as balancing length and is measured using a scale having 1 mm as least count.

(a) In one experiment known resistance R was taken to be 20Ω and balancing length was measured as $x = (20.0 \pm 0.1) cm$. find the value of R_x.

(b) Show that fractional error in calculated value of R_x is least when $x = \frac{L}{2}$. What shall we do to ensure that x is close to $L/2$?



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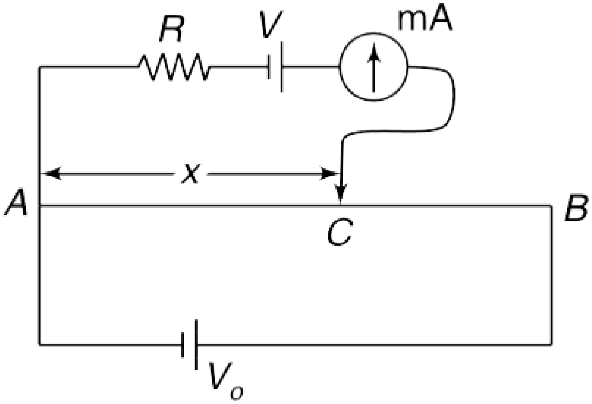
76. AB is a uniform wire of length $L = 100cm$. A cell of emf $V_0 = 12$ volt is connected across AB. A resistance R, cell of emf V and a milliammeter (which can show deflection in both directions] is connected to the circuit as shown. Contact C can be slid on the wire AB. Distance $AC = x$. The current (I) through the milliammeter is taken positive when the cell of emf V is discharging. A graph of $I Vs x$ has been shown.

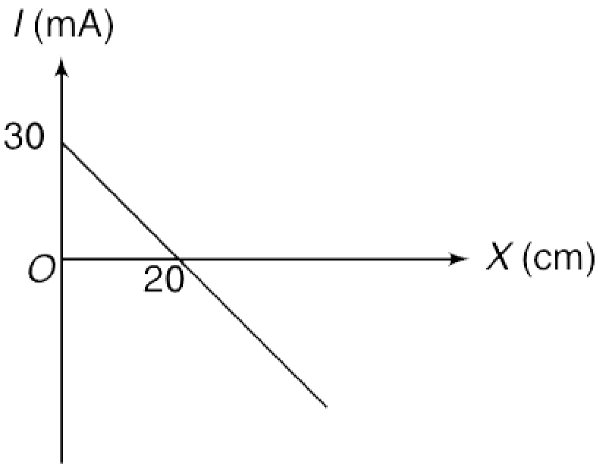
Neglect internal resistance of the cells.

(a) Find V

(b) Find R

(c) find I when $x = 100cm$





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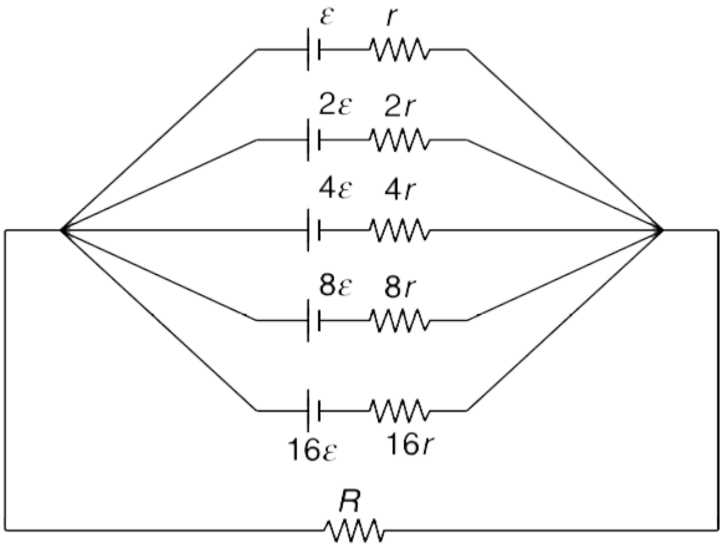
77. Five cells have been connected in parallel to form a battery. The emf and internal resistances of the cells have been shown in figure. A load resistance R is connected to the battery.

(a) Which of the 5 cells will have maximum current flowing through it?

(b) find the current through load resistance R.



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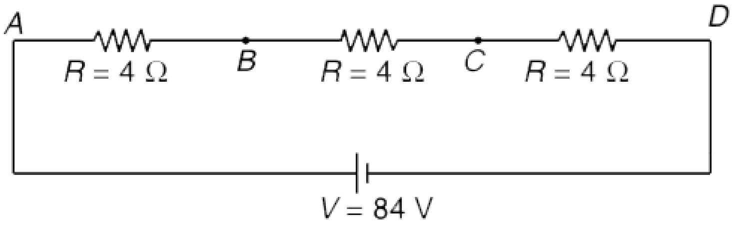
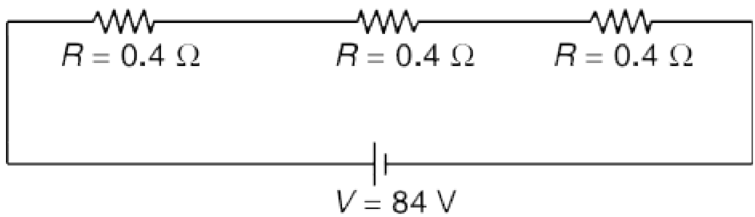
78. In the circuit shown, when a voltmeter is connected across any one of the three resistances, it shows a reading of $24V$.

(a) Find the reading of the voltmeter when it is connected between A and C



(b) The same voltmeter is used to measure potential difference across resistances shown in figure below. Will the voltmeter be more accurate this time ?



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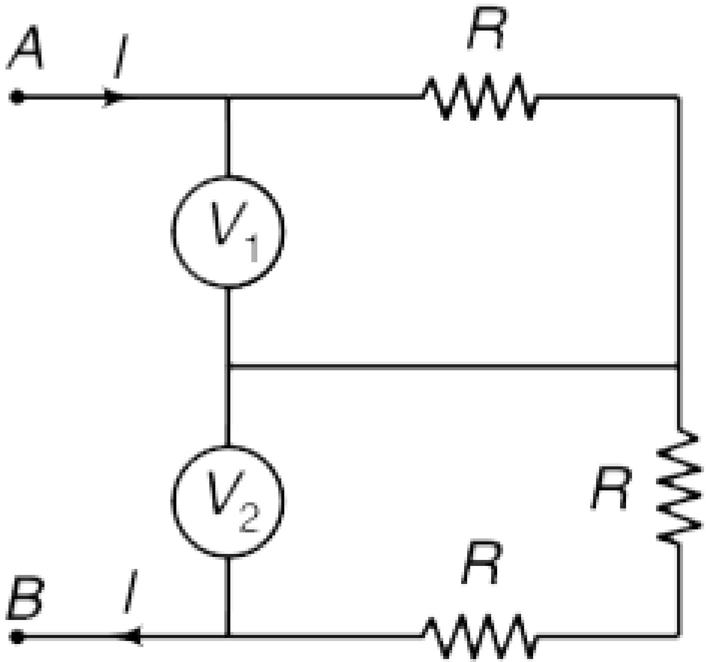
79. In the circuit shown in figure a current $I = 600\mu A$ enters through A and leaves through B. Reading of the identical voltmeters V_1 and V_2 are

$20V$ and $30V$ respectively. find R.



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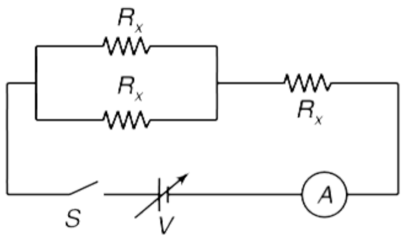
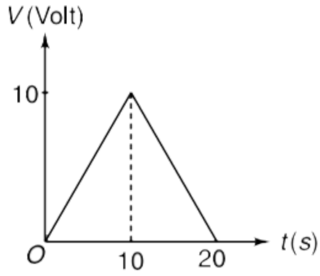
80. In the circuit shown, each resistor has a resistance R_X which depends on the voltage V_X across it.

For $V_X \leq 1V$, $R_X = 1\Omega$

and for $V_X > 1V$, $R_X = 2\Omega$

The emf (V) of the source, changes with time (t) after the switch is closed at $t = 0$. The variation of V with time is depicted in the graph. Plot the variation of ammeter reading with time.





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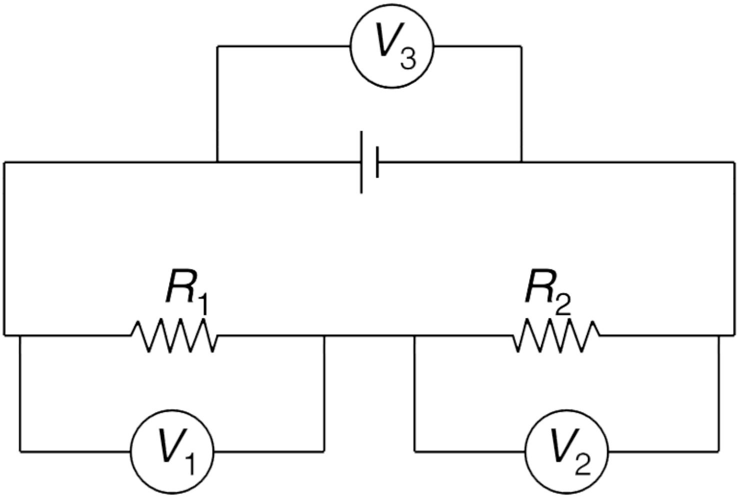
81. In the circuit shown in the figure, two resistors R_1 and R_2 have been connected in series to an ideal cell. When a voltmeter is connected across R_1 its reading is $V_1 = 4.0$ volt and when the same voltmeter is connected across R_2 its reading is $V_2 = 6.0$ volt. The reading of the voltmeter when it is connected across the cell is $V_3 = 12.0$ volt. Find the actual across R_1 in the circuit.



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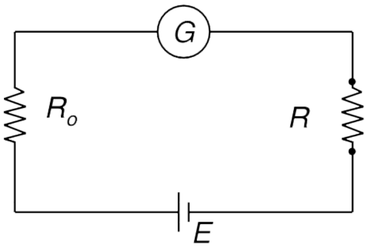
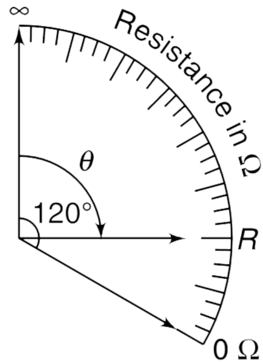
82. An ohm-meter is a device that measures an unknown resistance. A simple ohm-meter can be constructed using a galvanometer as shown in the figure. The cell used in the circuit has emf $E = 20$ volt. The full scale deflection current and resistance of the galvanometer are $2mA$ and 20Ω respectively. R_0 is a fixed resistance and R is the unknown resistance whose value is directly given by the galvanometer scale. The galvanometer scale is shown in figure. When an unknown resistance R is placed in the circuit, the pointer deflects by $\theta = 90^{\circ}$. Find R.





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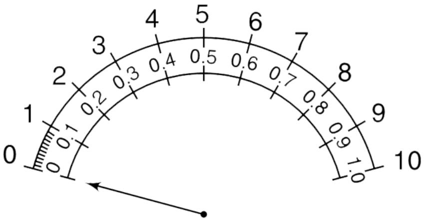
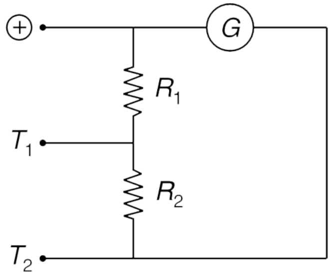
83. To enhance the sensitivity, an Ammeter is to be designed with two kinds of graduation on its scale — 0 to $10A$ and 0 to 1 A. for that a galvanometer of resistance 50Ω and full scale deflection current 1 mA was used along with two resistances R_1 and R_2 as shown. Either of T_1 or T_2 is to be used as negative terminal of the Ammeter.

(a) When measuring a current of the order of $0.1A$, which shall be used as negative terminal — T_1 or T_2 ?

(b) find the values of R_1 and R_2.





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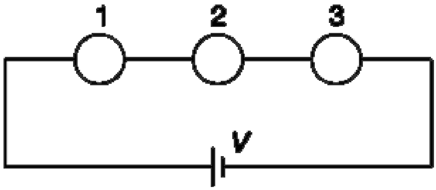
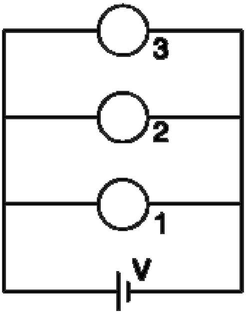
84. Three ammeters — 1, 2 and 3 have different internal resistances r_1, r_2 and r_3 respectively. Internal resistance r_1 is known but r_2 and r_3 are unknown. The angular deflection of pointer in each ammeter is proportional to the current. Initially, the three ammeters were connected in series to a voltage source (fig. a) and deflections for the three ammeters were θ_1, θ_2 and θ_3 respectively. The three ammeters were then connected in parallel to the same voltage source (fig. b). This time the deflections were observed to be θ'_1, θ'_2 and θ'_3 respectively.

(a) Find r_2 and r_3.

(b) If $\theta_2 = \theta_3$ but $\theta'_3 > \theta'_2$ then which one is larger r_2 or r_3 ?





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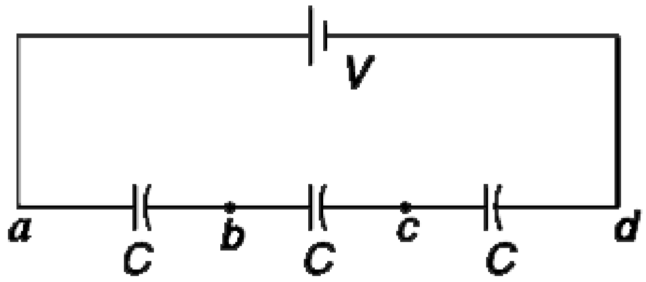
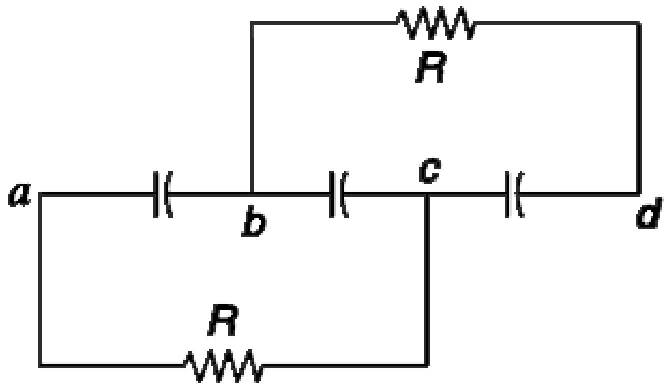
85. Three identical capacitors, each of capacitance C are connected in series. The capacitors are charged by connecting a battery of emf V to the terminals (a and d) of the circuit. Now the battery is removed and two resistors of resistance R each are connected as shown. find the heat dissipated in one of the resistors





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86. Assume that clouds are distributed around the entire earth at a height of $3000m$ above the ground. The atmosphere can be modeled as a spherical capacitor with the earth as one plate and the cloud as other. When the electric field between the earth and the cloud becomes large, the air begins to conduct and the phenomena is called lightning. On a typical day $4 \times 10^5 C$ of positive charge is spread over the surface of the earth and equal amount of negative charge is there on the cloud. Resistivity of the air is $\rho = 3 \times 10^{13} \Omega m$ and radius of the earth $= 6000 km$.

(a) Find the resistance of the air gap between the earth's surface and cloud.

(b) Estimate the potential difference between the surface of the earth and the cloud

(c) In how much time the capacitor formed between the earth and the cloud will lose 63 % of the charge ?

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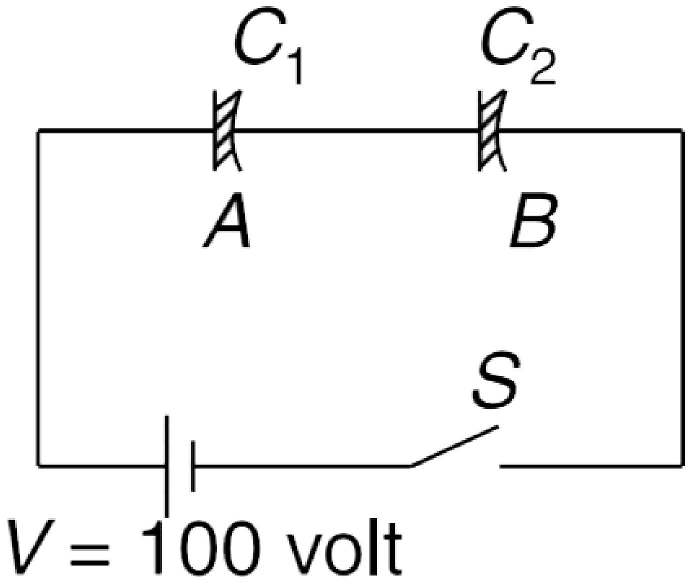
87. The capacitor A shown in fig. has a capacitance $C_1 = 3\mu F$. The dielectric filled in it has a breakdown voltage of $40V$ and it has a resistance of $3M\Omega$. The capacitor B has a capacitance of $C_2 = 2\mu F$ and dielectric in it has a resistance of $2M\Omega$. Breakdown voltage for B is $50V$. The switch is closed at $t = 0$. Will there be breakdown of any capacitor after the switch is closed ? If yes, which will breakdown first and at what time?



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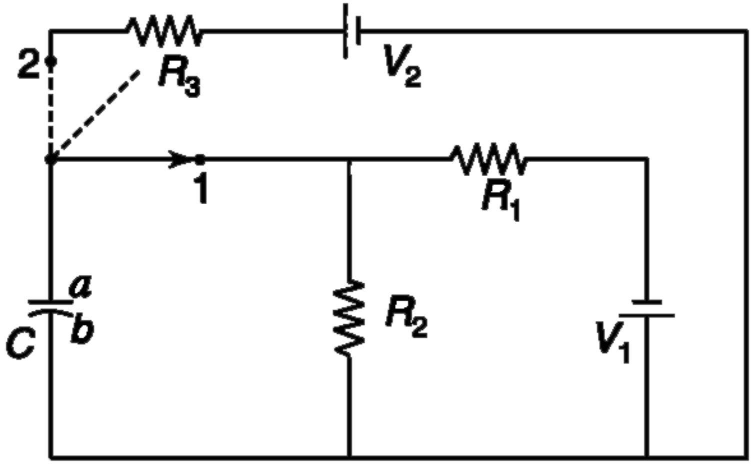
88. In the circuit shown in fig. the switch is kept closed in position 1 for a long time. At time $t = 0$ the switch is moved to position 2. Write the dependence of voltage (V_C) across the capacitor as a function of time (t). Take V_C to be positive when plate a is positive.

Given:

$R_1 = 20\Omega$, $R_2 = 60\Omega$, $R_3 = 400k\Omega$, $V_1 = 40V$, $V_2 = 90V$ and $C = 0.5\mu F$

.



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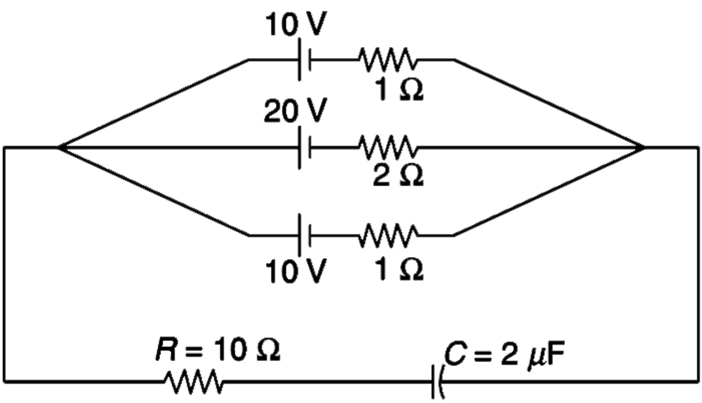
89. Find the charge on the capacitor in the circuit shown in fig.



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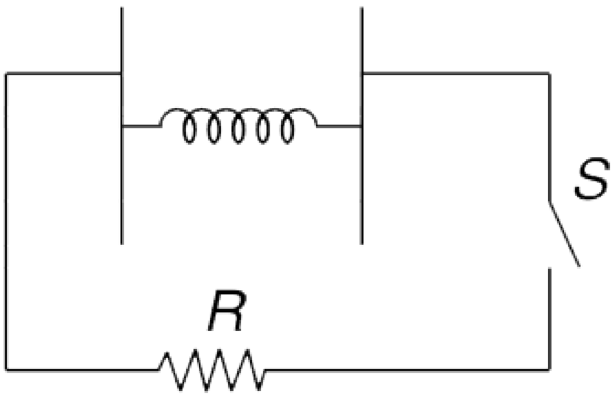
90. A parallel plate capacitor has its two plates connected to an ideal spring of force constant K. Relaxed length of spring is L and it is made of non conducting material. The area of each plate is A. The capacitor has a charge q_0 on it. To discharge the capacitor through the resistance R, switch S is closed.

If the time constant of the circuit is very large and discharge process is very slow, how much heat will be dissipated in the resistance? Assume that there is no friction and the plates always remains parallel to each other.



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91. In the last problem calculate the amount of heat dissipated in the resistance assuming that the time constant of the circuit is very small and the discharge process is almost instantaneous.

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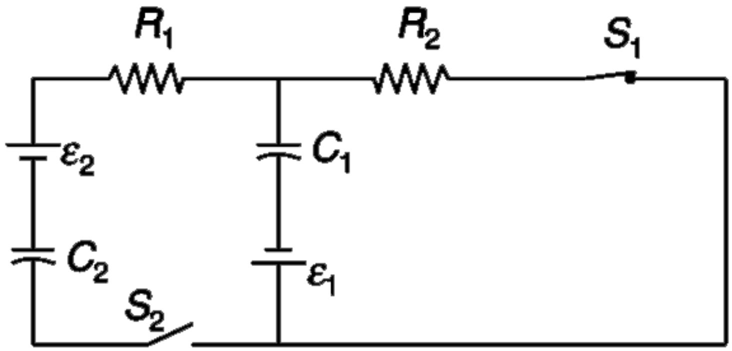
92. In the circuit shown in the figure $R_1 = R_2 = 5\Omega, C_1 = C_2 = 2\mu f$ and $\varepsilon_1 = \varepsilon_2 = 5V$. Switch S_1 is kept closed for a long time. Now switch S_2 is also closed. Immediately after S_1 is closed, find

(a) current through R_1

(b) current through R_2



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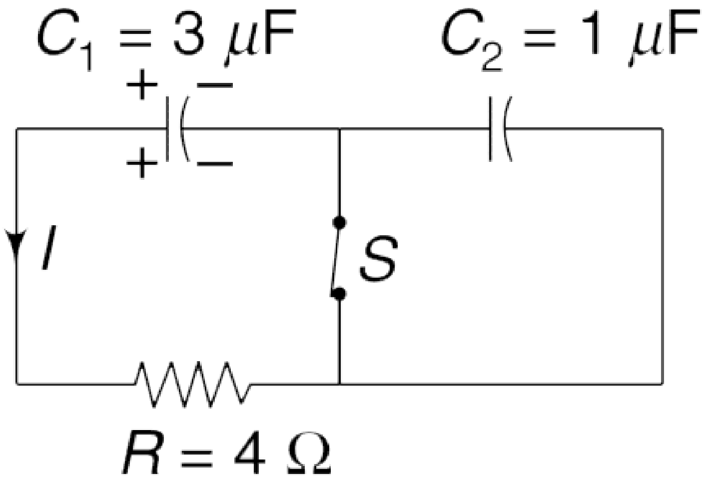
93. A charged capacitor $(C_1 = 3\mu F)$ is getting discharged in the circuit shown. When the current I was observed to be 2.5 A, switch 'S' was opened. Determine the amount of heat that will be liberated in the circuit after 'S' is opened.



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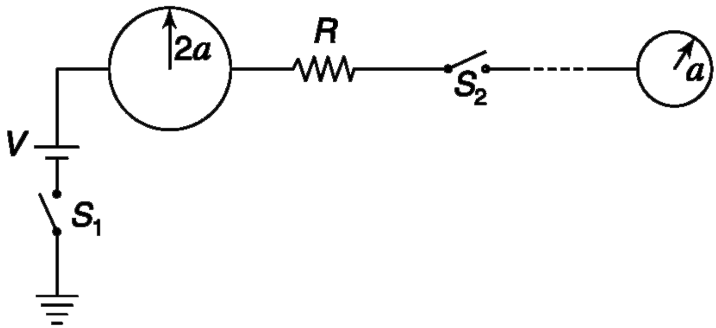
94. In the Fig. two neutral spherical conductors of radii $2a$ and a are separated by a large distance. Initially, switch S_1 is kept closed and S_2 is open. Now S_1 is opened and S_2 is closed at $t = 0$.

(a) Find the rate of fall in potential of the conductor of radius 2a as a function of time.

(b) find the heat dissipated after S_2 is closed.



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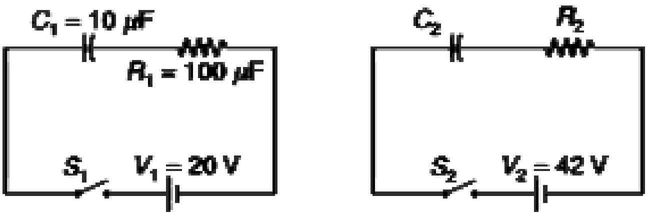
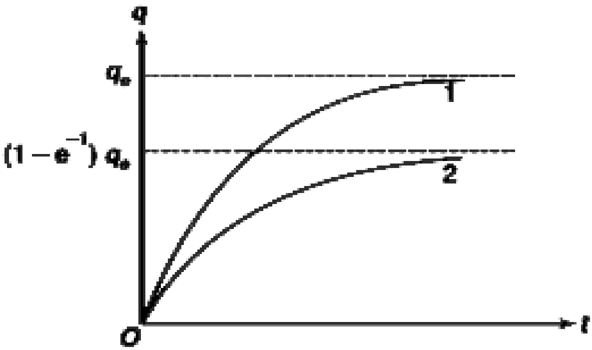
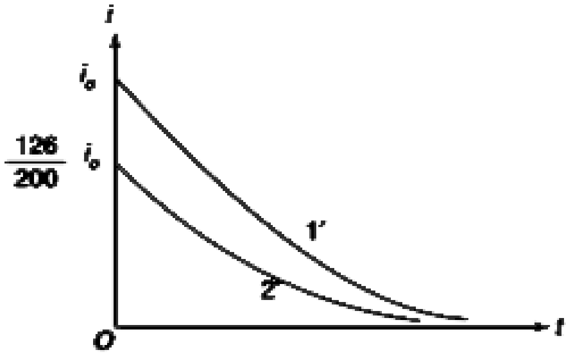
95. Consider two circuits given below. When switches S_1 and S_2 are closed at $t = 0$, the charge on capacitors C_1 and C_2 change with time as shown in graph 1 and 2 respectively. The current i_1 and i_2 in the two circuits change as shown in graph 1' & 2' respectively. Write the variation of current in the second circuit as function of time after the switch is closed at $t = 0$. $e^{-1} = 0.37$







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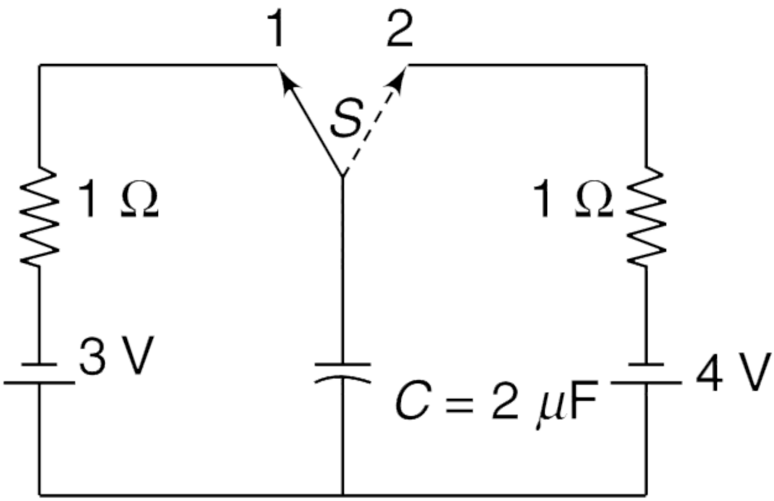
96. In the circuit shown in fig. the capacitor is initially uncharged. Two way switch (s) is placed in position 1 for a very short interval of time $(\Delta\ t)$ and then is moved to position 2. The switch is held in position 2 for equally short interval $\Delta\ t$ and is then moved back to position 1. The process is repeated a large number of times until the charge on the capacitor stops changing. find this final a value of charge on the capacitor. [Assume that in each contact the charge on the capacitor changes by a very small amount]



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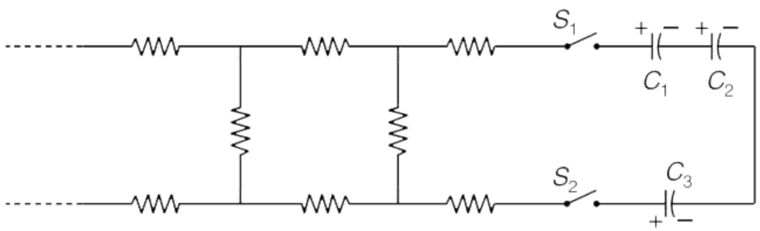
97. An infinite ladder network consisting of all equal resistances, $r = \frac{10}{2.732}\Omega$ is placed side by side to a capacitor system as shown in fig. Initially, all the switches are kept open and all the three capacitors are given equal charges of $30\mu C$each. The capacitances are $C_1 = 3\mu F, C_2 = 6\mu F$ and $C_3 = 6\mu F$. Polarity of charges on the capacitor plates is shown in the fig. Now all the three switches are closed simultaneously.

(a) find the magnitude of rate of change of charge on the plates of the capacitors immediately after the switches are closed.

(b) Calculate heat generated in the circuit by the time steady sate condition is established.



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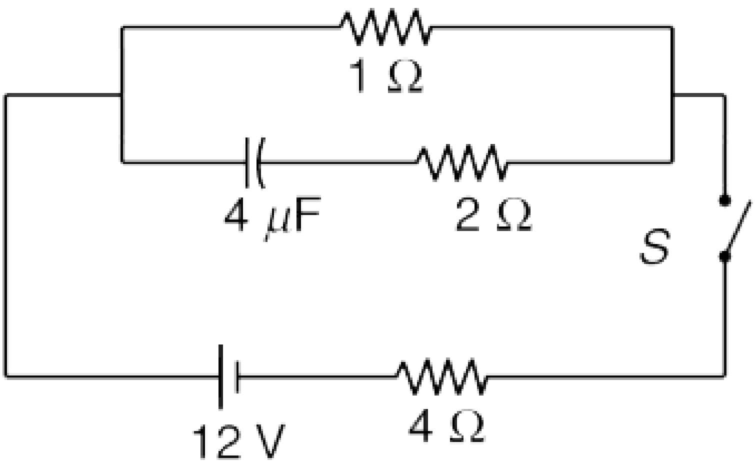
98. In the circuit shown in the figure, switch S is closed at time $t = 0$.

Charge on positive plate of capacitor is q at time t.

(a) Derive a differential equation for q at time t.

(b) Solve the equation to write q as a function of time.

(c) Put t = 0 and $t = \infty$ in your equation to get charge on the capacitor at these times.



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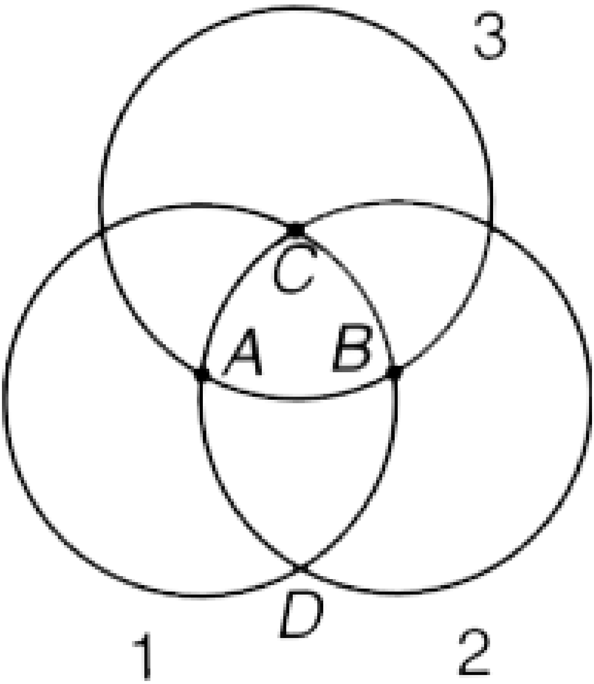
99. Three identical wire rings have been placed symmetrically as shown in the figure A, B and C are centres of the three rings. Resistance of each ring is 3R. find the equivalent resistance of this wire mesh across points C and D.



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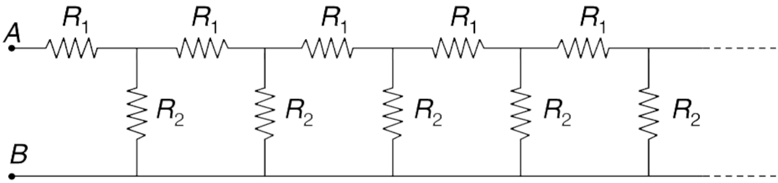
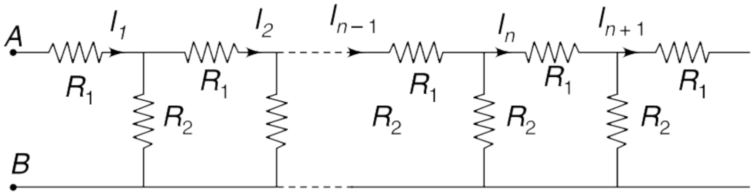
100. The fig shows a network consisting of an infinite number of pairs of resistors $R_1 = 2\Omega$ and $R_2 = 1\Omega$. Since the network is infinite, removing a pair of R_1 and R_2 from either end of the network will not make any difference. Using this calculate the equivalent (R) across points A and B.



(b) Prove that $I_n = \frac{I_{n-1}R_2}{R_2+R} = \frac{I_{n-1}}{\sqrt{3}+2}$ ltbr Where I_n and I_{n-1} represent the current through R_1 in n^{th} and $(n-1)^{th}$ segment respectively (see Fig)



(c) If a 20 V battery is connected across A and B find I_{10}

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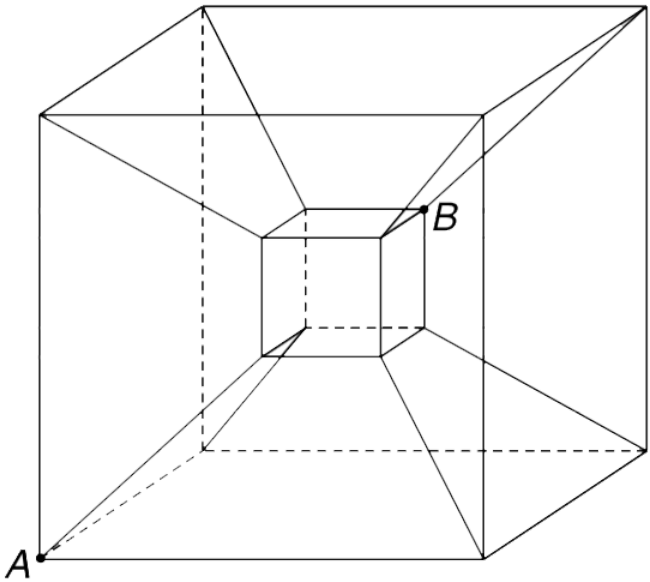
101. Consider the double cube resistor network shown in fig. Each side of both cubes has resistance R and each of the wires joining the vertices of the two cubes also have same resistance R. find the equivalent resistance between points A & B.



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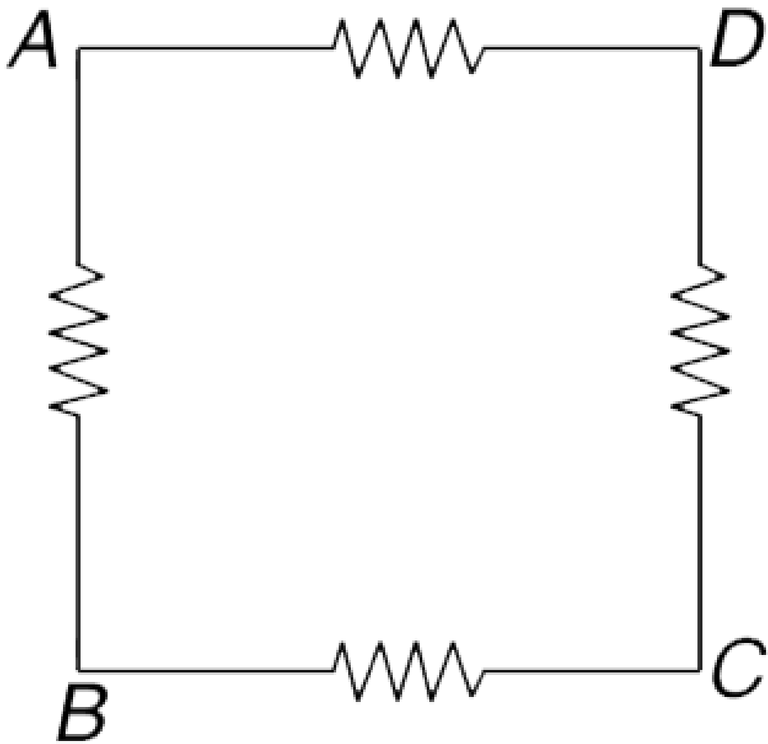
102. In the circuit shown in the figure, the power dissipated in the circuit is P_0 if an ideal cell is connected across A and B. Same power is dissipated in the circuit if the same cell is connected across C and D. When the cell was connected across A and D or across B and C, the power dissipated in the circuit is found to be $3P_0$.

Calculate the power dissipated in the circuit if the cell is connected across A and C.



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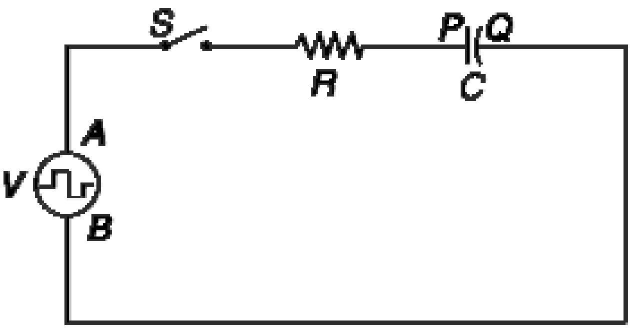
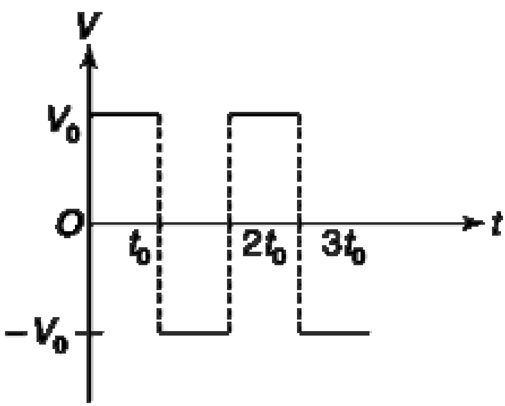
103. The voltage source shown in the fig. is a square wave source. Its polarity changes after every $t_0 = 50\tau$ second [$\tau = RC$ is time constant of the R – C circuit]. The magnitude of voltage across the source remains constant at V_0. When A is at higher potential compared to B the graph depicts the voltage as positive. Negative voltage means that terminal B is positive. Switch S is closed at t = 0.

(a) Taking charge on the capacitor to be positive when plate P is positive, plot the variation of charge on the capacitor as function of time (t).

(b) Write the magnitude of maximum current in the circuit.

(c) Plot the variation of current as function of time (t). Take clockwise current as positive.





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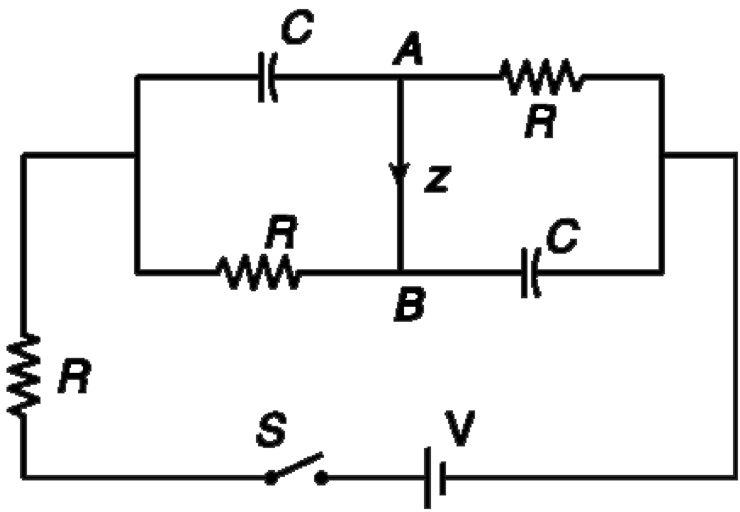
104. In the circuit shown in the fig, the switch 'S' is closed at time $t = 0$. The current in branch AB is represented by z and is taken to be positive when it is from A to B.

(a) Write the value of z immediately after the switch is closed.

(b) Write the value of z infinite time after the switch is closed.

(c) Write z as a function of time (t) and plot the variation of z with time.

(d) At what time t_0 the current z becomes zero ?



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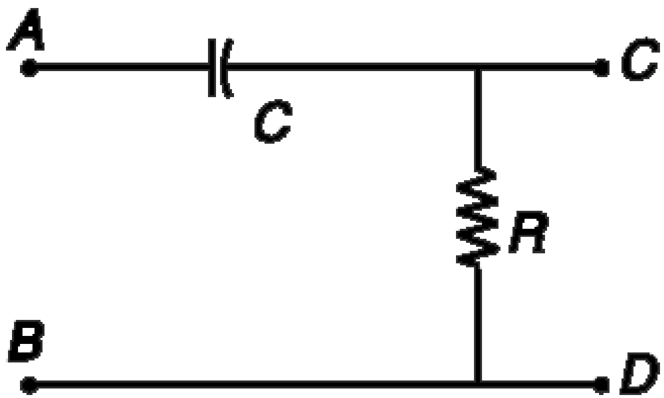
105. In the circuit shown in the figure, a voltage is applied between points A and B which changes with time as

$V_0 = kt$ for $0 \leq t \leq t_0$

$= kt_0$ for $t > t_0$

Plot the variation of potential difference (V) between C and D as a function of time



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