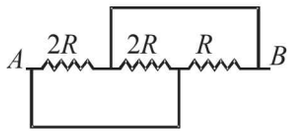
CHAPTER

13 Current Electricity

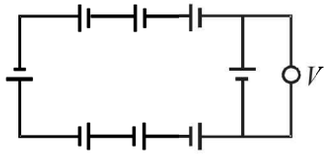
Section-A JEE Advanced/ IIT-JEE

A Fill in the Blanks

1. An electric bulb rated for 500 watts at 100 volts is used in a circuit having a 200 volts supply. The resistance R that must be put in series with the bulb, so that the bulb delivers 500 watt is .....ohm. **(1987 - 2 Marks)**
2. The equivalent resistance between points A and B of the circuit given below is .....Ω . ***(1997 - 2 Marks)***



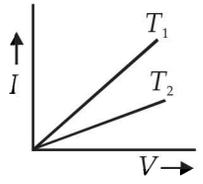
3. In the circuit shown below, each battery is 5V and has an internal resistance of 0.2 ohm.



The reading in the ideal voltmeter V is ..... V. ***(1997 - 2 Marks)***

B True/False

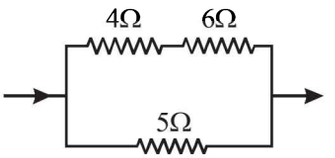
1. In an electrolytic solution the electric current is mainly due to the movement of free electrons. ***(1980)***
2. Electrons in a conductor have no motion in the absence of a potential difference across it. ***(1982 - 2 Marks)***
3. The current –voltage graphs for a given metallic wire at two different temperatures T_1 and T_2 are shown in the figure. ***(1985 - 3 Marks)***



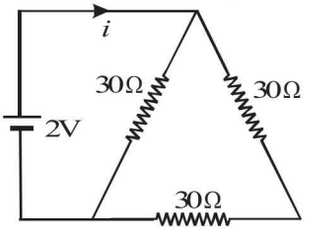
The temperature T_2 is greater than T_1.

C MCQs with One Correct Answer

1. The temperature coefficient of resistance of a wire is 0.00125 per °C. At 300 K, its resistance is 1 ohm. This resistance of the wire will be 2 ohm at. ***(1980)***
   (a) 1154 K (b) 1100 K
   (c) 1400 K (d) 1127 K
2. A constant voltage is applied between the two ends of a uniform metallic wire. Some heat is developed in it. The heat developed is doubled if ***(1980)***
   (a) both the length and the radius of the wire are halved.
   (b) both the length and the radius of the wire are doubled.
   (c) the radius of the wire is doubled.
   (d) the length of the wire is doubled.
3. The electrostatic field due to a point charge depends on the distance r as $\frac{1}{r^2}$. Indicate which of the following quantities shows same dependence on r. ***(1980)***
   (a) Intensity of light from a point source.
   (b) Electrostatic potential due to a point charge.
   (c) Electrostatic potential at a distance r from the centre of a charged metallic sphere. Given $r <$ radius of the sphere.
   (d) None of these
4. In the circuit shown in fig the heat produced in the 5 ohm resistor due to the current flowing through it is 10 calories per second. ***(1981- 2 Marks)***

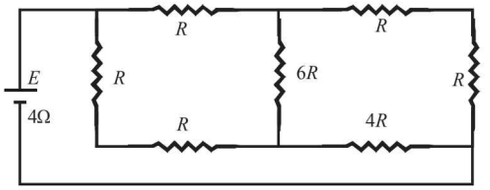


The heat generated in the 4 ohms resistor is
   (a) 1 calorie / sec (b) 2 calories /sec
   (c) 3 calories /sec (d) 4 calories /sec
5. The current i in the circuit (see Fig) is ***(1983 - 1 Mark)***



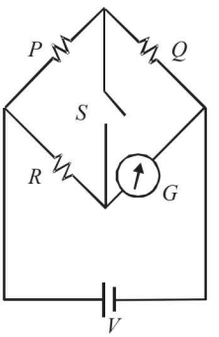
   (a) $\frac{1}{45}$ A (b) $\frac{1}{15}$ A
   (c) $\frac{1}{10}$ A (d) $\frac{1}{5}$ A
6. A piece of copper and another of germanium are cooled from room temperature to 80° K. The resistance of ***(1988 - 1 Mark)***
   (a) each of them increases
   (b) each of them decreases
   (c) copper increases and germanium decreases
   (d) copper decreases and germanium increases

7. A battery of internal resistance 4Ω is connected to the network of resistances as shown. In order that the maximum power can be delivered to the network, the value of R in Ω should be *(1995S)*



(a) $\frac{4}{9}$ (b) 2 (c) $\frac{8}{3}$ (d) 18

8. In the circuit $P \neq R$, the reading of the galvanometer is same with switch S open or closed. Then *(1999 - 2 Marks)*



(a) $I_R = I_G$

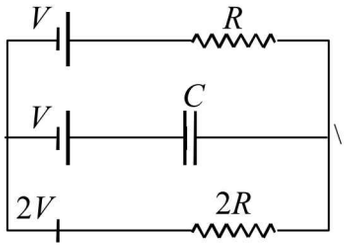
(b) $I_P = I_G$

(c) $I_Q = I_G$

(d) $I_Q = I_R$

9. In the given circuit, with steady current, the potential drop across the capacitor must be *(2001S)*

(a) V (b) $V/2$ (c) $V/3$ (d) $2V/3$

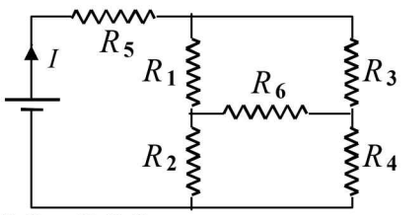


10. A wire of length L and 3 identical cells of negligible internal resistances are connected in series. Due to the current, the temperature of the wire is raised by ΔT in a time t. A number N of similar cells is now connected in series with a wire of the same material and cross-section but of length $2L$. The temperature of the wire is raised by the same amount ΔT in the same time t. the value of N is *(2001S)*

(a) 4 (b) 6

(c) 8 (d) 9

11. In the given circuit, it is observed that the current I is independent of the value of the resistance R_6. Then the resistance values must satisfy *(2001S)*



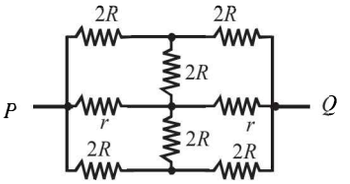
(a) $R_1R_2R_5 = R_3R_4R_6$

(b) $\frac{1}{R_5} + \frac{1}{R_6} = \frac{1}{R_1 + R_2} + \frac{1}{R_3 + R_4}$

(c) $R_1R_4 = R_2R_3$

(d) $R_1R_3 = R_2R_4 = R_5R_6$

12. The effective resistance between points P and Q of the electrical circuit shown in the figure is *(2002S)*



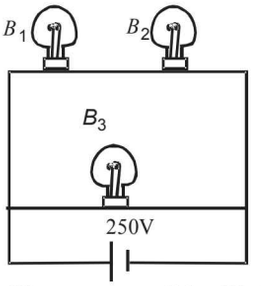
(a) $\frac{2Rr}{R+r}$

(b) $\frac{8R(R+r)}{3R+r}$

(c) $2r + 4R$

(d) $\frac{5R}{2} + 2r$

13. A 100 W bulb B_1, and two 60 W bulb B_2 and B_3, are connected to a 250 V source, as shown in figure. Now W_1, W_2 and W_3 are the output powers of the bulbs B_1, B_2 and B_3, respectively. Then *(2002S)*

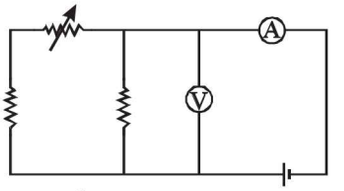


(a) $W_1 > W_2 = W_3$ (b) $W_1 > W_2 > W_3$

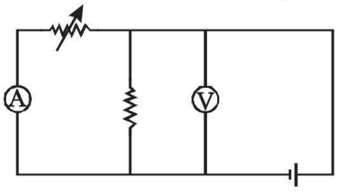
(c) $W_1 < W_2 = W_3$ (d) $W_1 < W_2 < W_3$

14. Express which of the following set ups can be used to verify Ohm's law? *(2003S)*

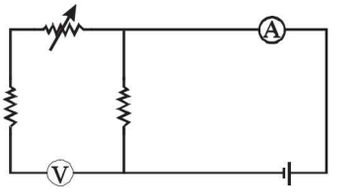
(a)



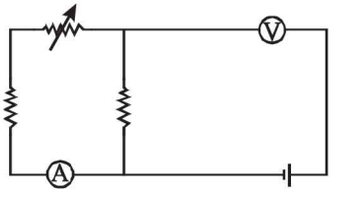
(b)



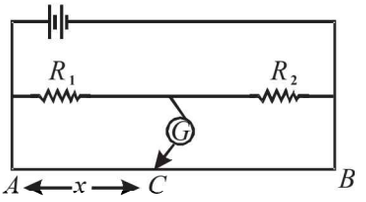
(c)



(d)

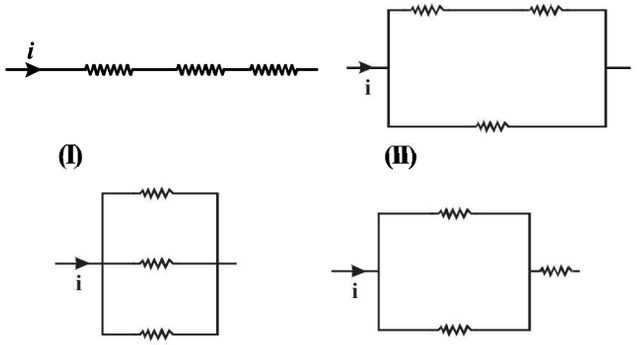


15. In the shown arrangement of the experiment of the meter bridge if AC corresponding to null deflection of galvanometer is x, what would be its value if the radius of the wire AB is doubled? *(2003S)*



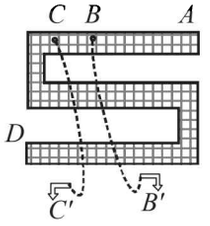
(a) x (b) $x/4$
(c) $4x$ (d) $2x$

16. The three resistance of equal value are arranged in the different combinations shown below. Arrange them in increasing order of power dissipation. ***(2003S)***



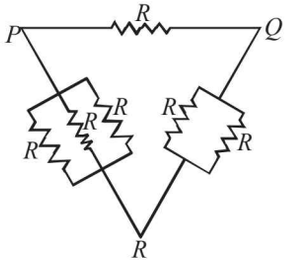
(a) III < II < IV < I (b) II < III < IV < I
(c) I < IV < III < II (d) I < III < II < IV

17. Shown in figure is a Post Office box. In order to calculate the value of external resistance, it should be connected between ***(2004S)***



(a) B' and C' (b) A and D
(c) C and D (d) B and D

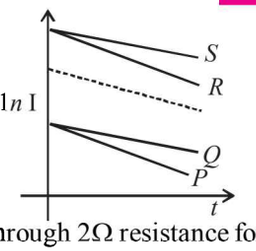
18. Six identical resistors are connected as shown in the figure. The equivalent resistance will be ***(2004S)***



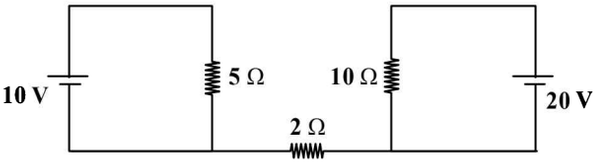
(a) Maximum between P and R
(b) Maximum between Q and R
(c) Maximum between P and Q
(d) All are equal

19. A capacitor is charged using an external battery with a resistance x in series. The dashed line shows the variation of ln I with respect to time. If the resistance is changed to $2x$, the new graph will be ***(2004S)***

(a) P
(b) Q
(c) R
(d) S



20. Find out the value of current through 2Ω resistance for the given circuit. ***(2005S)***



(a) zero (b) 2 A
(c) 5 A (d) 4 A

21. A 4 μF capacitor, a resistance of 2.5 $M\Omega$ is in series with 12 V battery. Find the time after which the potential difference across the capacitor is 3 times the potential difference across the resistor. [Given $\ln(2) = 0.693$] ***(2005S)***

(a) 13.86s (b) 6.93s
(c) 7s (d) 14s

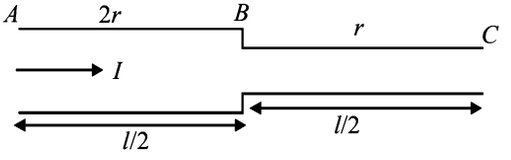
22. A moving coil galvanometer of resistance 100 Ω is used as an ammeter using a resistance 0.1 Ω. The maximum deflection current in the galvanometer is 100 μA. Find the minimum current in the circuit so that the ammeter shows maximum deflection ***(2005S)***

(a) 100.1 mA (b) 1000.1 mA
(c) 10.01 mA (d) 1.01 mA

23. An ideal gas is filled in a closed rigid and thermally insulated container. A coil of 100 Ω resistor carrying current 1 A for 5 minutes supplies heat to the gas. The change in internal energy of the gas is ***(2005S)***

(a) 10 kJ (b) 30 kJ
(c) 20 kJ (d) 0 kJ

24. If a steady current I is flowing through a cylindrical element ABC. Choose the correct relationship

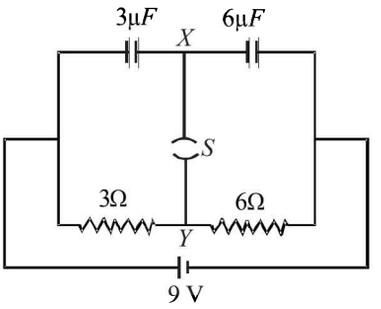


(a) $V_{AB} = 2V_{BC}$
(b) Power across BC is 4 times the power across AB
(c) Current densities in AB and BC are equal
(d) Electric field due to current inside AB and BC are equal

25. A resistance of 2Ω is connected across one gap of a metre-bridge (the length of the wire is 100 cm) and an unknown resistance, greater than 2Ω, is connected across the other gap. When these resistances are interchanged, the balance point shifts by 20 cm. Neglecting any corrections, the unknown resistance is

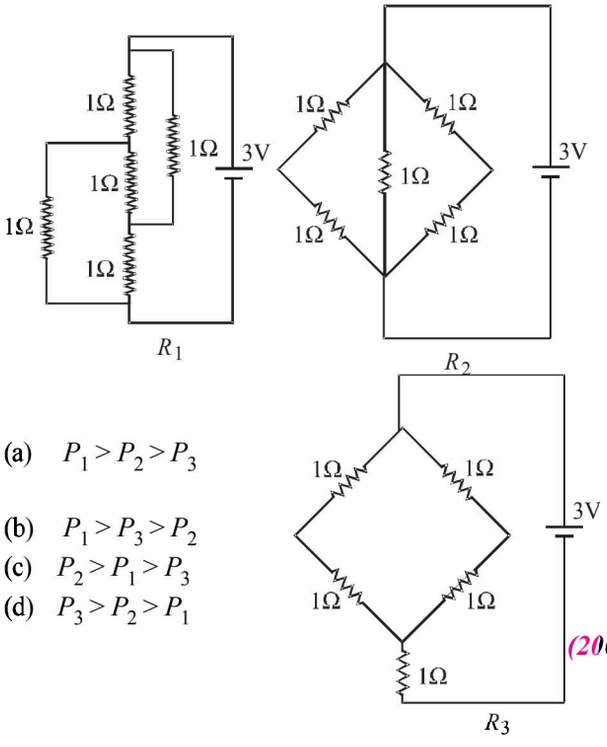
(a) 3Ω (b) 4Ω ***(2007)***
(c) 5Ω (d) 6Ω

26. A circuit is connected as shown in the figure with the switch S open. When the switch is closed, the total amount of charge that flows from Y to X is *(2007)*



(a) 0 (b) 54 μC
(c) 27μC (d) 81 μC

27. Figure shows three resistor configurations R_1, R_2 and R_3 connected to 3V battery. If the power dissipated by the configuration R_1, R_2 and R_3 is P_1, P_2 and P_3, respectively, then –



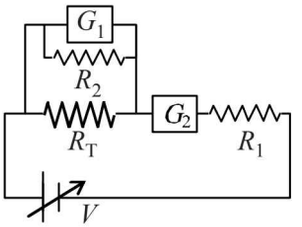
(a) $P_1 > P_2 > P_3$
(b) $P_1 > P_3 > P_2$
(c) $P_2 > P_1 > P_3$
(d) $P_3 > P_2 > P_1$ *(2008)*

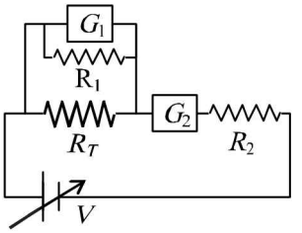
28. Incandescent bulbs are designed by keeping in mind that the resistance of their filament increases with the increase in temperature. If at room temperature, 100 W, 60 W and 40 W bulbs have filament resistances R_{100}, R_{60} and R_{40}, respectively, the relation between these resistances is

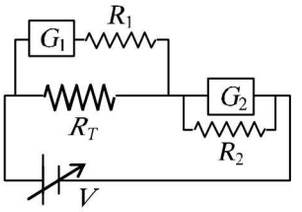
(a) $\frac{1}{R_{100}} = \frac{1}{R_{40}} + \frac{1}{R_{60}}$ (b) $R_{100} = R_{40} + R_{60}$ *(2010)*

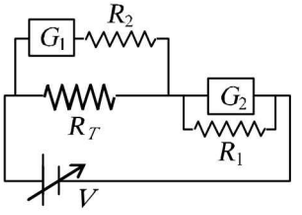
(c) $R_{100} > R_{60} > R_{40}$ (d) $\frac{1}{R_{100}} > \frac{1}{R_{60}} > \frac{1}{R_{40}}$

29. To verify Ohm's law, a student is provided with a test resistor R_T, a high resistance R_1, a small resistance R_2, two identical galvanometers G_1 and G_2, and a variable voltage source V. The correct circuit to carry out the experiment is *(2010)*

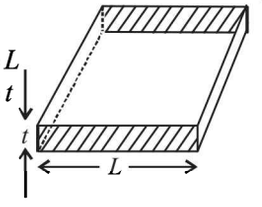
(a)


(b)


(c)


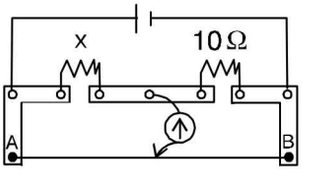
(d)


30. Consider a thin square sheet of side L and thickness t, made of a material of resistivity ρ. The resistance between two opposite faces, shown by the shaded areas in the figure is *(2010)*



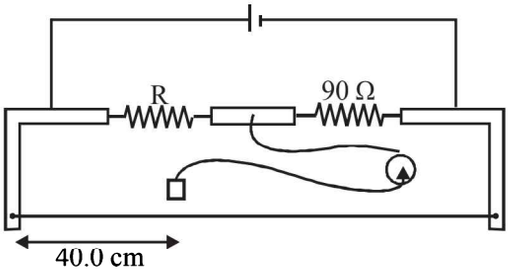
(a) directly proportional to L
(b) directly proportional to t
(c) independent of L
(d) independent of t

31. A meter bridge is set up as shown, to determine an unknown resistance 'X' using a standard 10 ohm resistor. The galvanometer shows null point when tapping-key is at 52 cm mark. The end-corrections are 1 cm and 2 cm respectively for the ends A and B. The determined value of 'X' is *(2011)*



(a) 10.2 ohm (b) 10.6 ohm
(c) 10.8 ohm (d) 11.1 ohm

32. During an experiment with a metre bridge, the galvanometer shows a null point when the jockey is pressed at 40.0 cm using a standard resistance of 90 Ω, as shown in the figure. The least count of the scale used in the metre bridge is 1mm. The unknown resistance is ***(JEE Adv. 2014)***

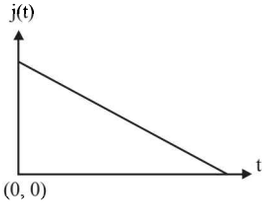


(a) $60 \pm 0.15\ \Omega$ (b) $135 \pm 0.56\ \Omega$

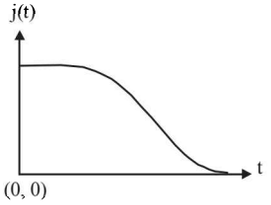
(c) $60 \pm 0.25\ \Omega$ (d) $135 \pm 0.23\ \Omega$

33. An infinite line charge of uniform electric charge density λ lies along the axis of an electrically conducting infinite cylindrical shell of radius R. At time t = 0, the space inside the cylinder is filled with a material of permittivity ε and electrical conductivity σ. The electrical conduction in the material follows Ohm's law. Which one of the following graphs best describes the subsequent variation of the magnitude of current density j(t) at any point in the material? ***(JEE Adv. 2016)***

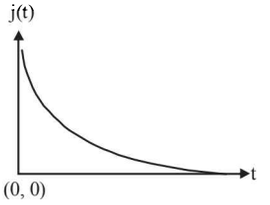
(a)



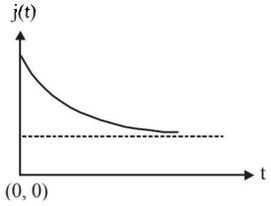
(b)



(c)



(d)



D MCQs with One or More than One Correct

1. Capacitor C_1 of capacitance 1 micro-farad and capacitor C_2 of capacitance 2 microfarad are separately charged fully by a common battery. The two capacitors are then separately allowed to discharge through equal resistors at time $t = 0$. ***(1989 - 2 Marks)***

(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) Capacitor C_1, losses 50% of its initial charge sooner than C_2 loses 50% of its initial charge.

2. Read the following statements carefully: ***(1993-2 Marks)***

Y: The resistivity of a semiconductor decreases with increase of temperature.

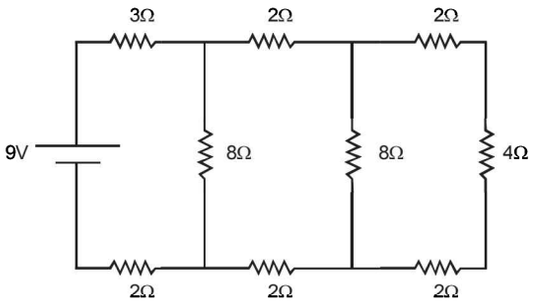
Z: In a conducing solid, the rate of collisions between free electrons and ions increases with increase of temperature

Select the correct statement(s) from the following;

(a) *Y* is true but *Z* is false (b) *Y* is false but *Z* is true

(c) Both *Y* and *Z* are true (d) *Y* is true and *Z* is the correct reason for *Y*

3. In the circuit shown in Figure the current through ***(1998S - 2 Marks)***



(a) the 3 Ω resistor is 0.50 A.

(b) the 3 Ω resistor is 0.25 A.

(c) the 4 Ω resistor is 0.50 A

(d) the 4 Ω resistor is 0.25 A.

4. When a potential difference is applied across, the current passing through ***(1999S - 3 Marks)***

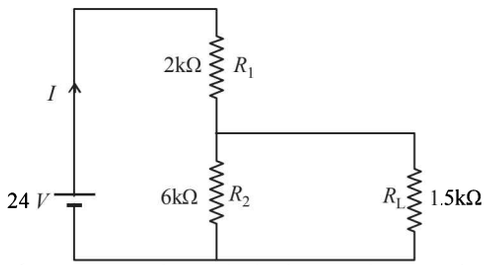
(a) an insulator at 0 K is zero

(b) a semiconductor at 0 K is zero

(c) a metal at 0 K is finite

(d) a *p-n* diode at 300K is finite, if it is reverse biased

5. For the circuit shown in the figure ***(2009)***



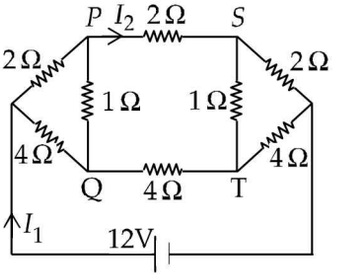
(a) the current *I* through the battery is 7.5 mA

(b) the potential difference across R_L is 18 V

(c) ratio of powers dissipated in R_1 and R_2 is 3

(d) if R_1 and R_2 are interchanged, magnitude of the power dissipated in R_L will decrease by a factor of 9

6. For the resistance network shown in the figure, choose the correct option(s) ***(2012- I)***



(a) The current through PQ is zero.

(b) $I_1 = 3A$

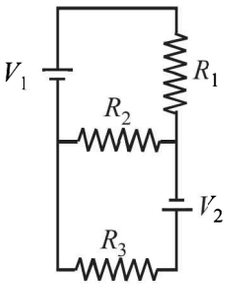
(c) The potential at S is less than that at Q.

(d) $I_2 = 2A$

7. Heater of an electric kettle is made of a wire of length L and diameter d. It takes 4 minutes to raise the temperature of 0.5 kg water by 40 K. This heater is replaced by a new heater having two wires of the same material, each of length L and diameter $2d$. The way these wires are connected is given in the options. How much time in minutes will it take to raise the temperature of the same amount of water by 40 K? *(JEE Adv. 2014)*

(a) 4 if wires are in parallel (b) 2 if wires are in series
(c) 1 if wires are in series (d) 0.5 if wires are in parallel

8. Two ideal batteries of emf V_1 and V_2 and three resistances R_1, R_2 and R_3 are connected as shown in the figure. The current in resistance R_2 would be zero if *(JEE Adv. 2014)*



(a) $V_1 = V_2$ and $R_1 = R_2 = R_3$
(b) $V_1 = V_2$ and $R_1 = 2R_2 = R_3$
(c) $V_1 = 2V_2$ and $2R_1 = 2R_2 = R_3$
(d) $2V_1 = V_2$ and $2R_1 = R_2 = R_3$

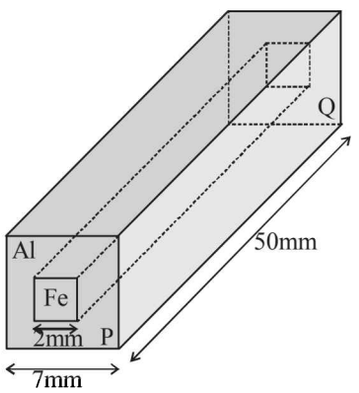
9. In an aluminium (Al) bar of square cross section, a square hole is drilled and is filled with iron (Fe) as shown in the figure. The electrical resistivities of Al and Fe are 2.7×10^{-8} Ω m and 1.0×10^{-7} Ω m, respectively. The electrical resistance between the two faces P and Q of the composite bar is *(JEE Adv. 2015)*

(a) $\frac{2475}{64}\mu\Omega$

(b) $\frac{1875}{64}\mu\Omega$

(c) $\frac{1875}{49}\mu\Omega$

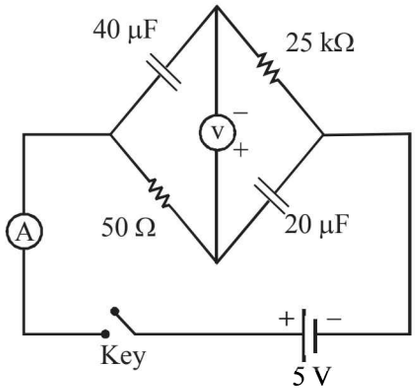
(d) $\frac{2475}{132}\mu\Omega$



10. An incandescent bulb has a thin filament of tungsten that is heated to high temperature by passing an electric current. The hot filament emits black–body radiation. The filament is observed to break up at random locations after a sufficiently long time of operation due to non–uniform evaporation of tungsten from the filament. If the bulb is powered at constant voltage, which of the following statement(s) is(are) true? *(JEE Adv. 2016)*

(a) The temperature distribution over the filament is uniform
(b) The resistance over small sections of the filament decreases with time
(c) The filament emits more light at higher band of frequencies before it breaks up
(d) The filament consumes less electrical power towards the end of the life of the bulb

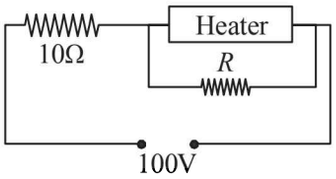
11. In the circuit shown below, the key is pressed at time t = 0. Which of the following statement(s) is(are) true? *(JEE Adv. 2016)*



(a) The voltmeter displays –5V as soon as the key is pressed, and displays +5V after a long time
(b) The voltmeter will display 0V at time t = ln 2 seconds
(c) The current in the ammeter becomes 1/e of the initial value after 1 second
(d) The current in the ammeter becomes zero after a long time.

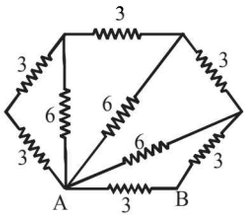
E Subjective Problems

1. A heater is designed to operate with a power of 1000 watts in a 100 volt line. It is connected in a combinations with a resistance of 10 ohms and a resistance R to a 100 volts mains as shown in the figure. What should be the value of R so that the heater operates with a power of 62.5 watts. *(1978)*

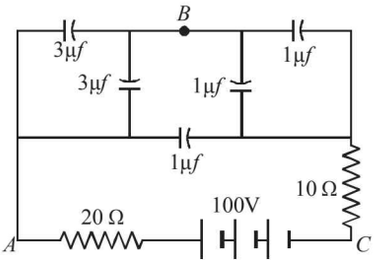


2. If a copper wire is stretched to make it 0.1% longer what is the percentage change in its resistance? *(1978)*

3. All resistances in the diagram below are in ohms. Find the effective resistance between the points A and B. *(1979)*

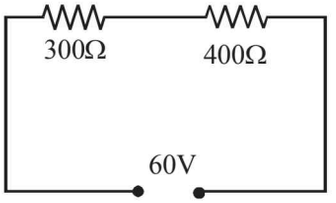


4. In the diagram shown find the potential difference between the points A and B and between the points B and C in the steady state. *(1979)*

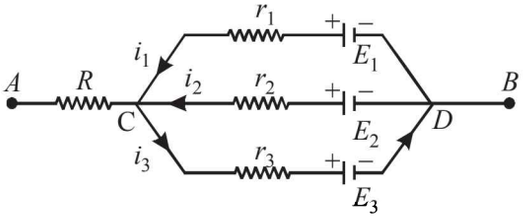


5. A battery of emf 2 volts and internal resistance 0.1 ohm is being charged with a current of 5 amps. ***(1980)***
In what direction will the current flow inside the battery?
What is the potential difference between the two terminal of the battery?

6. State ohm's law.
In the circuit shown in figure, a voltmeter reads 30 volts when it is connected across 400 ohm resistance. Calculate what the same voltmeter will read when it is connected across the 300 ohm resistance. ***(1980)***

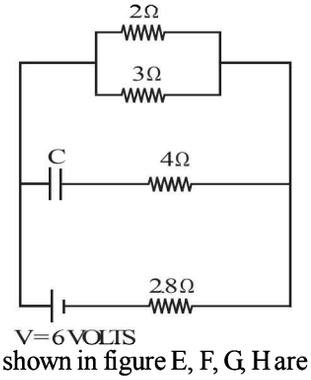


7. In the circuit shown in fig E_1 =3 volts, E_2 = 2 volts, E_3 = 1 volt and R = r_1 = r_2 = r_3 = 1 ohm. ***(1981 - 6 Marks)***

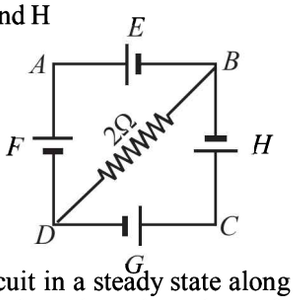


(i) Find the potential difference between the points *A* and *B* and the currents through each branch.
(ii) If r_2 is short circuited and the point *A* is connected to point *B*, find the currents through E_1, E_2 E_3 and the resistor *R*.

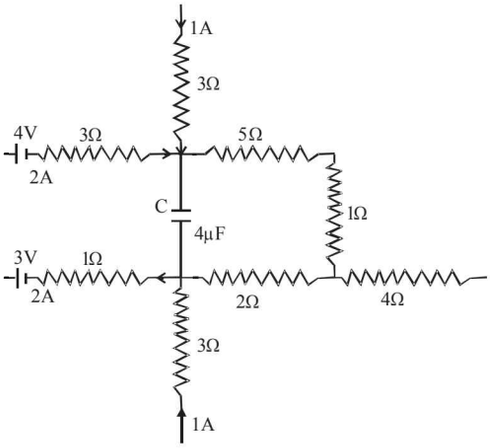
8. Calculate the steady state current in the 2-ohm resistor shown in the circuit in the figure. The internal resistance of the battery is negligible and the capacitance of the condenser *C* is 0.2 microfarad. ***(1982 - 5 Marks)***



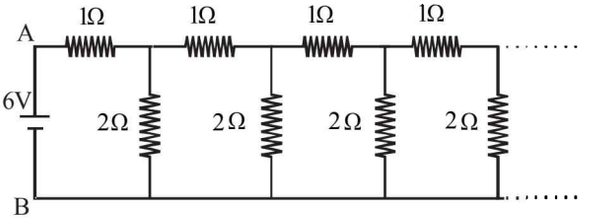
9. In the circuit shown in figure E, F, G, H are cells of emf 2, 1, 3 and 1 volt respectively, and their internal resistances are 2, 1, 3 and 1 ohm respectively. ***(1984 - 6 Marks)***
Calculate :
(i) the potential difference between B and D and
(ii) the potential difference across the terminals of each cells G and H



10. A part of ciucuit in a steady state along with the currents flowing in the branches, the values of resistances etc., is shown in the figure. Calculate the energy stored in the capacitor *C* (4μF) ***(1986 - 4 Marks)***



11. An infinite ladder network of resistances is constructed with a1 ohm and 2 ohm resistances, as shown in fig. ***(1987 - 7 Marks)***



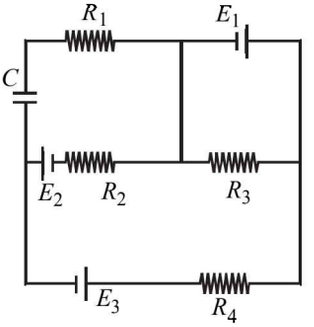
The 6 volt battery between *A* and *B* has negligible internal resistance :
(i) Show that the effective resistance between *A* and *B* is 2 ohms.
(ii) What is the current that passes through the 2 ohm resistance nearest to the battery ?

12. In the given circuit ***(1988 - 5 Marks)***

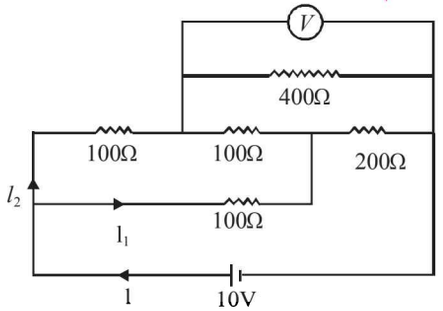
$E_1 = 3E_2 = 2E_3 = 6$ volts $\quad R_1 = 2R_4 = 6$ ohms

$R_3 = 2R_2 = 4$ ohms $\quad C = 5\mu f$.

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



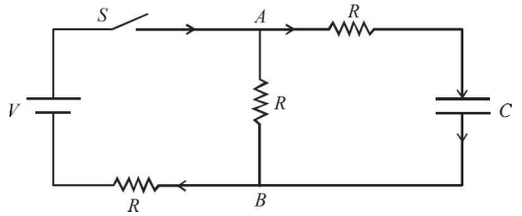
13. An electrical circuit is shown in Fig. Calculate the potential difference across the resistor of 400 ohm, as will be measured by the voltmeter V of resistance 400 ohm, either by applying Kirchhoff's rules or otherwise. ***(1996 - 5 Marks)***



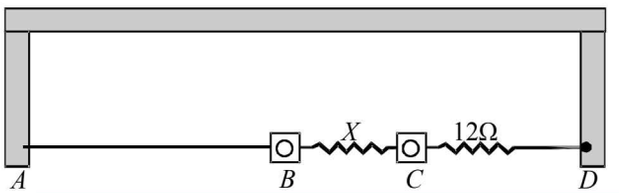
14. In the circuit shown in Figure, the battery is an ideal one, with emf V. The capacitor is initially uncharged. The switch S is closed at time $t = 0$. ***(1998 - 8 Marks)***

(a) Find the charge Q on the capacitor at time t.

(b) Find the current in AB at time t. What is its limiting value as $t \to \infty$:



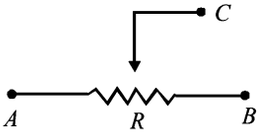
15. A thin uniform wire AB of length 1m, an unknown resistance X and a resistance of 12 Ω are connected by thick conducting strips, as shown in the figure. A battery and a galvanometer (with a sliding jockey connected to it) are also available. Connections are to be made to measure the unknown resistance X using the principle of Wheatstone bridge. Answer the following questions. ***(2002 - 5 Marks)***



(a) Are there positive and negative terminals on the galvanometer?

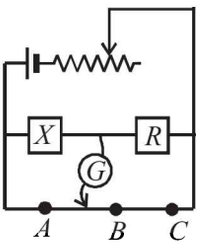
(b) Copy the figure in your answer book and show the battery and the galvanometer (with jockey) connected at appropriate points.

16. How a battery is to be connected so that the shown rheostat will behave like a potential divider? Also indicate the points about which output can be taken. ***(2003 - 2 Marks)***



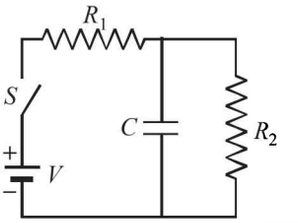
17. Draw the circuit diagram to verify Ohm's Law with the help of a main resistance of 100 Ω and two galvanometers of resistances 10^6 Ω and 10^{-3} Ω and a source of varying emf. Show the correct positions of voltmeter and ammeter. ***(2004 - 4 Marks)***

18. An unknown resistance X is to be determined using resistances R_1, R_2 or R_3. Their corresponding null points are A, B and C. Find which of the above will give the most accurate reading and why? ***(2005 - 2 Marks)***



$R = R_1$ or R_2 or R_3

19. In the given circuit, the switch S is closed at time $t = 0$. The charge Q on the capacitor at any instant t is given by $Q(t) = Q(1 - e^{-\alpha t})$. Find the value of Q_0 and α in terms of given parameters as shown in the circuit.



(2005 - 4 Marks)

F Match the Following

DIRECTIONS (Q. No. 1) : *Each question contains statements given in two columns, which have to be matched. The statements in Column-I are labelled A, B, C and D, while the statements in Column-II are labelled p, q, r and s. Any given statement in Column-I can have correct matching with ONE OR MORE statement(s) in Column-II. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example :*

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s then the correct darkening of bubbles will look like the given.

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	○

1. Column I gives some devices and Column II gives some processes on which the functioning of these devices depend. Match the devices in Column I with the processes in Column II and indicate your answer by darkening appropriate bubbles in the 4 × 4 matrix given in the ORS. ***(2007)***

Column I

(A) Bimetallic strip
(B) Steam engine
(C) Incandescent lamp
(D) Electric fuse

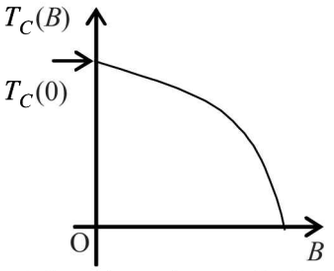
Column II

(p) Radiation from a hot body
(q) Energy conversion
(r) Melting
(s) Thermal expansion of solids

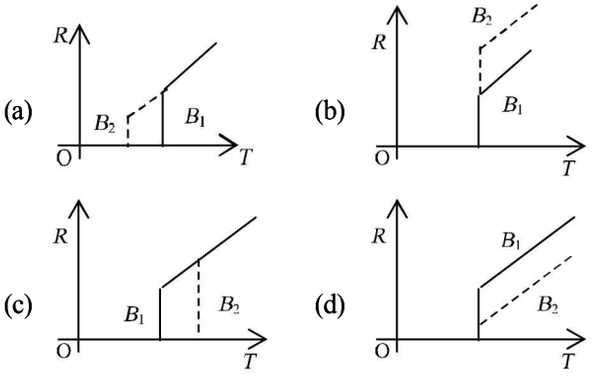
G Comprehension Based Questions

PASSAGE

Electrical resistance of certain materials, known as superconductors, changes abruptly from a nonzero value to zero as their temperature is lowered below a critical temperature $T_C(0)$. An interesting property of superconductors is that their critical temperature becomes smaller than $T_C(0)$ if they are placed in a magnetic field, i.e., the critical temperature $T_C(B)$ is a function of the magnetic field strength B. The dependence of $T_C(B)$ on B is shown in the figure. ***(2010)***



1. In the graphs below, the resistance R of a superconductor is shown as a function of its temperature T for two different magnetic fields B_1 (solid line) and B_2 (dashed line). If B_2 is larger than B_1 which of the following graphs shows the correct variation of R with T in these fields?



2. A superconductor has T_C (0) = 100 K. When a magnetic field of 7.5 Tesla is applied, its T_C decreases to 75 K. For this material one can definitely say that when

(a) $B = 5$ Tesla, T_C (B) = 80 K
(b) $B = 5$ Tesla, 75 K < T_C (B) < 100 K
(c) $B = 10$ Tesla, 75K < T_C (B) < 100 K
(d) $B = 10$ Tesla, T_C (B) = 70K

H Assertion & Reason Type Questions

1. **STATEMENT-1 :** In a Meter Bridge experiment, null point for an unknown resistance is measured. Now, the unknown resistance is put inside an enclosure maintained at a higher temperature. The null point can be obtained at the same point as before by decreasing the value of the standard resistance.

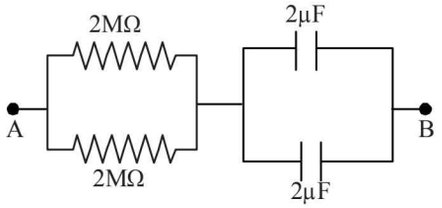
STATEMENT-2 : Resistance of a metal increases with increase in temperature. ***(2008)***

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(c) Statement -1 is True, Statement-2 is False
(d) Statement-1 is False, Statement-2 is True

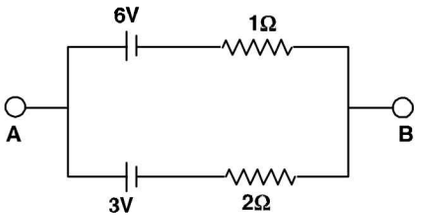
I Integer Value Correct Type

1. When two identical batteries of internal resistance 1Ω each are connected in series across a resistor R, the rate of heat produced in R is J_1. When the same batteries are connected in parallel across R, the rate is J_2. If $J_1 = 2.25\ J_2$ then the value of R in Ω is ***(2010)***

2. At time $t = 0$, a battery of 10 V is connected across points A and B in the given circuit. If the capacitors have no charge initially, at what time (in sceonds) does the voltage across them become 4 V? [Take : $\ell n5 = 1.6$, $\ell n3 = 1.1$] ***(2010)***

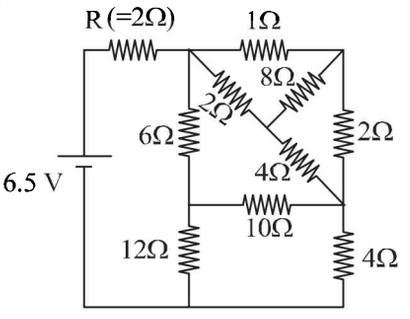


3. Two batteries of different emfs and different internal resistances are connected as shown. The voltage across AB in volts is ***(2011)***



4. A galvanometer gives full scale deflection with 0.006 A current. By connecting it to a 4990 Ω resistance, it can be converted into a voltmeter of range 0 – 30 V. If connected to a $\frac{2n}{249}\Omega$ resistance, it becomes an ammeter of range 0 – 1.5A. The value of n is ***(JEE Adv. 2014)***

5. In the following circuit, the current through the resistor R (= 2 Ω) is I amperes. The value of I is ***(JEE Adv. 2015)***



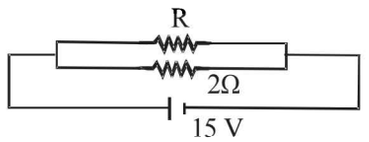
Section-B JEE Main / AIEEE

1. If an ammeter is to be used in place of a voltmeter, then we must connect with the ammeter a **[2002]**
(a) low resistance in parallel
(b) high resistance in parallel
(c) high resistance in series
(d) low resistance in series.

2. A wire when connected to 220 V mains supply has power dissipation P_1. Now the wire is cut into two equal pieces which are connected in parallel to the same supply. Power dissipation in this case is P_2. Then $P_2 : P_1$ is **[2002]**
(a) 1 (b) 4
(c) 2 (d) 3

3. If a current is passed through a spring then the spring will
(a) expand (b) compress **[2002]**
(c) remains same (d) none of these.

4. If in the circuit, power dissipation is 150 W, then R is



(a) 2 Ω (b) 6 Ω **[2002]**
(c) 5 Ω (d) 4 Ω

5. The mass of product liberated on anode in an electrochemical cell depends on **[2002]**
(a) $(It)^{1/2}$ (b) It
(c) I/t (d) I^2t
(where t is the time period for which the current is passed).

6. If θ_i, is the inversion temperature, θ_n is the neutral temperature, θ_c is the temperature of the cold junction, then **[2002]**

(a) $\theta_i + \theta_c = \theta_n$ (b) $\theta_i - \theta_c = 2\theta_n$

(c) $\frac{\theta_i + \theta_C}{2} = \theta_n$ (d) $\theta_c - \theta_i = 2\theta_n$

7. The length of a wire of a potentiometer is 100 cm, and the e. m.f. of its standard cell is E volt. It is employed to measure the e.m.f. of a battery whose internal resistance is 0.5Ω. If the balance point is obtained at l = 30 cm from the positive end, the e.m.f. of the battery is **[2003]**

(a) $\frac{30E}{100.5}$ (b) $\frac{30E}{(100-0.5)}$

(c) $\frac{30(E-0.5i)}{100}$ (d) $\frac{30E}{100}$

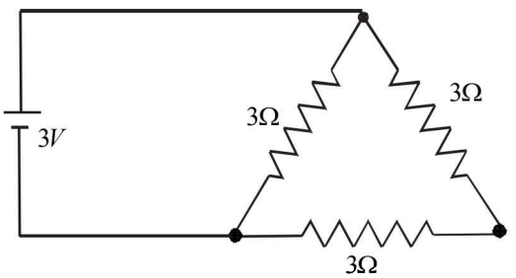
where i is the current in the potentiometer wire.

8. The thermo e.m.f. of a thermo -couple is 25 $\mu V/^oC$ at room temperature. A galvanometer of 40 ohm resistance, capable of detecting current as low as 10^{-5} A, is connected with the thermo couple. The smallest temperature difference that can be detected by this system is **[2003]**
(a) 16^oC (b) 12^oC
(c) 8^oC (d) 20^oC

9. The negative Zn pole of a Daniell cell, sending a constant current through a circuit, decreases in mass by 0.13g in 30 minutes. If the electeochemical equivalent of Zn and Cu are 32.5 and 31.5 respectively, the increase in the mass of the positive Cu pole in this time is **[2003]**
(a) 0.180 g (b) 0.141g
(c) 0.126 g (d) 0.242 g

10. An ammeter reads upto 1 ampere. Its internal resistance is 0.81ohm. To increase the range to 10 A the value of the required shunt is **[2003]**
(a) 0.03 Ω (b) 0.3 Ω
(c) 0.9 Ω (d) 0.09 Ω

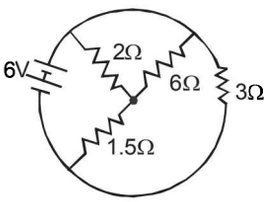
11. A 3 volt battery with negligible internal resistance is connected in a circuit as shown in the figure. The current I, in the circuit will be **[2003]**



(a) 1 A (b) 1.5 A
(c) 2 A (d) 1/3 A

12. A 220 volt, 1000 watt bulb is connected across a 110 volt mains supply. The power consumed will be **[2003]**
(a) 750 watt (b) 500 watt
(c) 250 watt (d) 1000 watt

13. The total current supplied to the circuit by the battery is **[2004]**



(a) 4 A (b) 2 A
(c) 1 A (d) 6 A

14. The resistance of the series combination of two resistances is S. when they are joined in parallel the total resistance is P. If $S = nP$ then the Minimum possible value of n is
(a) 2 (b) 3 **[2004]**
(c) 4 (d) 1

15. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the lengths and radii arein the ratio of $\frac{4}{3}$ and $\frac{2}{3}$, then the ratio of the current passing through the wires will be **[2004]**
(a) 8/9 (b) 1/3
(c) 3 (d) 2

16. In a meter bridge experiment null point is obtained at 20 cm. from one end of the wire when resistance X is balanced against another resistance Y. If $X < Y$, then where will be the new position of the null point from the same end, if one decides to balance a resistance of 4 X against Y
(a) 40 cm (b) 80 cm **[2004]**
(c) 50 cm (d) 70 cm

17. The termistors are usually made of **[2004]**
(a) metal oxides with high temperature coefficient of resistivity
(b) metals with high temperature coefficient of resistivity
(c) metals with low temperature coefficient of resistivity
(d) semiconducting materials having low temperature coefficient of resistivity

18. Time taken by a 836 W heater to heat one litre of water from 10°C to 40°C is **[2004]**
(a) 150 s (b) 100 s
(c) 50 s (d) 200 s

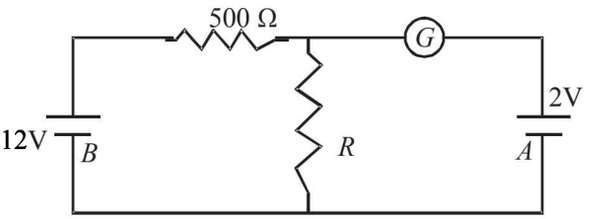
19. The thermo emf of a thermocouple varies with the temperature θ of the hot junction as $E = a\theta + b\theta^2$ in volts where the ratio a/b is 700°C. If the cold junction is kept at 0°C, then the neutral temperature is **[2004]**
(a) 1400°C
(b) 350°C
(c) 700°C
(d) No neutral temperature is possible for this termocouple.

20. The electrochemical equivalent of a metal is 3.35109^{-7} kg per Coulomb. The mass of the metal liberated at the cathode when a 3A current is passed for 2 seconds will be
(a) 6.6×10^{57}kg (b) 9.9×10^{-7} kg **[2004]**
(c) 19.8×10^{-7} kg (d) 1.1×10^{-7} kg

21. Two thin, long, parallel wires, separated by a distance 'd' carry a current of 'i' A in the same direction. They will **[2005]**
(a) repel each other with a force of $\mu_0 i^2/(2\pi d)$
(b) attract each other with a force of $\mu_0 i^2/(2\pi d)$
(c) repel each other with a force of $\mu_0 i^2/(2\pi d^2)$
(d) attract each other with a force of $\mu_0 i^2/(2\pi d^2)$

22. A heater coil is cut into two equal parts and only one part is now used in the heater. The heat generated will now be
(a) four times (b) doubled **[2005]**
(c) halved (d) one fourth

23. In the circuit , the galvanometer G shows zero deflection. If the batteries A and B have negligible internal resistance, the value of the resistor R will be - **[2005]**



(a) 100Ω (b) 200Ω
(c) 1000Ω (d) 500Ω

24. A moving coil galvanometer has 150 equal divisions. Its current sensitivity is 10-divisions per milliampere and voltage sensitivity is 2 divisions per millivolt. In order that each division reads 1 volt, the resistance in ohms needed to be connected in series with the coil will be - **[2005]**
(a) 10^5 (b) 10^3
(c) 9995 (d) 99995

25. Two sources of equal emf are connected to an external resistance R. The internal resistance of the two sources are R_1 and R_2 ($R_1 > R_1$). If the potential difference across the source having internal resistance R_2 is zero, then
(a) $R = R_2 - R_1$ **[2005]**
(b) $R = R_2 \times (R_1 + R_2)/(R_2 - R_1)$
(c) $R = R_1 R_2/(R_2 - R_1)$
(d) $R = R_1 R_2/(R_1 - R_2)$

26. Two voltameters, one of copper and another of silver, are joined in parallel. When a total charge q flows through the voltameters, equal amount of metals are deposited. If the electrochemical equivalents of copper and silver are Z_1 and Z_2 respectively the charge which flows through the silver voltameter is **[2005]**
(a) $\frac{q}{1+\frac{Z_2}{Z_1}}$ (b) $\frac{q}{1+\frac{Z_1}{Z_2}}$
(c) $q\frac{Z_2}{Z_1}$ (d) $q\frac{Z_1}{Z_2}$

27. In a potentiometer experiment the balancing with a cell is at length 240 cm. On shunting the cell with a resistance of 2Ω, the balancing length becomes 120 cm. The internal resistance of the cell is **[2005]**

(a) 0.5Ω (b) 1Ω
(c) 2Ω (d) 4Ω

28. The resistance of hot tungsten filament is about 10 times the cold resistance. What will be the resistance of 100 W and 200 V lamp when not in use ? **[2005]**

(a) 20Ω (b) 40Ω
(c) 200Ω (d) 400Ω

29. An energy source will supply a constant current into the load if its internal resistance is **[2005]**

(a) very large as compared to the load resistance
(b) equal to the resistance of the load
(c) non-zero but less than the resistance of the load
(d) zero

30. The Kirchhoff's first law ($\Sigma i = 0$) and second law ($\Sigma iR = \Sigma E$), where the symbols have their usual meanings, are respectively based on **[2006]**

(a) conservation of charge, conservation of momentum
(b) conservation of energy, conservation of charge
(c) conservation of momentum, conservation of charge
(d) conservation of charge, conservatrion of energy

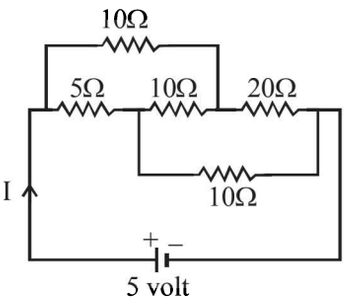
31. A material '*B*' has twice the specific resistance of '*A*'. A circular wire made of '*B*' has twice the diameter of a wire made of '*A*'. then for the two wires to have the same resistance, the ratio l_B/l_A of their respective lengths must be **[2006]**

(a) 1 (b) $\frac{1}{2}$
(c) $\frac{1}{4}$ (d) 2

32. A thermocouple is made from two metals, Antimony and Bismuth. If one junction of the couple is kept hot and the other is kept cold, then, an electric current will **[2006]**

(a) flow from Antimony to Bismuth at the hot junction
(b) flow from Bismuth to Antimony at the cold junction
(c) now flow through the thermocouple
(d) flow from Antimony to Bismuth at the cold junction

33. The current I drawn from the 5 volt source will be **[2006]**



(a) 0.33 A (b) 0.5 A
(c) 0.67 A (d) 0.17 A

34. The resistance of a bulb filmanet is 100Ω at a temperature of 100°C. If its temperature coefficient of resistance be 0.005 per °C, its resistance will become 200 Ω at a temperature of **[2006]**

(a) 300°C (b) 400°C
(c) 500°C (d) 200°C

35. In a Wheatstone's bridge, three resistances *P*, *Q* and *R* connected in the three arms and the fourth arm is formed by two resistances S_1 and S_2 connected in parallel. The condition for the bridge to be balanced will be **[2006]**

(a) $\frac{P}{Q} = \frac{2R}{S_1 + S_2}$ (b) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{S_1 S_2}$

(c) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{2S_1 S_2}$ (d) $\frac{P}{Q} = \frac{R}{S_1 + S_2}$

36. An electric bulb is rated 220 volt - 100 watt. The power consumed by it when operated on 110 volt will be **[2006]**

(a) 75 watt (b) 40 watt
(c) 25 watt (d) 50 watt

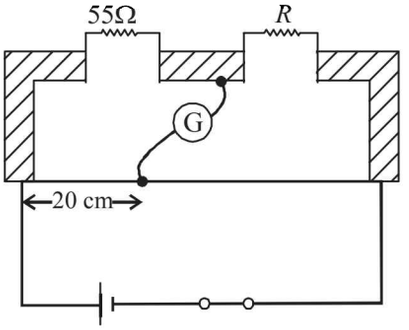
37. A battery is used to charge a parallel plate capacitor till the potential difference between the plates becomes equal to the electromotive force of the battery. The ratio of the energy stored in the capacitor and the work done by the battery will be **[2007]**

(a) 1/2 (b) 1
(c) 2 (d) 1/4

38. The resistance of a wire is 5 ohm at 50°C and 6 ohm at 100°C. The resistance of the wire at 0°C will be **[2007]**

(a) 3 ohm (b) 2 ohm
(c) 1 ohm (d) 4 ohm

39. Shown in the figure below is a meter-bridge set up with null deflection in the galvanometer.



The value of the unknown resistor *R* is **[2008]**

(a) 13.75Ω (b) 220Ω
(c) 110Ω (d) 55Ω

DIRECTIONS : *Question No.* 40 *and* 41 *are based on the following paragraph.*

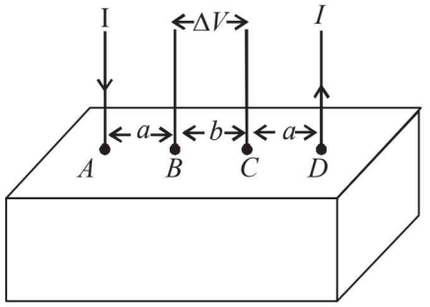
Consider a block of conducting material of resistivity 'ρ' shown in the figure. Current 'I' enters at 'A' and leaves from 'D'. We apply superposition principle to find voltage 'ΔV' developed between 'B' and 'C'. The calculation is done in the following steps:

(i) Take current 'I' entering from 'A' and assume it to spread over a hemispherical surface in the block.

(ii) Calculate field E(r) at distance 'r' from A by using Ohm's law $E = \rho j$, where j is the current per unit area at 'r'.

(iii) From the 'r' dependence of E(r), obtain the potential V(r) at r.

(iv) Repeat (i), (ii) and (iii) for current 'I' leaving 'D' and superpose results for 'A' and 'D'.



40. ΔV measured between B and C is **[2008]**

(a) $\frac{\rho I}{\pi a} - \frac{\rho I}{\pi(a+b)}$ (b) $\frac{\rho I}{a} - \frac{\rho I}{(a+b)}$

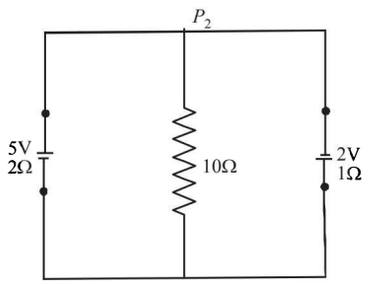
(c) $\frac{\rho I}{2\pi a} - \frac{\rho I}{2\pi(a+b)}$ (d) $\frac{\rho I}{2\pi(a-b)}$

41. For current entering at A, the electric field at a distance 'r' from A is **[2008]**

(a) $\frac{\rho I}{8\pi r^2}$ (b) $\frac{\rho I}{r^2}$

(c) $\frac{\rho I}{2\pi r^2}$ (d) $\frac{\rho I}{4\pi r^2}$

42. A 5V battery with internal resistance 2Ω and a 2V battery with internal resistance 1Ω are connected to a 10Ω resistor as shown in the figure. **[2008]**



The current in the 10Ω resistor is

(a) 0.27 A P_2 to P_1 (b) 0.03 A P_1 to P_2

(c) 0.03 A P_2 to P_1 (d) 0.27 A P_1 to P_2

43. Let C be the capacitance of a capacitor discharging through a resistor R. Suppose t_1 is the time taken for the energy stored in the capacitor to reduce to half its initial value and t_2 is the time taken for the charge to reduce to one-fourth its initial value. Then the ratio t_1/t_2 will be **[2010]**

(a) 1 (b) $\frac{1}{2}$

(c) $\frac{1}{4}$ (d) 2

44. Two conductors have the same resistance at 0°C but their temperature coefficients of resistance are α_1 and α_2. The respective temperature coefficients of their series and parallel combinations are nearly **[2010]**

(a) $\frac{\alpha_1+\alpha_2}{2}, \alpha_1+\alpha_2$ (b) $\alpha_1+\alpha_2, \frac{\alpha_1+\alpha_2}{2}$

(c) $\alpha_1+\alpha_2, \frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$ (d) $\frac{\alpha_1+\alpha_2}{2}, \frac{\alpha_1+\alpha_2}{2}$

45. If a wire is stretched to make it 0.1% longer, its resistance will : **[2011]**

(a) increase by 0.2% (b) decrease by 0.2%

(c) decrease by 0.05% (d) increase by 0.05%

46. Two electric bulbs marked 25W – 220 V and 100W – 220V are connected in series to a 440 V supply. Which of the bulbs will fuse? **[2012]**

(a) Both (b) 100 W

(c) 25 W (d) Neither

47. The supply voltage to room is 120V. The resistance of the lead wires is 6Ω. A 60 W bulb is already switched on. What is the decrease of voltage across the bulb, when a 240 W heater is switched on in parallel to the bulb?

(a) zero (b) 2.9 Volt **[JEE Main 2013]**

(c) 13.3 Volt (d) 10.04 Volt

48. This questions has Statement I and Statement II. Of the four choices given after the Statements, choose the one that best describes into two Statements. **[JEE Main 2013]**

Statement-I : Higher the range, greater is the resistance of ammeter.

Statement-II : To increase the range of ammeter, additional shunt needs to be used across it.

(a) Statement-I is true, Statement-II is true, Statement-II is the correct explanation of Statement-I.

(b) Statement-I is true, Statement-II is true, Statement-II is not the correct explanation of Statement-I.

(c) Statement-I is true, Statement-II is false.

(d) Statement-I is false, Statement-II is true.

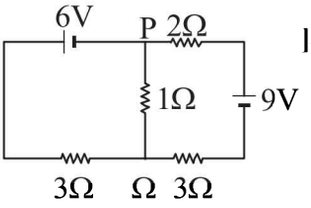
49. In a large building, there are 15 bulbs of 40 W, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1 kW. The voltage of electric mains is 220 V. The minimum capacity of the main fuse of the building will be: **[JEE Main 2014]**

(a) 8 A (b) 10 A
(c) 12 A (d) 14 A

50. When 5V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is 2.5×10^{-4} ms^{-1}. If the electron density in the wire is 8×10^{28} m^{-3}, the resistivity of the material is close to : **[JEE Main 2015]**

(a) $1.6 \times 10^{-6}\ \Omega m$ (b) $1.6 \times 10^{-5}\ \Omega m$
(c) $1.6 \times 10^{-8}\ \Omega m$ (d) $1.6 \times 10^{-7}\ \Omega m$

51. In the circuit shown, the current in the 1Ω resistor is : **[JEE Main 2015]**



(a) 0.13 A, from Q to P (b) 0.13 A, from P to Q
(c) 1.3A from P to Q (d) 0A

52. The temperature dependence of resistances of Cu and undoped Si in the temperature range 300-400 K, is best described by : **[JEE Main 2016]**

(a) Linear increase for Cu, exponential decrease of Si.
(b) Linear decrease for Cu, linear decrease for Si.
(c) Linear increase for Cu, linear increase for Si.
(d) Linear increase for Cu, exponential increase for Si.