PHYSICS

BOOKS - HC VERMA

ELECTRIC CURRENT IN CONDUCTORS

Example

1. An electron beam has an aperture $1.0mm^2$. A total of 6.0×10^{16} electrons go through any perpendicular cross section per second. Find(a) the current and (b) the current density in the beam.

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2. Calculate the drift speed of the electrons when 1A of current exists in a copper wire of cross section 2 mm^2.The number of free electrons in $1cm^3$of copper is 8.5×10^{22}.

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3. Calculate the resistance of an aluminium wire of length 50 cm and cross sectional area $2.0mm^2$. The resistivity of aluminium is $(\rho) = 2.6 \times 10^{-8}(\Omega)m$.

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4. A resistor develops 400J of thermal energy in 10 s when a current of 2A is pased through it. (a) Find its resistance . (b) If the current is increased to 4 A, what will be the energy developed in 10 s.

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5. A battery of emf 2.0 V and internal resistance $0.50(\Omega)$ supplies a current of 100 mA. Find (a) the potential defference across the terminals of the battary and (b) the thermal energy develop in the battery in 10 s.

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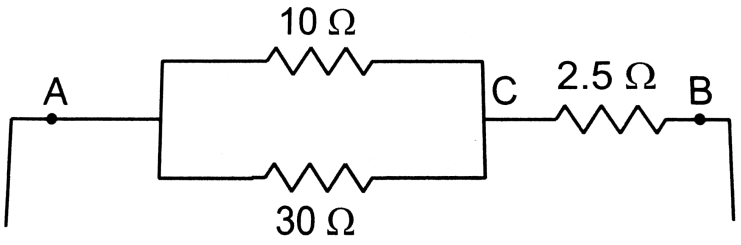
6. Find the equivalent resistance of the network shown in figure between the point A and B.



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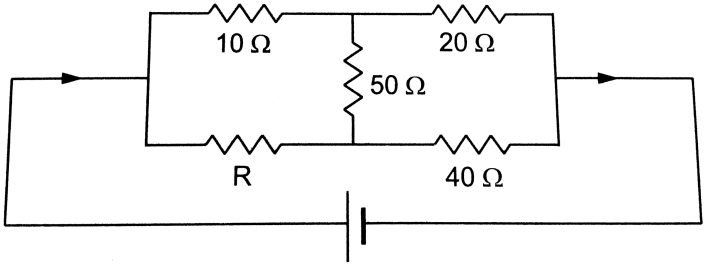
7. Find the value of R in figure so that there is no current in the 50(Omega) resistor.



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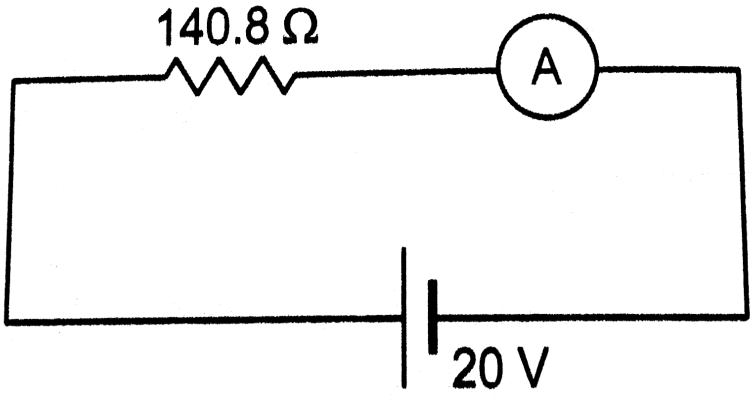
8. The ammeter shown in figure consists of a$480(\omega)$coil connected in parallel to a$20(\omega)$ shunt. Find the reading of the ammeter.



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9. A capacitor of capacitance $100(\mu)F$ is charged by connecting it to a battery of emf 12 V and internal

resistance $2(\Omega)$. (a) Find the time constant of the circuit. (b) Find the time taken before 99% of maximum charge is stored on the capacitor.

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10. The plates of a $50\mu F$ capacitor charged to $400\mu C$ are connected through a resistance of $1.0kohm$. Find the charge remaining on the capacitor 1s after the connection is made.

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Worked Out Example

1. An electorn moves in a circle of radius 10cm with a constant speed of $4.0 \times 10^6 ms^{-1}$.Find the electric current at a point on the circle.

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2. A current 4.0 A exist in a wire of cross-sectional area $2.0mm^2$. If each cubic metre of the wire contains 12.0×10^{28} free electrons, then the drift spped is

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3. Find the resistance of a copper coil of total wire-length 10m and area of cross section $1.0mm^2$. What would be the

resistance of a similar coil of aluminium? The resistivity of copper $= 1.7 \times 10^{-8}(\Omega)m$ and that of aluminium $2.6 \times 10^{-8}(\Omega)$.

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4. A parallel-plate capacitor has plates of area $10cm^2$ separated by a distance of 1mm. It is filled with the dielectric mica and connected to a battery of emf 6 volts. Find the leakage current through the capacitor. Resistivity of mica $= 1 \times 10^{13}(\Omega)m$.

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5. Find the resistance of a hollow cylindrical conductor of length 1.0m and inner and outer radii 1.0mm and 2.0mm respectively. The resistivity of the material is $2.0 \times 10^{-8}(\Omega)m$.

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6. A battery of emf 2V and internal resistance $0.5(\Omega)$is connected across a resistance 9.5(Ω). Find the current flow through battery ?

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7. A battery of emf 2.0 volts and internal resistance $0.10(\Omega)$ is being charged with a current of 5.0A. What is the potential difference between the terminals of the battery?

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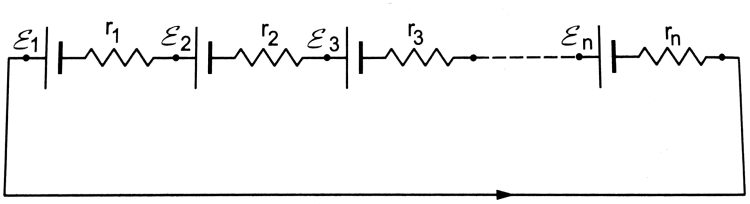
8. Shown n batteries connected to form a circuit. The resistances denote the internal resistances of the batteries which are related to the emf as $r_i = k(\varepsilon)_i$where K is a constant. The solid dots represent the terminals of the batteries. Find (a)the current through the circuit and (b) the potential difference between the terminals of the ith

battery.



A. 1/k, 0

B. k, 0

C. k^2, 1

D. 2/k, 0

Answer: A

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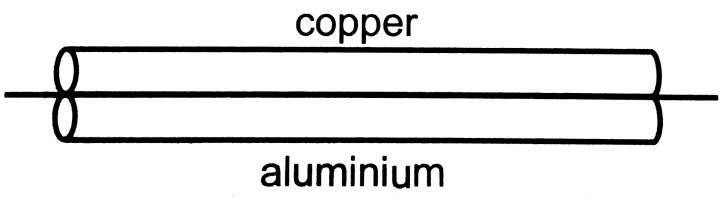
9. A copper rod of length 20cm and cross-sectional area $2mm^2$is joined with a similar aluminium rod as shown in

figure .Find the resistance of the combination between the ends, Resistivity of copper $= 1.7 \times 10^{-8}(\Omega)m$and that of aluminium $= 2.6 \times 10^{-8}(\Omega)m$.



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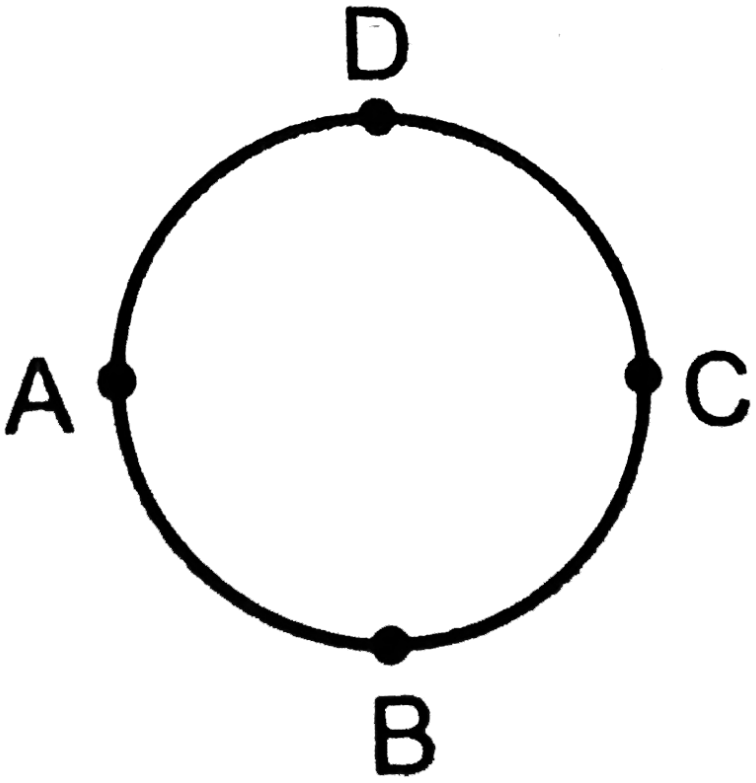
10. A wire of resistance 10Ω is bent to form a complete circle. Find its resistance between two diametrically

opposite points.



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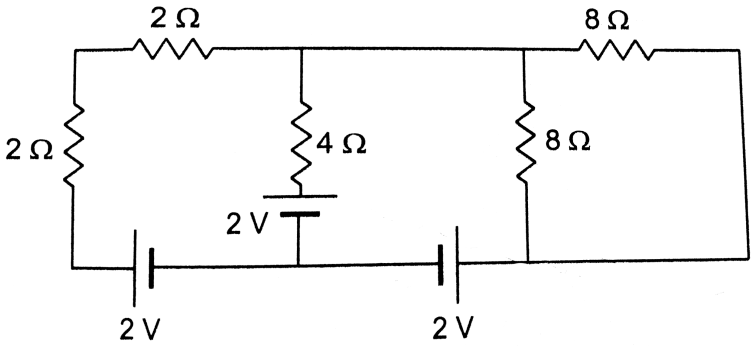
11. find the currents in the different resistor shown in figure.



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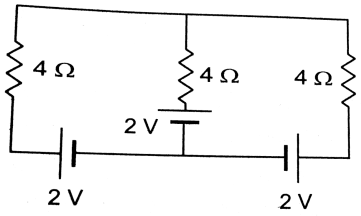
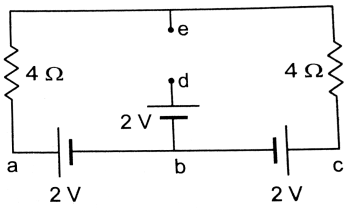
12. Find the current supplied by the battery in the circuit shown in figure.





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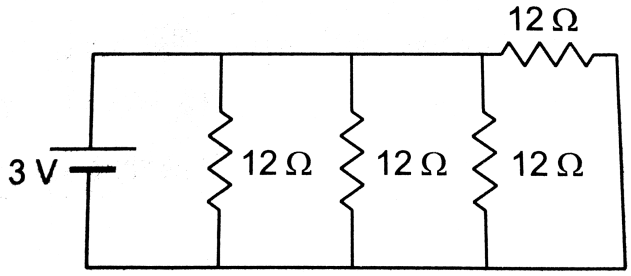
13. Find the current supplied by the battery in the circuit shown in figure.



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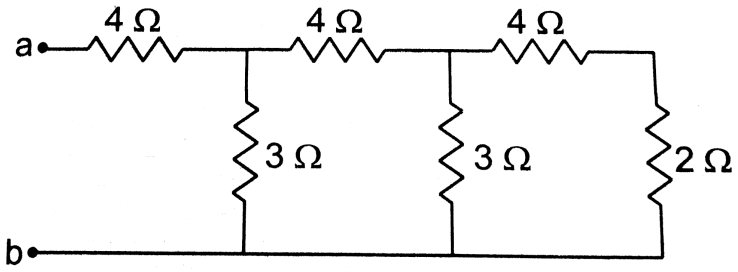
14. Find the effective resistance between the points A and B in figure.



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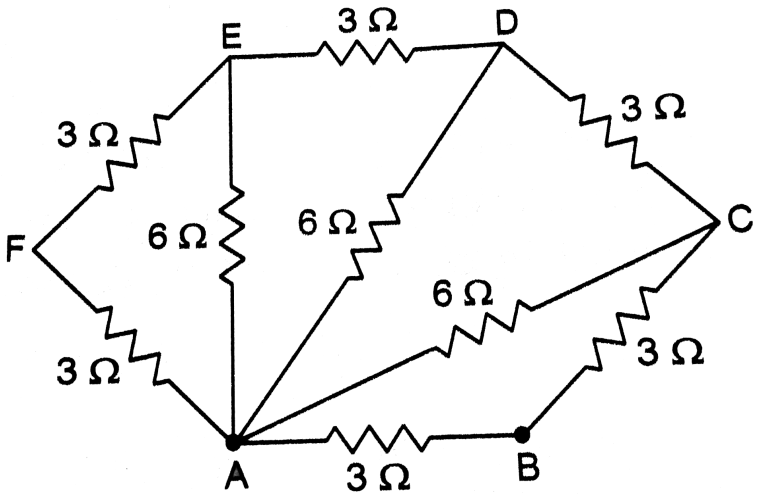
15. Find the equivalent resistance of the network shown in figure between the points A and B .



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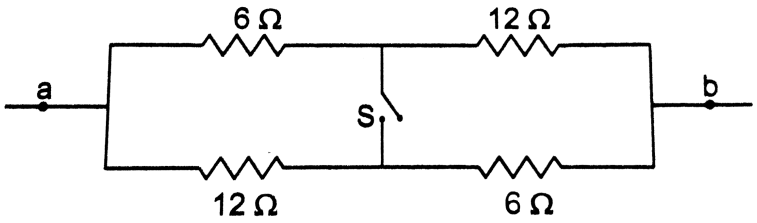
16. Find the equivalent resistance between the point a and b when (a) the switch S is open and (b) the switch S is

closed .



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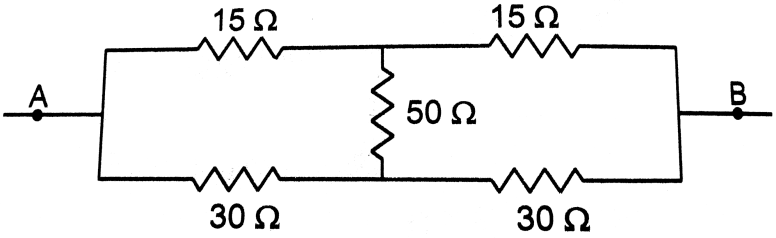
17. Find the equivalent resistances of the nerwork shown in figure between the points A and B.



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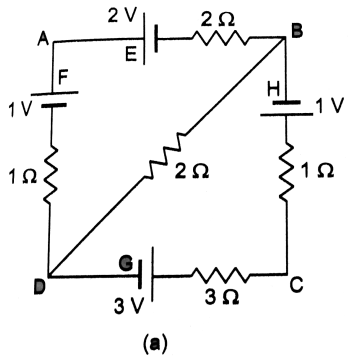
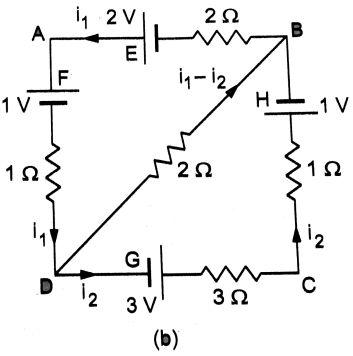
18. In the circuit shown in figure E,F, G and H are cell of emf 2,1,3, and $1V$ respectively. The resistances 2,1,3 and 1(Omega)are their respective internal resistance .Calculate (a)the potential difference between B and D and (b) the potential differences across the terminals of each of each of the cells G and H.



(a)



(b)

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19. Find the equivalent resistance between the point a and b of the circuit shown in figure

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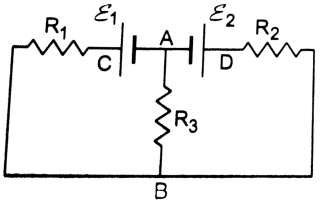
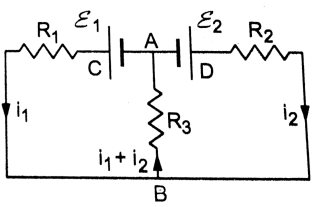
20. Find the currents going through the three resistors R_1, R_2 and R_3 in the circuit of figure.



(a)



(b)

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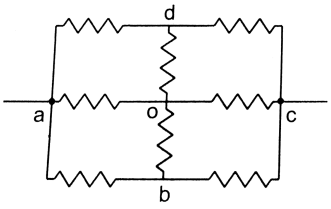
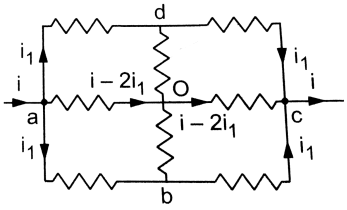
21. Find the equivalent resistances between the points a and c of the network shown in figure. Each resistance is equal to r.



(a)



(b)

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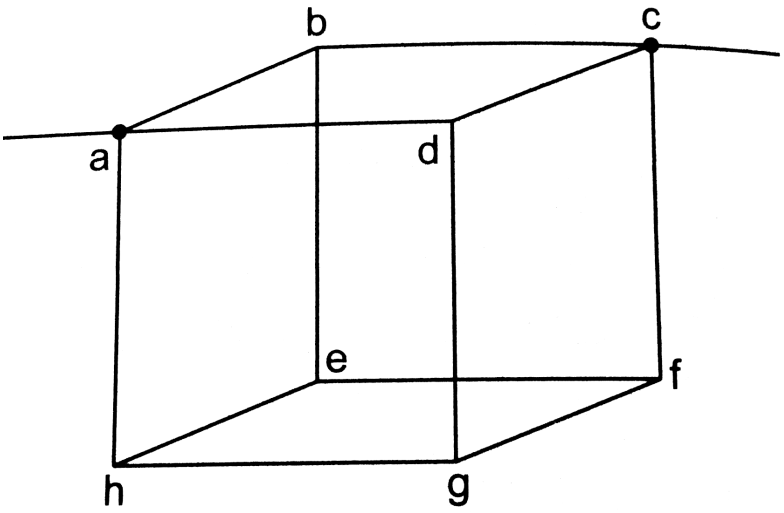
22. Twelve wire, each having resistance r, are joined to form a cube as shown in figure.Find the equivalent resistance

between the end of a face diagonal such as a and c.



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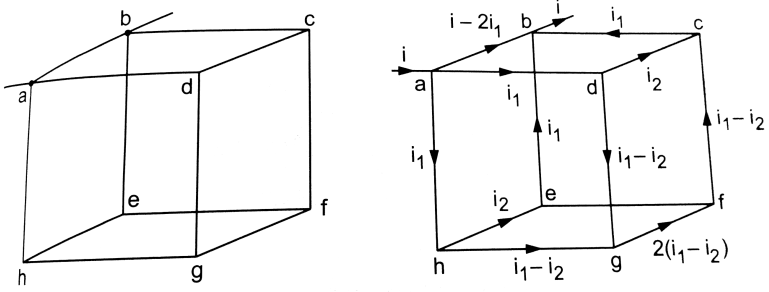
23. Find the equivalent resistance of the circuit of the previous problen between the ends of an edge such as a

and b in figure.



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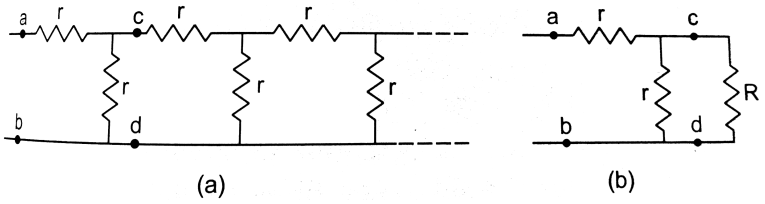
24. Find the equivalent resistance between thepoints a and b of the infinite ladder shown in figure.



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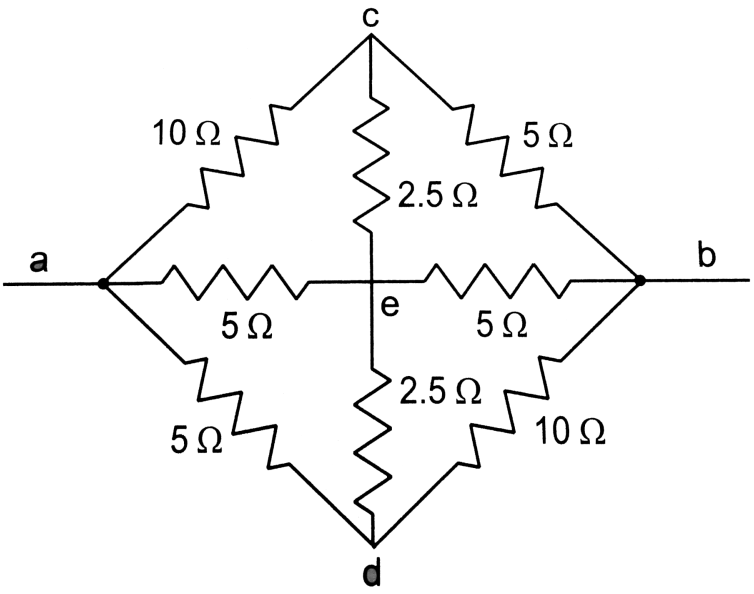
25. Find the equivalent resistance of the network shown in figure between the points a and b.



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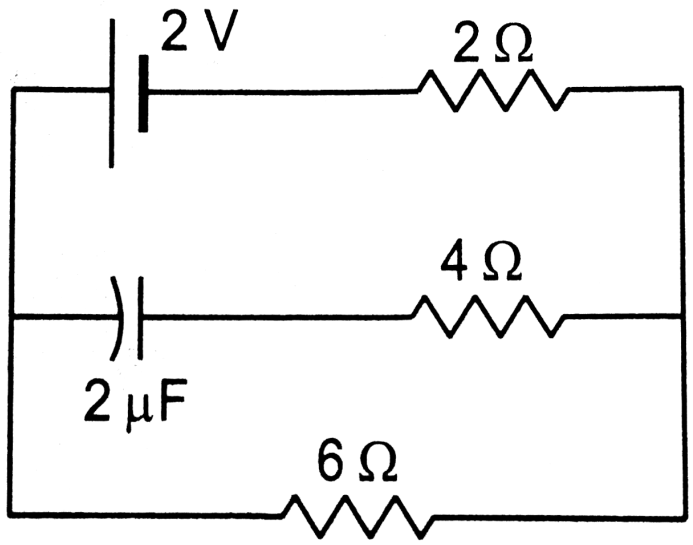
26. (a)Find the current I supplied by the battery in the network shown in figure in steady state. (b)find the charge

on the capacitor.



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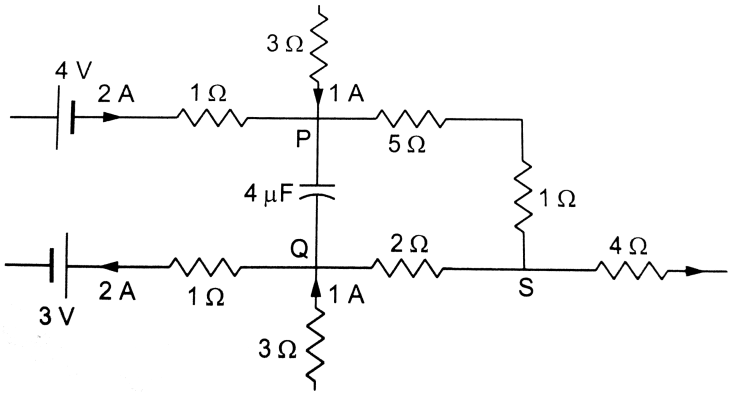
27. A part of a circuit in steady state along with the currents flowing in the branches,the values of resistances,etc, is shown in figure.Calculate the energy

stored in the capacitor.



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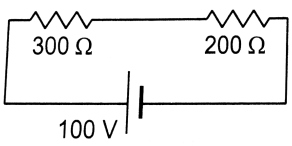
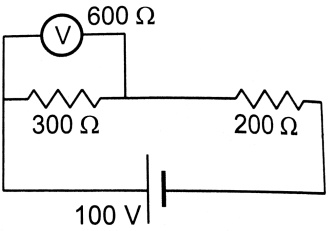
28. (a)find the potential drops across the two resistors shown in figure (a). (b) A voltmeter of resistance $(600\Omega)$is used to measure the potential drop across the (300Ω)

resistor.What will be the measured potential drop?



(a)



(b)

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29. A galvanometer has a coil of resistance $100(\Omega)$showing a full-scale deflection at 50(mu)A. What resistance should be added to use it as (a) a voltmeter of range 50 V (b) an ammeter of range 10 mA?

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30. The electric field between the plates of a parallel-plate capacitor of capacitance$2.0(\mu)F$ drops to one third of its initial value in $(4.4\mu)s$ when the plates are connected by a thin wire. Find the resistance of the wire.

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31. A capacitor is connected to a 12 V battery through a resistance of (10Ω).It is found that the potential difference across the capacitor rises to 4.0 V in 1(mu)s. find the capacitance of the capacitor.

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32. A capacitor charged to $50V$ is discharged by connecting the two plates at $t = 0$.If the potential difference across the plates drops to 1.0 V at t=10 ms,what will be the potential difference at t=20 ms?

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33. A $5.0(\mu)F$ capacitor having a charge of $(20(\mu)C)$is discharged through a wire aof resistance (5.0Ω). Find the heat dissipated in the wire between 25 to `50 (mu)s after the connections are made.

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Questions For Short Answer

1. Suppose you have three resistor each of value (30Ω).List all the different resistances you can obtian using them.

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2. A proton beam is going from east to west. Is there an electric current ? If yes, in what direction?

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3. In an electolyte, the positive ions move form left to right and the negative ions from right to left.Is there a net current? If yes, in what direction?

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4. In a TV tube, the electrons are accelerated from the rear to the front. What is the direction of the current?

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5. The drift speed is defined as $v_d = (\Delta l / \Delta t)$where $(\Delta l) is the dis \tan ce dr$ if $ted \in along time$(Delta t). $Why don't we def \in eth edr$ if $t speed as the \lim it of$ (Delta l//Delta t)`as (Delta t (rarr)0)?

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6. One of your friends argues that he has read in previous chapters that there can be no electric field inside a conductor. And hence there can be no current through it.What is the fallacy in this argument?

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7. When a current is established in a wire, the free electrons drift in the direction opposite to the current, Does the number of free electrons in the wire continuously decrease?

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8. A fan with copper winding in its motor consumes less power as compared to an otherwise similar fan having aluminium winding.Explain.

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9. The thermal energy developed in a current-carrying resistor is given by $U = I^2Rt$ and also by $U = VIt$. should we say that U is proportional to I^2or to I ?

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10. Consider a Circuit Containing an Ideal Battery Connected to a Resistor. Do "work done by the battery" and

"the thermal energy developed" represents two names of the same physical quantity?

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11. Is work done by a battery always equal to the thermal energy develop in electrical circuits? What happens if a capacitor is connected in the circuit?

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12. A non ideal battery is connected to a resistor. Is work done by the battery equal to the thermal energy developed in the resistor? Does your answer change If the battery is ideal?

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13. Sometimes it is said that "heat is developed" in a resistance when there is an electric eurrent in it .Recall that heat is defined as the energy being transferred due to the temperature difference, Is the statement under quotes technically correct?

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14. we often say "a current is going through the wire " What goes through the wire,the charge or the current ?

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15. Would you prefer a vlotmeter over a potentiomer to measure the emf of a battery?

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16. Does a conductor become charged when a current is passed through it?

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17. Can the potential difference across a battery be greater than its emf?

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Objective 1

1. A metallic resistor is connected across a battery.If the number of collisions if the free electrons with the lattice is somehow decreased in the resistor (for example,by cooling it),the current will

A. (a)increase

B. (b)decrease

C. (c) remain constant

D. (d) become zero

Answer: A

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2. Two resistors A and B have resistances R_A and R_B respectively with $R_A < R_B$.the resistivities of their materials are (ρ_A) and (ρ_B).

A. (a)$(\rho_A) > (\rho_B)$

B. (b)$(\rho_A) = (\rho_B)$

C. (c) $(\rho_A) < (\rho_B)$

D. (d) the information is not sufficient to find the relation between (ρ_A) and (ρ_B)

Answer: D

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3. The product of resistivity and conductivity of a cylindrical conductor depends on

A. (a) temperature

B. (b) meterial

C. (c) area of cross cestion

D. (d) none of these

Answer: D

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4. As the temperature of a metallic resistor is increased,the product of its resistivity and conductivity

A. (a)increase

B. (b)decrease

C. (c) remains constant

D. (d) may increase or decrease.

Answer: C

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5. In an electric circuit containing a battery,the charge (assumed positive)inside the battery.

A. (a) always goes from the positive terminal to the negative terminal

B. (b)may go form the positive terminal to the negative terminal

C. (c)always goes form the negative terminal to the positive terminal

D. (d)does not move

Answer: B

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6. A resistor of resistance R is connected to an ideal battery. If the value of R is decreased,the power dissipated in the resistor will

A. (a) increase

B. (b) decrease

C. (c)remain unchanged.

D. (d) none of these

Answer: A

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7. A current passes through a resistor.Let K_1 and K_2 represent the average kinetic energy of the conduction electrons and the metal ions respectively.

A. (a)$K_1 < K_2$

B. (b)$K_1 = K_2$

C. (c)$K_1 > K_2$

D. (d) any of these three may occur.

Answer: C

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8. Two resistors R and 2R are connected in series in an electric circuit. The thermal energy developed in R and 2R are in the ratio

A. (a)1:2

B. (b)2:1

C. (c)1:4

D. (d)4:1

Answer: A

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9. Two resistances R and 2R are connected in parallel in an electric circuit. The thermal energy developed in R and 2R are in the ratio

A. (a)1:2

B. (b)2:1

C. (c)1:4

D. (d)4:1

Answer: B

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10. A uniform wire of resistance $(50\Omega)$is cut into 5 equal parts. These parts are now connected in parallel.the Equivalent resistance of the combination is

A. (a)2Ω

B. (b)10Ω

C. (c)250Ω

D. (d) 6250Ω

Answer: A

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11. Consider the following two statements:

(A)Kirchhoff's junction law follows from conservation of charge.

(B)Kirchhoff's loop law follows from conservative nature of electric field .

A. (a)Both A and B are correct

B. (b)A is correct but B is worng

C. (c)B is correct but A is worng

D. (d) Both A and B are wrong

Answer: A

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12. the nonideal batteries are connected in series. Consider the following statements :

(A)The equivalent emf is larger than either of the two emfs.

(B) the equivalent internal resistances is smaller than either of the two internal resistances.

A. (Each of A and B is correct.

B. (b)A is correct but B is worng

C. (c)B is correct but A is worng

D. (d)each of A and B are worng

Answer: B

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13. Two nonideal batteries are connected in parallel. Consider the following statements:

(A)The equivalent emf is smaller than either of the two emfs.

(B) The equivalent internal resistance is smaller than either of the two internal resistances.

A. (a)Both A and B are correct

B. (b)A is correct but B is worng

C. (c)B is correct but A is worng

D. (d)Both A and B are worng

Answer: C

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14. The net resistance of an ammeter should be small to ensure that

A. (a)it does not get overheated

B. (b)it does not draw excessive current

C. (c)it can measure large currents

D. (d)it does not apperciably change the current to be measured.

Answer: D

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15. The net resistance of a volmeter should be large to ensure that

A. (a)it does not get overheated

B. (b)it does not draw excessive current

C. (c)it can measure large potential defferences

D. (d)it does not apperciably change the potential difference to be measured.

Answer: D

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16. Consider a capacitor-charging circuit.Let Q_1 be the charge given to the capacitor in a time interval of 10ms and Q_2 be the charge given in the next time interval of 10ms. Let $1o(\mu)C$charge be deposited in a time interval t_1 and the next $(10\mu C)char \geq isdeposited \in the \neq xttime \int ervalt\_(2)`.$

A. (a)$Q_1 > Q_2, t_1 > t_2.$

B. (b)$Q_1 > Q_2, t_1 < t_2.$

C. (c)$Q_1 < Q_2, t_1 > t_2.$

D. (d)$Q_1 < Q_2, t_1 < t_2.$

Answer: B

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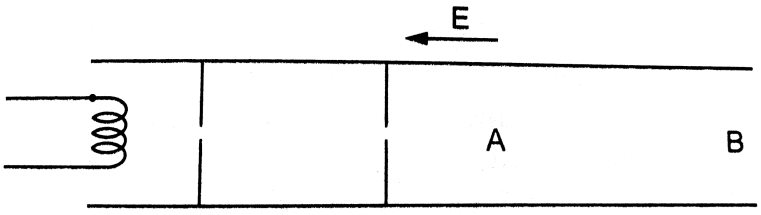
Objective 2

1. Electrons are emitted by a hot filament and are accelerated by an electric field as shown in figure .The two stops at the left ensure that the electron beam has a uniform cross-section.



A. (a)The speed of the electron is more at B than at A.

B. (b)The electric current is from left to right.

C. (c)The magnitude of the current is larger at B than at A .

D. (d)The current density is more at B than at A.

Answer: A

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2. A capacitor with no dielectric is connected to a battery at t=0.Consider a point A in the connecting wires and a point B in between the plates. What about the current at A and B ?

A. (a)There is no current through A.

B. (b)There is no current through B.

C. (c)There is a current through A as long as the charging is not complete.

D. (d)There is a current through B as long as the charging is not complete.

Answer: B::C

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3. When current is passed through the conductor, the compass needle deflects. Why?

A. (a)the free electrons do not move

B. (b)the average speed of a free electron over a large period of time is zero

C. (c)the average velocity of a free electron over a large period of time is zero

D. (d)The average of the velocities of all the free electrons at an instant is zero.

Answer: C::D

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4. Which of the following quantities do not change when a resistor connected to a battery is heated due to the current?

A. (a)Drift speed

B. (b)Resistivity

C. (c)Resistance

D. (d)Number of free electrons

Answer: D

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5. As the temperature of a conductor increases,its resistivity and conductivity change.the ratio of resistivity to conductivity

A. (a)increase

B. (b)decrease

C. (c)remain constant

D. (d)may increase or decrease depending on the actual temperature.

Answer: A

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6. A current passes through a wire of nonuniform cross-section. Which of the following quantites are independent of the cross section?

A. (a)The charge crossing in a given time interval

B. (b)Drift speed

C. (c)Current density

D. (d)Free-electron density

Answer: A::D

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7. Mark out the correct options

A. (a)An ammeter should have small resistance

B. (b)An ammeter should have large resistance.

C. (c)A voltmeter should have small resistance

D. (d)A voltmeter should have large resistance

Answer: A::D

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8. A capacitor of capacitance $500(\mu)F$is connected to a battery through a $(10k(\Omega))$ resistor.The charge stored on the capacitance $2(\mu)F$ are separately charged by a common battery for a long time. The two capacitors are then separately discharged through equal resistors.Both the discharge circuits are connected at t=0.

A. (a)The current in each of the two dischaging circuits is zero at t=0.

B. (b)the current in the two discharging circuits at t=0 are equal but not zero.

C. (c)the current in the two discharging circuits at t=0 are unequal.

D. (d) C_1 loses 50% if its initial charge sooner than C_2 loses 50% of its initial charge .

Answer: A::B::C::D

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9. A capacitor C_1 of capacitance $1\mu F$ and a capacitor C_2 of capacitance $2\mu F$ are separately charged by a common battery for a long time. The two capacitors are then separately discharged through equal resistors. Both the discharge circuits are connected at $t = 0$.

A. The current in each of the two discharging circuits is zero at $t = 0$

B. The currents in the two discharging circuits at $t = 0$ are equal but not zero

C. The currents in the two discharging circuits at $t = 0$ are unequal.

D. C_1 loses 50% of its initial charge sooner than C_2 loses 50% of its initial charge.

Answer: B::D

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Exercises

1. The amount of charge passed in time t through a cross-section of a wire is

$Q(t) = At^2 + Bt + C.$

(a)Write the dimensional formulae for A,B and C.

(b) If the numerical values of A,B,and C are 5,3 and 1 respectively in SI units,find the value of the current at t=5 s.

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2. An electric gun emits 2.0×10^{16} electrons per second. What electric current does this correspond to ?

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3. The electric current existing in a discharge tube is $2.0(\mu)A$. How much charge is tarnsferred across a cross-section of the tube in 5 minutes ?

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4. The current through a wire depends on time as

$I = i_0 + \alpha t,$

where $i_0 = 10A$ and $\alpha = 4As^{-1}$.Find the charge crossed through a section of the wire in 10 second

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5. A current of 1.0 A exists in a copper wore of cross-section $1.0mm^2$. Assuming one free electron per atom calculate the drift speed of the free electrons in the wire. The density of copper is $9000kgm^{-3}$.

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6. A wire of length 1 m and radius 0.1mm has a resistance of $100(\Omega)$.Find the resistivity of the material .

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7. A uniform wire resistance $100(\Omega)$is melted and recast in a wire of length double that of the original . What would

be the resistance of the wire?

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8. Consider a wire of length 4m and cross-sectional areal $1mm^2$ carrying of 2A. If each cubic metre of the material contains 10^{29}free electrons, find the average time taken by an electron to cross the length of the wire.

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9. What length of a copper wire of cross-sectional area $0.01mm^2$ will be needed to prepare a resistance of $1k\Omega$? Resistivity of copper $= 1.7 \times 10^{-8}\Omega m$.

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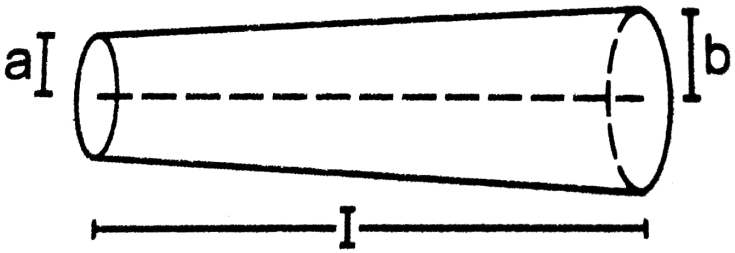
10. Shown a conductor of length l having a circular cross section. The radius of cross section varies linearly form $a \to b$. The resistivity of the material is(ρ).Assuming that $b - a < \ < l$,find the resistance of the conductor.



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11. A copper wire of radius 0.1mm and resistance $1k(\Omega)$is connected across a power supply of 20 V.(a)How many

electrons are transferred per second between the supply and the wire at one end?(b) Write down the current density in the wire.

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12. Calculate the electric field in a copper wire of cross-sectional area$2.0mm^2$ carrying a current of 1A .The resistivity of copper $= 1.7 \times 10^{-8}(\Omega)m.$

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13. A wire has a length of 2.0m and a resistance of $5.0(\Omega)$ .Find the electric field existing inside the wire if it carries a current of 10A.

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14. The resistances of an iron wire and a copper wire at $20^\circ C$ are $3.9(\Omega)$ and $4.1(\Omega)$ respectively. At what temperature will the resistances be equal?Temperature coefficient of resistivity for iron is $5.0 \times 10^{-3} K^{-1}$ and for copper it is $4.0 \times 10^{-3} k^{-1}$. Neglect any thermal expansion.

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15. The current in a conductor and the potential difference across its ends are measured by an ammeter and a voltmeter.The meters draw negligible current.The ammeter

is accurate but the vlotmeter has a zero error(that is ,it does not read zero when no potential difference is applied).Calculate the zero error if the readings for two different conditions are 1.75A, 14.4Vand 2.75a, 22.4V.

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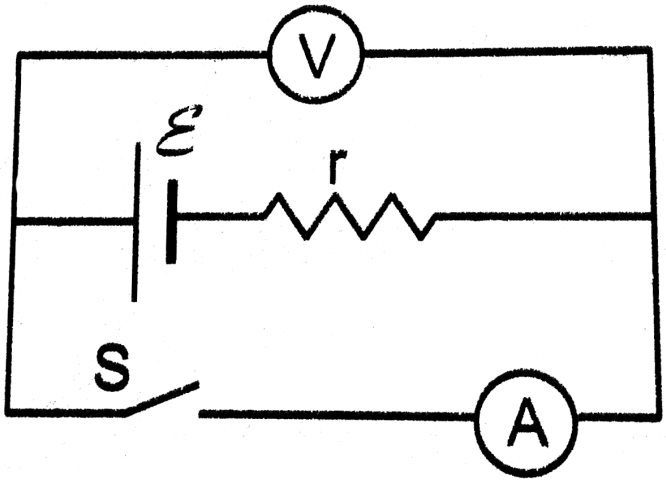
16. Shown an arrangement to measure the emf $(\varepsilon)$and internal resistance r of a battery. The voltmeter has a very high resistance and the ammeter also has some resistance.The voltmeter reads 1.52 V when the switch S is open.When the switch is closed the voltmeter reading drops to 1.45 V and the ammeter read 1.0A Find the emf

and the internal resistance of the battery.



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17. The potential difference between the terminals of a battery of emf 6.0V and internal resistance$1(\Omega)$drops to 5.8 V when connected across an external resistor. Find the resistance of the external resistor.

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18. The potential difference between the terminals of a 6.0V battery is 7.2 V when it is being charged by a current of 2.0A.What is the internal resistance of the battery?

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19. The internal resistance of an accumulator battery of emf 6V is $10(\Omega)$when it is fully discharged,As the battery gets charged up.its internal resistance decreases to $1(\Omega)$ The battery in its completely discharged state is connected to a charger which maintains a constant potential difference of 9 V.Find the current through the battery (a)just after the connections are made and (b) after a long time when it is completely charged.

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20. Find the value of $\frac{i_1}{I_2}$ in figure if where $R = 10\Omega$

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21. Consider $N = n_1 n_2$ indentical cells, each of emf(ε) and internal resistance r. Suppose n_1 cells are joined in series to forn a line and n_(2) such are connected in parallel. The combination drives a current in an external resistance R.(a) find the current in the external resistance, (b) Assuming that n_1 and n_(2) can be continuously varied, find the relation between `n_(1) ,n_(2) R and r for which the current in R in maximum.

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22. A battery of emf 100V and a resistor of resistance $10k(\Omega)$ are joined in series. This system is used as a source to supply current to an external resistance R. If R is not greater than $100(\Omega)$, the current through it is constant up to two significant digits. Find its value, This is the basic principle of a constant-current source.

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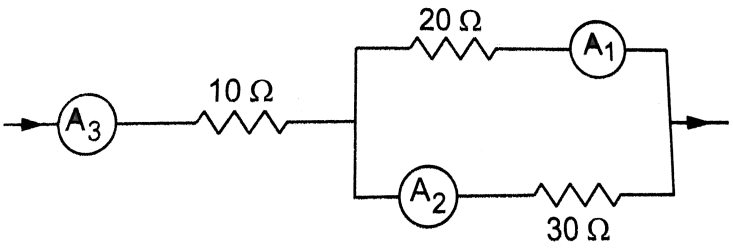
23. If the reading of ammeter A_1 in figure is 2.4 A, what will the ammeter A_2 and A_3 read? Neglect the resistances of

the ammeter.



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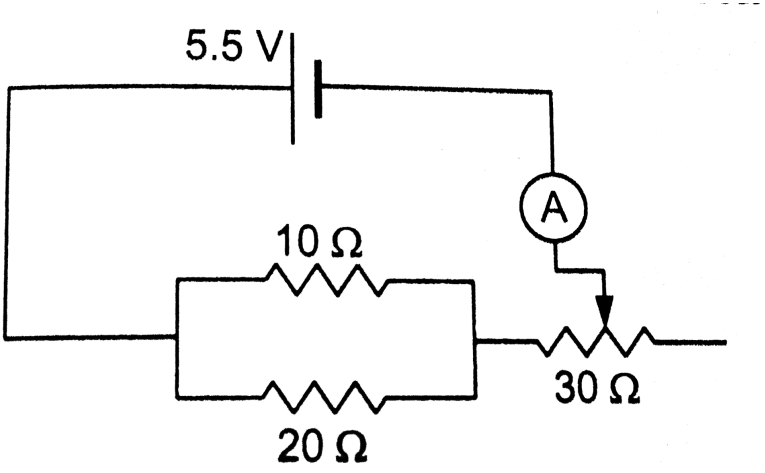
24. The resistance of the rheostat shown in figure is $30(\Omega)$. Neglecting the meter resistance,find the minimum and maximum currents through the ammeter as the rheostat is

varied.



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25. Three bulbs,each having a resistance of $180(\Omega)$are connected in parallel to an ideal battery of emf60V. Find the current delivered by the battery when (a)all the bulbs are switched on,(b)two of the bulbs are switched on and (c)only one bulb is switched on.

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26. Suppose you have three resistor of $(20\Omega), (50\Omega)$ and (100Ω).what minimum and maximum resistances can you obtain from these resistors?

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27. A bulb is made using two filaments.A switch selects whether the filaments are used individually or in parallel. When used with a 15V battery, the bulb can be operated at 5W ,10W and 15W. What should be the resistances of the filaments ?

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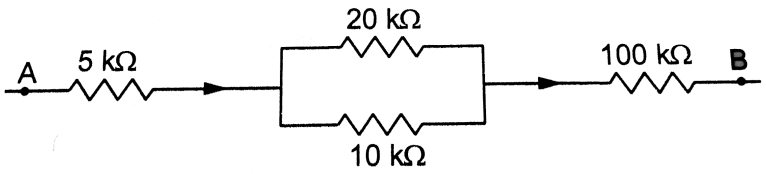
28. 100A exists in the $5k(\Omega)$ resistor, find the currents in the other three resistors .what is the potential difference between the points A and B?



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29. An ideal battery sends a current of 5A in a resistor. When another resistor of value 10Ω is connected in parallel ,the current through the battery is increased to 6A.Find the resistance of the first resistor.

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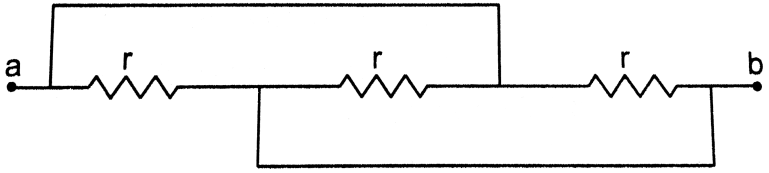
30. Find the equivalent resistances of the network shown in figurebetween the points a and b.



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31. A wire of resistance $15.0(\Omega)$is bent to form a regular hexagon ABCDEFA.Find the equivalent resistance of the loop between the points (a)A and B, (b)A and C and (c)A and D .

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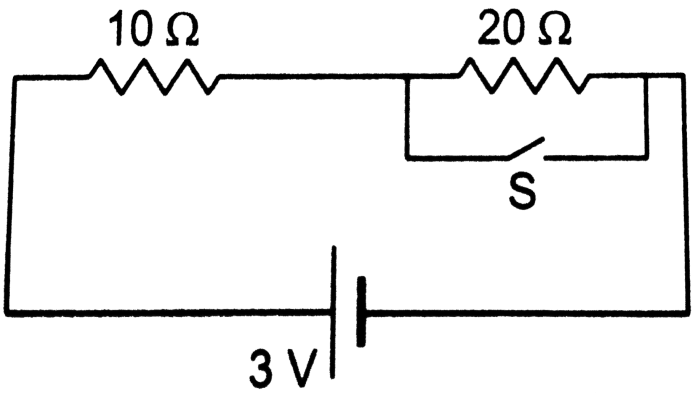
32. Consider the circuit shown in figure.Find the current through the$10(\Omega)$resistor when the switch S is (a)open (b)closed .



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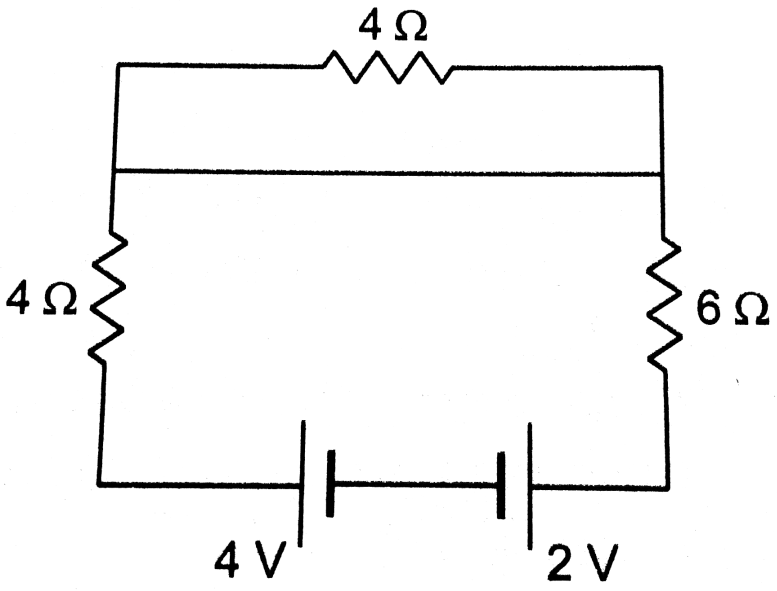
33. Find the currents through the three resistors shown in Figure



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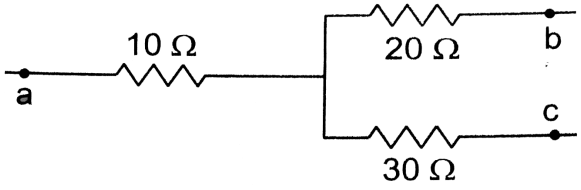
34. Shown a part of an electric circuit, The potentials at the points a,b,and c are 30V,12V,and 2V respectively.Find the currents through the three resistors.



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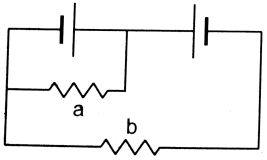
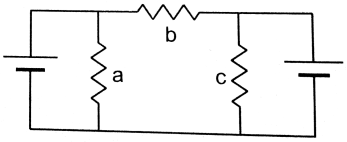
35. Each of the resistors shown in figure has a resistances of $10(\Omega)$and each of the batteries has an emf of 10V.Find the currents through the resistors a and b in the two circuits.



(a)



(b)

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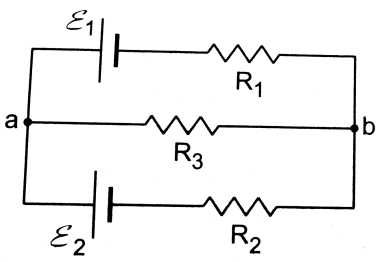
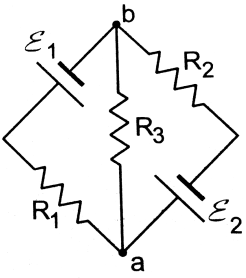
36. Find the potential difference $V_a - V_b$in the circutis shown in figure





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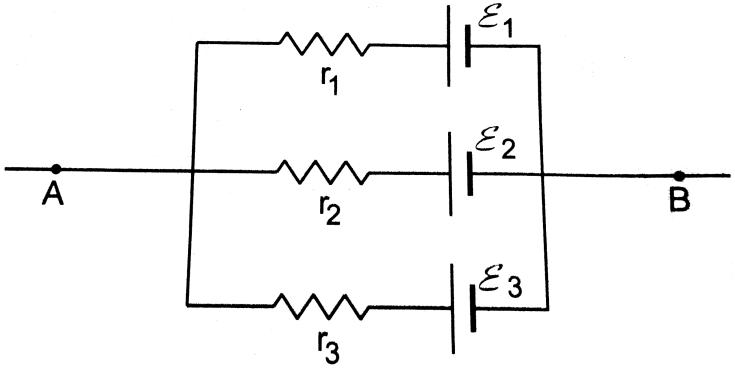
37. In the circuit shown in figure , $(\varepsilon)_1 = 3V, (\varepsilon)_2 = 2V, (\varepsilon)_3 = 1V$ and $r_1 = r_2 = r_3 = 1(\Omega)$ .Find the potential difference between the points A and B and the current through each branch.



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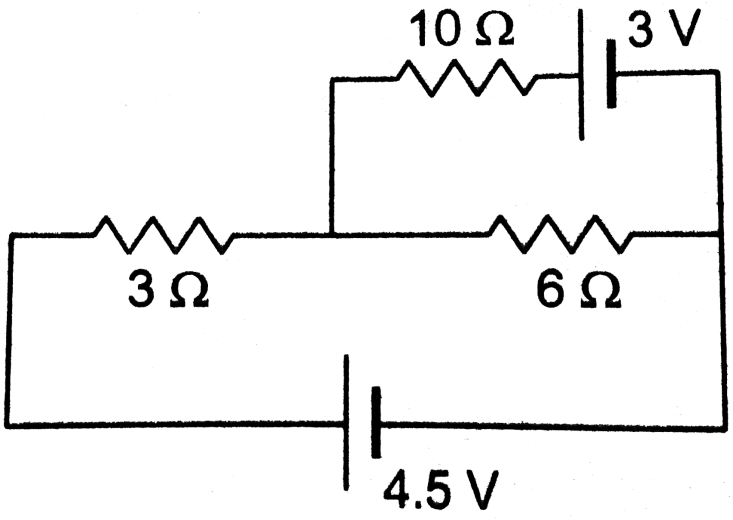
38. Find the current through the $10(\Omega)$resistor shown in figure.



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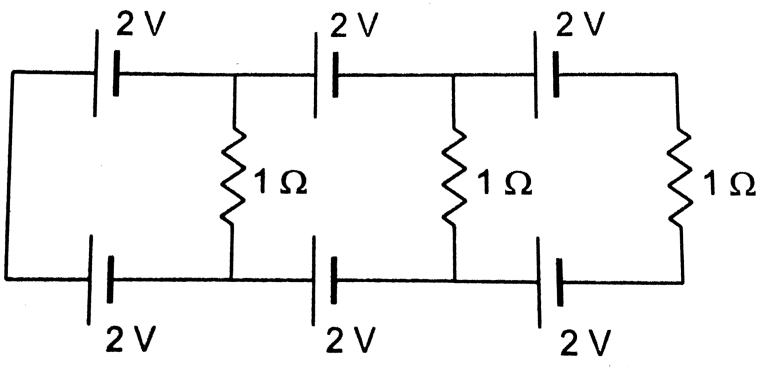
39. Find the current in the resistor shown in figure.



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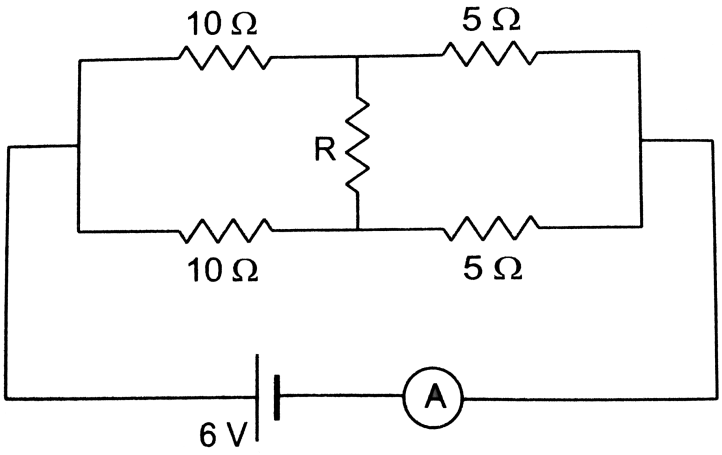
40. What should be the value of R in figure of which the current in it is zero?



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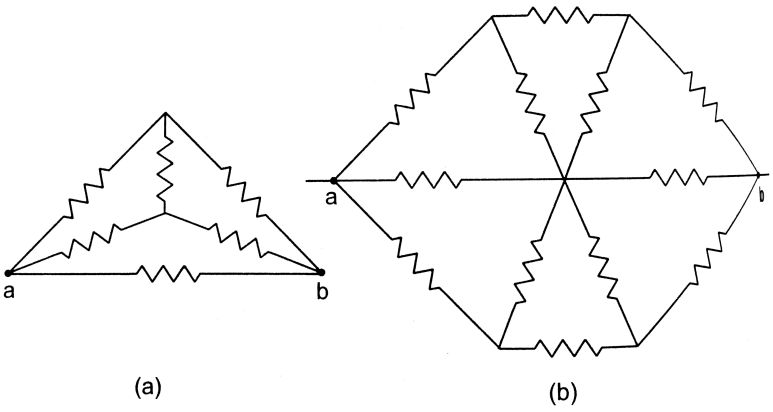
41. Find the equivalent resistance of the circuit shown in figure between the points a and b.Each resistor has a

resistances r.



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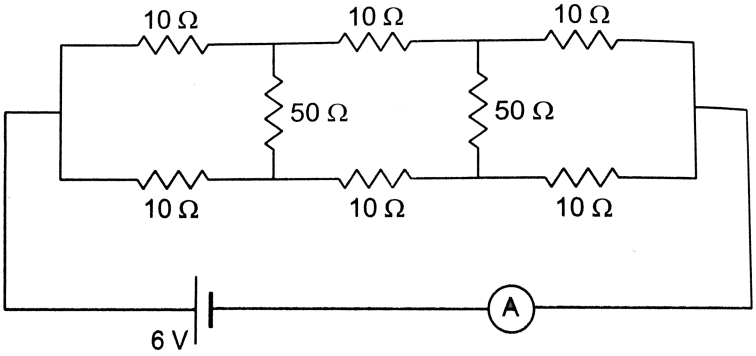
42. Find the current measured by the ammeter in the circuit shown in figure



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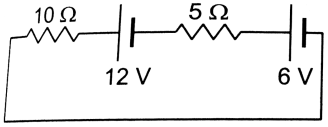
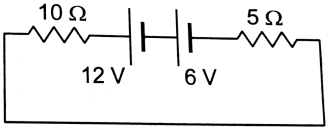
43. Consider the circuit shown in figure.Find (a) the current in the circuit, (b) the potential drop across the (5Ω) resistor,(c)the potential drop across the $10(\Omega)$resistor. (d)Answer the parts (a),(b)and (c)with reference to figure.



(a)



(b)

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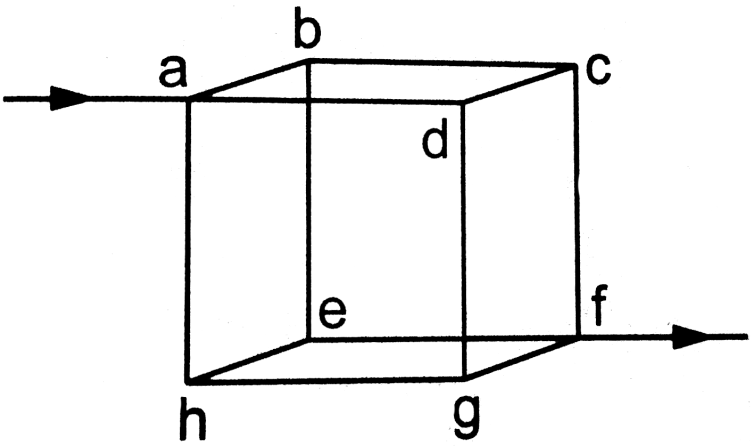
44. Twelve wire, each having equal resistance r, are joined to form a cube as shown in figure.Find the equivalent

resistance between the diagonally opposite points a and f.



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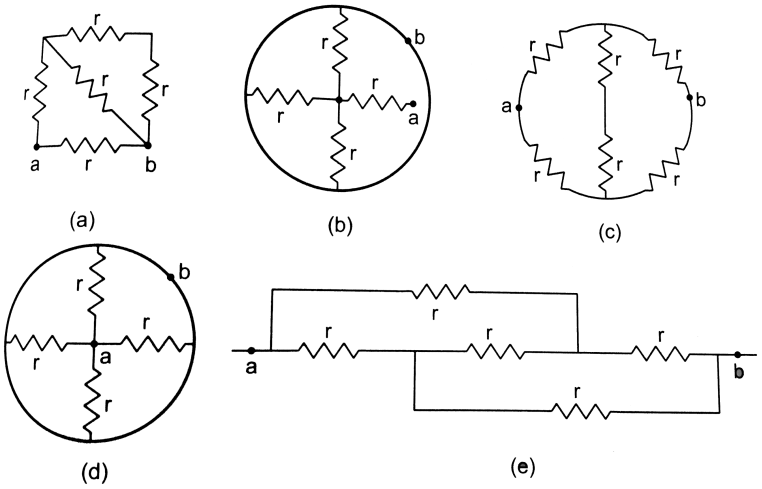
45. Find the equivalent resistances of the network shown in figure between the point a and b.



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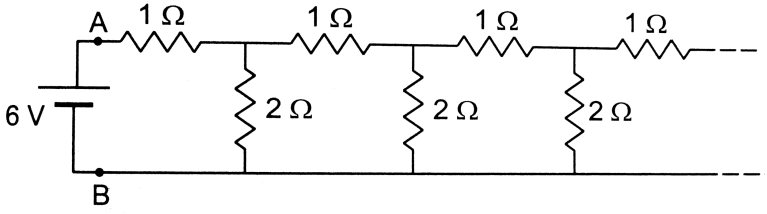
46. An infinite ladder is constructed with $1(\Omega)$and $2(\Omega)$ resistor as shown in figure.(a)Find the effective resistance between the point A and B. (b) Find the current that passes through the (2Ω) resistor nearest to the battery.



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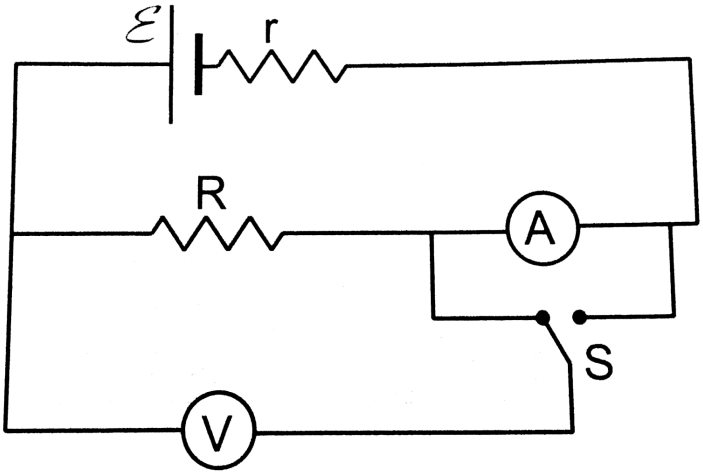
47. The emf $(\varepsilon)$and the internal resistance r of the battery shown in figure are 4.3V and $1.0Ohm$ respectively.The external resistance R is $50ohm$.The resistances of the ammeter and voltmeter are $2.0ohm$ and 200ohm respectively.(a)Find the reading of the two meters.



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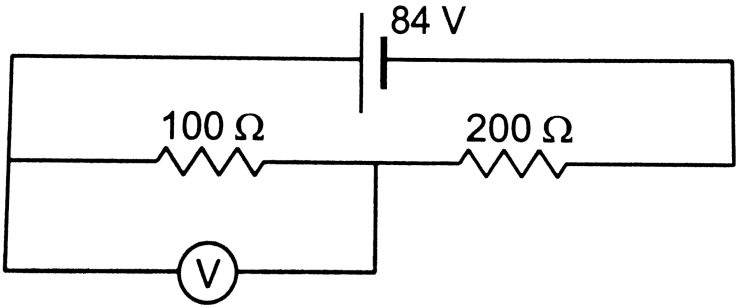
48. A voltmeter of resistances $400(\Omega)$is used to measure the potential difference across the $100(\Omega)$resistor in the circuit shown in figure.(a) What will be the reading of the voltmeter ?(b) What was the potential difference across $100(\Omega)$before the voltmeter was connected ?



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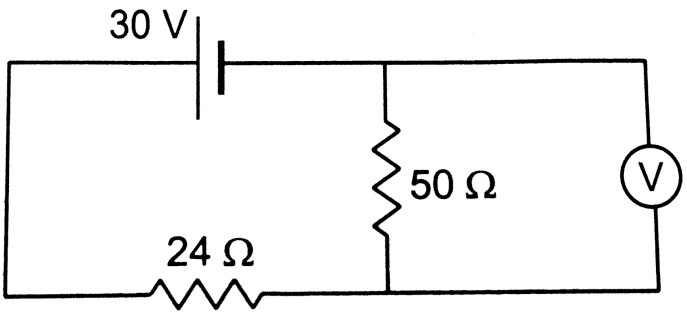
49. The voltmeter shown in figure reads 18V across the $50(\Omega)$resistor. Find the resistance of the voltmeter.



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50. A voltmeter consists of a $25(\Omega)$ coil connected in series with a $575(\Omega)$resistor. The coil takes 10mA for full scale deflection.What maximum potential difference can be measured on this voltmeter?

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51. An ammeter is to be constructed which can read currents up to 2.0A. If the coil has a resistance of $25(\Omega)$and takes 1mA for full-scale deflection, what should be the resistance of the shunt used?

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52. A voltmeter coil has resistance $50.0(\Omega)$and a resistor of $1.15k(\Omega)$is connected in series.It can read potential differences upto 12 volts.If this same coil is used to construct an ammeter which can measure currents up to 2.0A ,What should be the resistance of the shunt used ?

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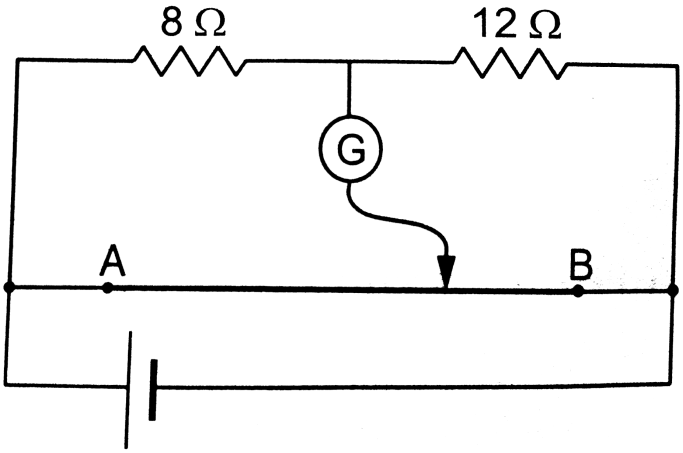
53. The potentiometer wire AB shown in figure is 40 cm long. Where should the free end of the galvanometer be connected on AB so that the galvanometer may show zero deflection?



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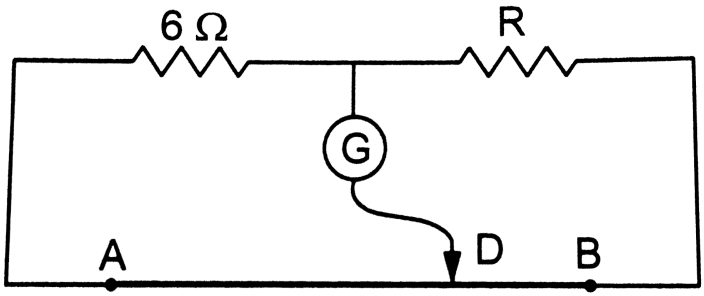
54. The potentiometer wire AB shown in figure is 50cm long.When AD=30cm, no deflection occurs in the

galvanmeter.Find R.



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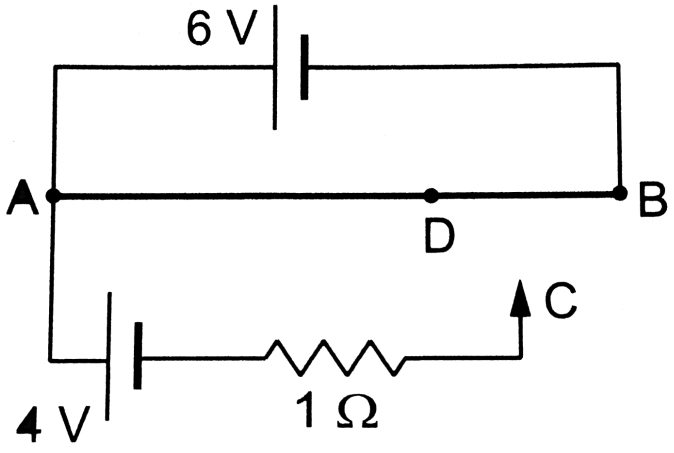
55. A 6-volt battery of negligible internal resistance is connected across a uniform wire AB of length 100cm. The positive terminal of another battery of emf 4V and internal resistance $1(\Omega)$is joined to the point A as shown in figure.Take the potential at B to be zero. (a) What are the potentials at the poits A and C ? (b) At which point D of the wire AB, the potential is equal to the potential at C?(c) If

the point C and D are connected by a wire, what will be the current through it ? (d) If the 4V battery is replaced by 7.5V battery,wht would be the answer of parts (a) and (b) ?



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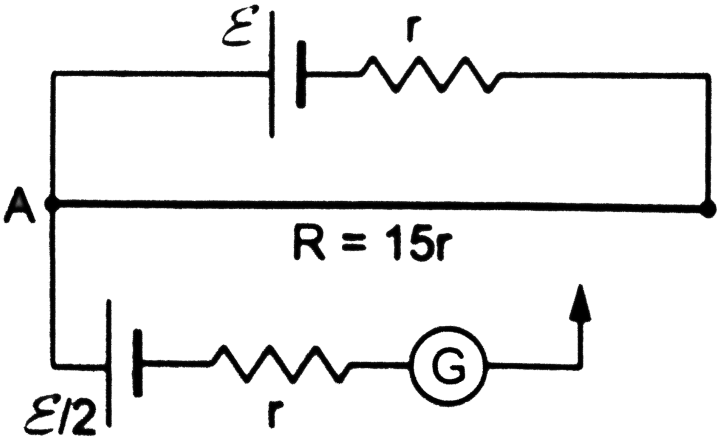
56. Consider the potentiometer circuit arranged as in figure. The potentiometer wire is 600cm long. At what distance from the point A should the jockey touch the wire

to get zero deflection in the galvanometer? b) If the jockey touches the wire at a distance of 560cm from A, What will be the current in the galvanometer?



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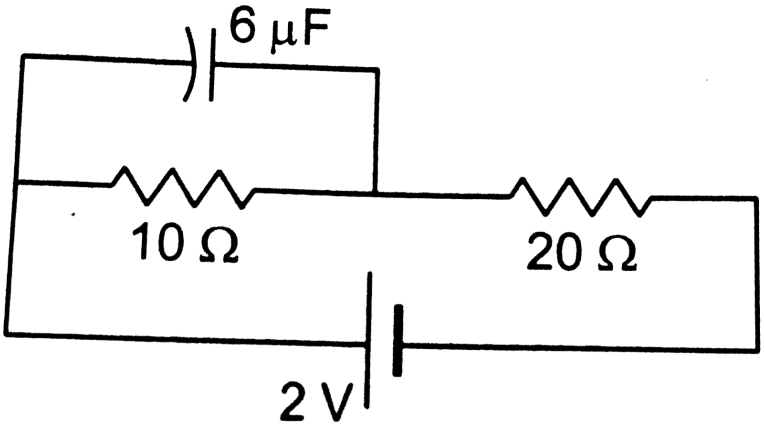
57. Find the charge on the capacitor shown in figure



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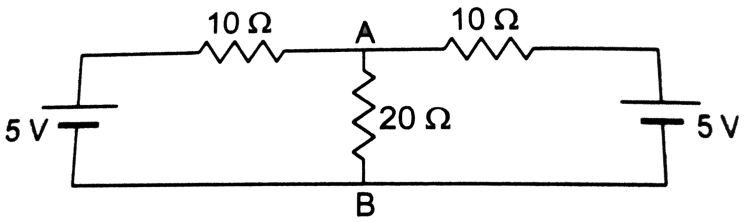
58. (a) Find the current in the $20(\Omega)$resistor shown in figure.(b)If a capacitor of capacitance `4(mu)F is joined between the point A and B,what would be the electrostatic

energy stored in it in steady state?



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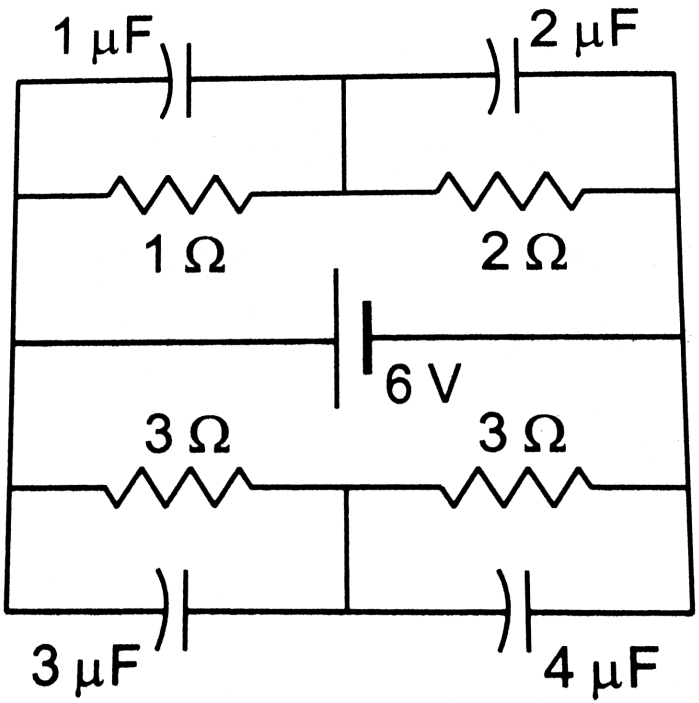
59. Find the charge on the four capacirtors of capacitances

`1(mu)F,2(mu)F,3(mu)F,and 4(mu)F, shown in figure.



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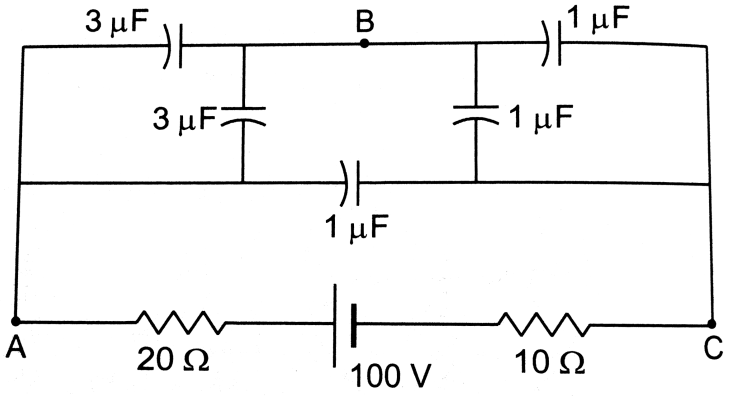
60. find the potential difference between th point A and B and between the point B and C of figure in steady state.



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61. A capacitance C, a resistance R and an emf $(\varepsilon)$are connected in series at t=0.What is the maximum value of (a) the potential difference across the resistor, (b) the current in the circuit,(c)the potential difference across the capacitor, (d) the energy stored in the capacitor ,(e)the power delivered by the battery and (f) the power converted int heat.

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62. A parallel-plate capacitor with plate are $20cm^2$ and plate separation 1.0mm is connected to a battery .The resistance of the circuit is $10k(\Omega)$.Find the time constant of the circuit.

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63. A capacitor of capacitance $10(\mu)F$ is connected to a battery of emf 2V.It is found that it takes 50 ms for the charge on the capacitor to bacome $12.6(\mu)C$. find the resistance of the circuit.

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64. A $20(\mu)F$capacitor is joined to a battery of emf 6.0V through a resistance of $100(\Omega)$.find the charge on the capacitor 2.0ms after the connections are made .

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65. The plates of a capacitor of capacitance $10(\mu)F$,charged to $60(\mu)C$,are joined together by a wire of resistance $10(\Omega)$at t=0.Find the charge on the capacitor in the circuit at (a)t=0,(b)t=30(mu)s,(c)t=120(mu)s and (d)t=1.0ms.

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66. A capacitor of capacitance $8.0(\mu)F$ is connected to a bettery of emf 6.0V through a resistance of $24(\Omega)$.Find the current in the circuit (a)just after the connections are made and (b)one time constant after the connections are made.

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67. A parallel-plate capacitor of plate area $40cm^2$ and separation between the plates $0.10mm$ is connected to a battery of $emf 2.0V$ through a 16Ω resistor. Find the electric field in the capacitor $10ns$ after the connections are made.

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68. A parallel-plalte capacitor has plate area $20cm^2$,plate separation 1.0mm and a dielectric slab of dielaectric constant 5.0 filling up the space between the plates.This capacitor is joined to a battery of emf 6.0V through a $100k(\Omega)$resistor.find the energy of the capacitor $8.9(\mu)s$ after the connections are made.

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69. A $100(\mu)F$ capacitor is joined to a 24 V battery through a $1.0M(\Omega)$ resistor.Plot qualitative graphs (a) between current and time for the first 10 minutes and (b)between charge and time for the same period .

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70. How many time constants will elapse before the current in a charging RC circuit drops to half of its initial value?

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71. How many time constants will elapse before the charge on a capacitor falls to 0.1% of its maximum value in a discharging RC circuit.

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72. How many time constants will elapse before the energy stored in the capacitor reaches half of its equilibrium value in a charging RC circuit ?

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73. how many time constants will elapse before the power delovered by the battery drops to half of its maximum value in an RC circuit ?

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74. A capacitor of capacitance C is connected to a battery of emf (ε)at t=0 through a resistance R. Find the maximum

rate at which energy is stored in the capacitor. When does the rate has this maximum value?

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75. A capacitor of capacitance $12(\mu)F$is connected to a battery of emf 6.00V and internal resistance $1.00(\Omega)$ through resistanceless leads. `12.0(mu)s after the connections are made, what will be (a) the current in the circuit, (b)the power delivered by the battery ,(c)the power dissipated in heat and (d)the rate at which the energy stored in the capacitor is increasing.

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76. A capacitance C charged to a potential difference V is discharged by connecting its plates through a resistance R. Find the heat dissipated in one time constant after the connections are made. Do this by calculating $\int i^2 R dt$and also by finding the decrease in the energy stored in the capacitor.

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77. By evaluating $\int i^2 R dt$,show that when a capacitor is charged by connecting it to a battery through a resistor,the energy dissipated as heat equals the energy stored in the capacitor.

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78. A parallel-plate capacitor is filled with a delectric meterial having resistivity$(\rho)$and dielectric constant K.The capcitor is charged and disconnected from the charging source. The capacitor is slowly discharged through the dielectric.Show that the time constant of the discharge is independent of all gepmetrical parameters like the plate area or separation between the plates. Find this time constant.

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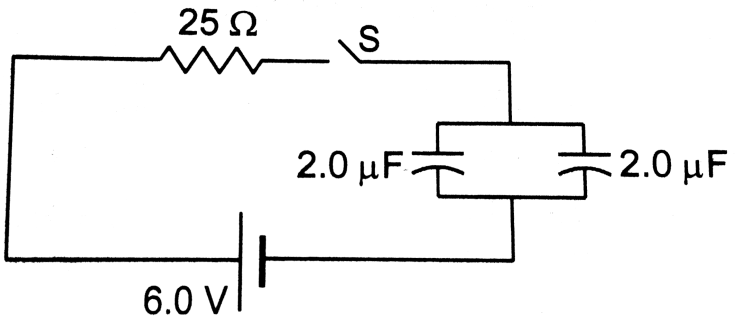
79. Find the charge on each of the capacitor 0.20ms after the switch S is closed in Figure.



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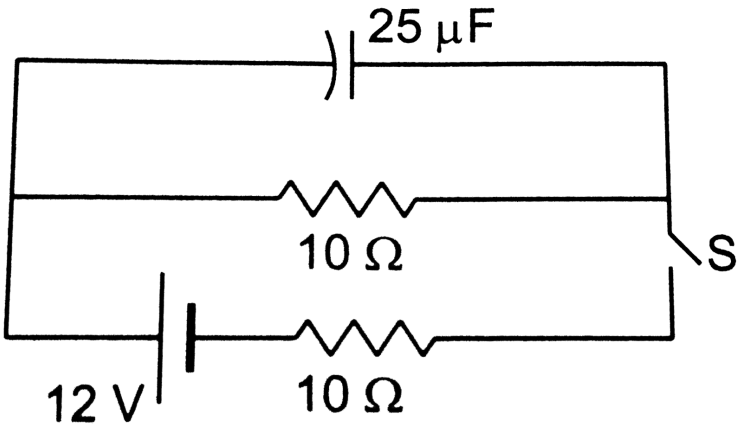
80. The switch S shown in figure is kept closed for a long time and is then opened at $t = 0$.Find the current in the middle $10(\Omega)$resistor at $t = 1.0ms$.



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81. A capacitor of capacitance $100(\mu)F$ is connected across a battery of emf6.0V through a resistance of $20k(\Omega)$for 4.0s after the battery is disconnecting?

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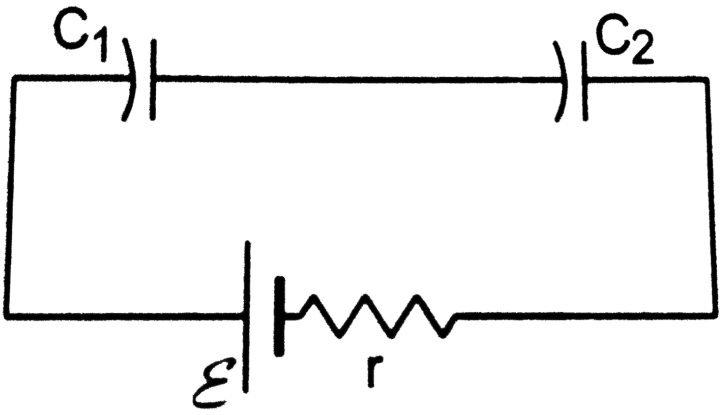
82. Consider the situation shown in figure.The switch is closed at $t = 0$when the capacitor C_1as a function of time

t.



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83. A capacitor of capacitance as C is given a charge Q. At $t = 0$,it is connected to an ideal battery of emf (ε)through a resistance R. Find the charge on the capacitor at time t.

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84. A capacitor of capacitance as C is given a charge Q. At $t = 0$,it is connected to an ideal battery of emf (ε)through a resistance R. Find the charge on the capacitor at time t.

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