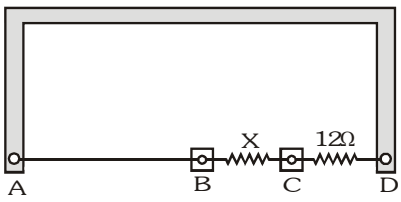
Subjective problems

1. A thin uniform wire AB of length 1m, an unknown resistance X and a resistance of 12Ω are connected by thick conducting strips, as shown in the figure. A battery and 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. **[IIT-JEE 2002]**

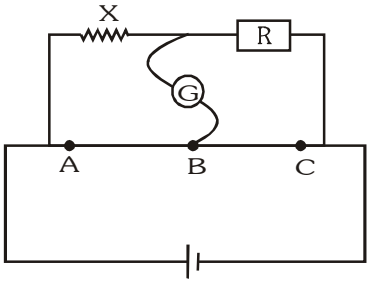


(i) Are there positive and negative terminals on the galvanometer ?
(ii) Copy the figure in your answer book and show the battery and the galvanometer (with jockey) connected at appropriate points.
(iii) After appropriate connections are made, it is found that no deflection takes place in the galvanometer when the sliding jockey touches the wire at a distance of 60 cm from A. Obtain the value of the resistance X.

2. Show by diagram, how can we use a rheostat as the potential divider ? **[IIT-JEE 2003]**

3. Draw the circuit for experimental verification of Ohm's law using a source of variable DC voltage, a main resistance of 100 Ω, two galvanometers and two resistances of values 10^6 Ω and 10^{-3} Ω respectively. Clearly show the positions of the voltmeter and the ammeter. **[IIT-JEE 2004]**

4. R_1, R_2, R_3 are different values of R. A, B, C are the null points obtained corresponding to R_1, R_2 and R_3 respectively. For which resistor, the value of X will be the most accurate and why ? **[IIT-JEE 2005]**



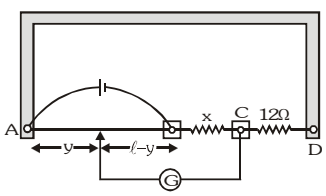
5. When two identical batteries of internal resistance 1Ω each are connected in series across a resistor R, the rate of heat produced in R is J_1. When the same batteries are connected in parallel across R, the rate is J_2. If $J_1 = 2.25\ J_2$ then the value of R in Ω is **[IIT-JEE 2010]**

PREVIOUS YEARS QUESTIONS — ANSWER KEY — EXERCISE –5 (B)

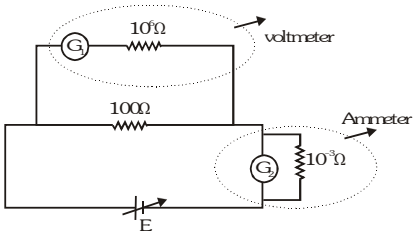
- **MCQ's One correct answers**

1	2	3	4	5	6	7	8	9	10
D	A	C	B	A	D	B	A	A	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	A	D	C	A	A	C	D	C	C

- **MCQ's one or more than one correct answers** **1.** A,D
- **Assertion-Reason** **1.** D
- ***Subjective*** (i) No, (ii)

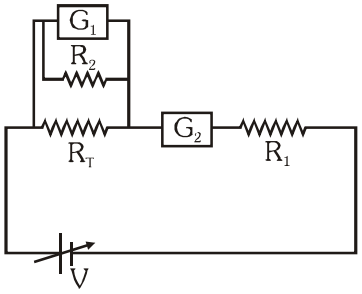


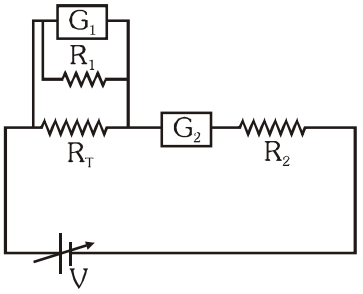
(ii) 8Ω **3.**

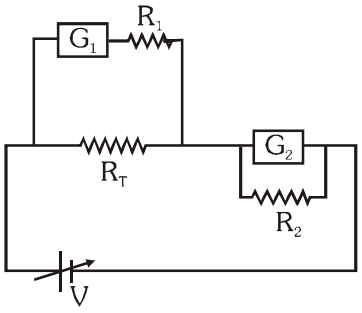


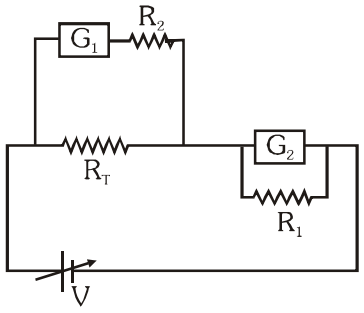
4. R_1=R_2. So B give more accurate value **5.** 4

19. 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 :– [IIT-JEE 2010]

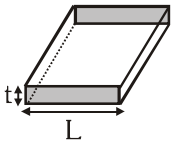
(A)


(B)


(C)


(D)


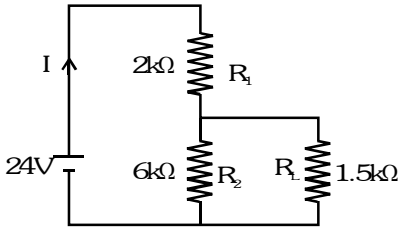
20. Consider a thin square sheet of side L and thickness t, made of a material of resistivity ρ. The resistance between two opposite faces, shown by the shaded areas in the figure is [IIT-JEE 2010]



(A) directly proportional to L
(B) directly proportional to t
(C) independent of L
(D) independent of t

MCQ's (one or more than one correct answers)

1. For the circuit shown in the figure [IIT-JEE 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

Assertion-Reason

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.
and [IIT-JEE 2008]
STATEMENT-2 : Resistance of a metal increases with increase in temperature.

(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.

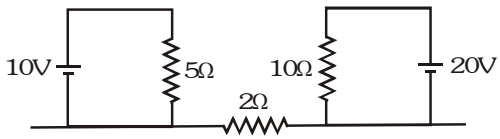
12. A moving coil galvanometer of resistance 100 Ω is used as an ammeter using a resistance 0.1Ω. The maximum deflection current in the galvanometer is 100 μA. Find the minimum current in the circuit, so that the ammeter shown maximum deflection. **[IIT-JEE 2005]**

(A) 100.1 mA (B) 1000.1 mA (C) 10.01 mA (D) 1.01 mA

13. A rigid container with thermally insulated walls contains a coil of resistance 100Ω, carrying current 1A. Change in internal energy after 5 min will be :- **[IIT-JEE 2005]**

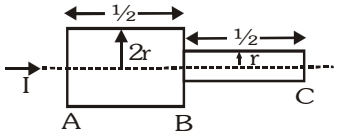
(A) zero (B) 10 kJ (C) 20 kJ (D) 30 kJ

14. Find out the value of current through 2Ω resistance for the given circuit :- **[IIT-JEE 2005]**



(A) 5A (B) 2 A (C) zero (D) 4 A

15. Two bars of radius r and 2r are kept in contact as shown. An electric current I is passed through the bars. Which one of following is correct :- **[IIT-JEE 2006]**



(A) Heat produced in bar BC is 4 times the heat produced in bar AB

(B) Electric field in both halves is equal

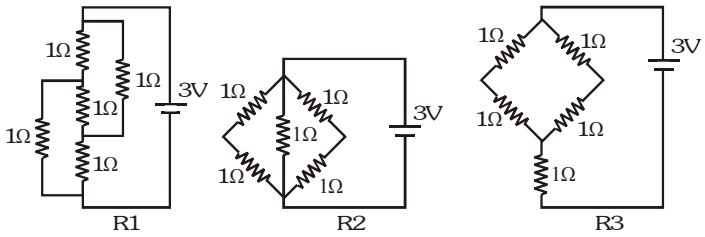
(C) Current density across AB is double that of across BC

(D) Potential difference across AB is 4 times that of across BC

16. 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 (C) 5Ω (D) 6Ω **[IIT-JEE 2007]**

17. 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 :- **[IIT-JEE 2008]**

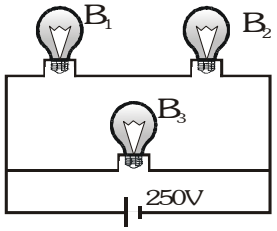


(A) $P_1 > P_2 > P_3$ (B) $P_1 > P_3 > P_2$ (C) $P_2 > P_1 > P_3$ (D) $P_3 > P_2 > P_1$

18. 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 resistance R_{100}, R_{60} and R_{40}, respectively, the relation between these resistances is **[IIT-JEE 2010]**

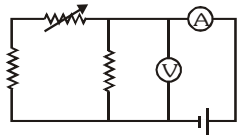
(A) $\frac{1}{R_{100}} = \frac{1}{R_{40}} + \frac{1}{R_{60}}$ (B) $R_{100} = R_{40} + R_{60}$ (C) $R_{100} > R_{60} > R_{40}$ (D) $\frac{1}{R_{100}} > \frac{1}{R_{60}} > \frac{1}{R_{40}}$

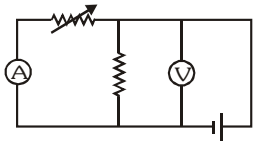
6. A 100 W bulb B_1, and two 60 W bulbs B_2 and B_3, are connected to a 250 V source, as shown in the figure. Now W_1, W_2 and W_3 are the output powers of the bulbs B_1, B_2 and B_3 respectively. Then [IIT-JEE 2002]

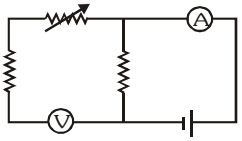


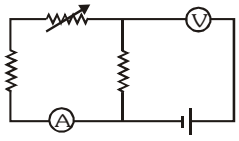
(A) $W_1 > W_2 = W_3$ (B) $W_1 > W_2 > W_3$ (C) $W_1 < W_2 = W_3$ (D) $W_1 < W_2 < W_3$

7. Express which of the following set–up can be used to verify Ohm's law (ammeter & voltmeter are ideal) [IIT-JEE 2003]

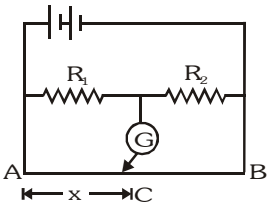
(A) 

(B) 

(C) 

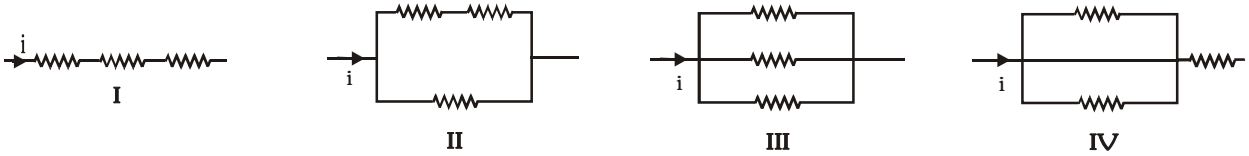
(D) 

8. 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? [IIT-JEE 2003]



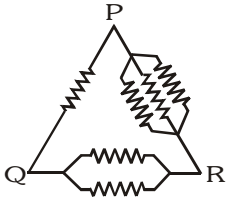
(A) x (B) x/4 (C) 4x (D) 2x

9. The three resistance of equal value are arranged in the different combinations shown below. Arrange them in increasing order of power dissipation : [IIT-JEE 2003]



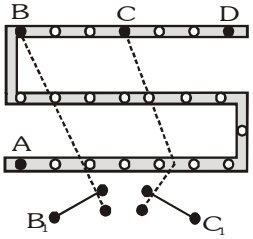
(A) III < II < IV < I (B) II < III < IV < I (C) I < IV < III < II (D) I < III < II < IV

10. Six equal resistances are connected between points P,Q and R as shown in the figure. Then, the net resistance will be maximum between [IIT-JEE 2003]



(A) P and Q (B) Q and R (C) P and R (D) any two points

11. For the post office box arrangement to determine the value of unknown resistance, the unknown resistance should be connected between [IIT-JEE 2004]



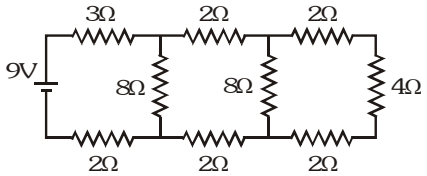
(A) B and C (B) C and D (C) A and D (D) B_1 and C_1

EXERCISE–05(B)

PREVIOUS YEAR QUESTIONS

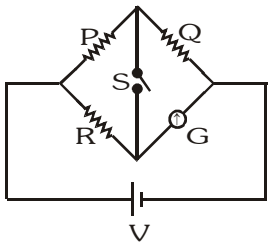
MCQ's (only one correct answers)

1. In the circuit shown in the figure, the current through : [IIT-JEE 1998]



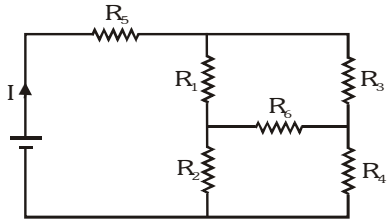
(A) the 3Ω resistor is 0.50 A (B) the 3Ω resistor is 0.25 A
(C) the 4Ω resistor is 0.50 A (D) the 4Ω resistor is 0.25 A

2. In the circuit shown P ≠ R, the reading of galvanometer is same with switch S open or closed. Then [IIT-JEE 1998]



(A) $I_R = I_G$ (B) $I_P = I_G$ (C) $I_Q = I_G$ (D) $I_Q = I_R$

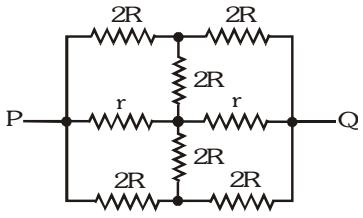
3. In the given circuit, it is observed that the current I is independent of the value of the resistance R_6. Then, the resistance values must satisfy :– [IIT-JEE 2001]



(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) $R_1R_3 = R_2R_4$

4. A wire of length L and 3 identical cells of negligible internal resistance 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. The value of N is :– [IIT-JEE 2001]
(A) 4 (B) 6 (C) 8 (D) 9

5. The effective resistance between points P and Q of the electrical circuit shown in the figure is :– [IIT-JEE 2002]



(A) $\frac{2Rr}{R+r}$ (B) $\frac{8R(R+r)}{3R+r}$ (C) 2r + 4R (D) $\frac{5R}{2}$ + 2r

29. If 400 Ω of resistance is made by adding four 100 Ω resistance of tolerance 5%, then the tolerance of the combination is : **[AIEEE - 2011]**

(1) 20% (2) 5% (3) 10% (4) 15%

30. The current in the primary circuit of a potentiometer is 0.2 A. The specific resistance and cross-section of the potentiometer wire are 4 10^{-7} ohm metre and 8 10^{-7} m^2 respectively. The potential gradient will be equal to :- **[AIEEE - 2011]**

(1) 0.2 V/m (2) 1 V/m (3) 0.5 V/m (4) 0.1 V/m

31. Two electric bulbs marked 25W-220 V and100 W-220 V are connected in series to a 440 V supply. Which of the bulbs will fuse ? **[AIEEE - 2012]**

(1) Neither (2) Both (3) 100 W (4) 25 W

32. The supply voltage to a 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? **[AIEEE - 2013]**

(1) zero Volt (2) 2.9 Volt (3) 13.3 Volt (4) 10.04 Volt

33. This question has Statement I and Statement II. Of the four choice given after the Statements, choose the one that best describes the two Statemens. **[AIEEE - 2013]**

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

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

(1) Statement-I is true, Statement-II is true, Statement-II is the **correct** explanation of Statement-I

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

(3) Statement-I is **true,** Statement-II is false.

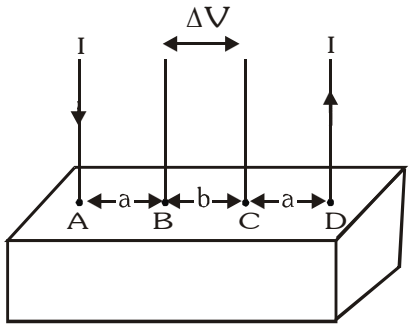
(4) Statement-I is **false,** Statement-II is true.

PREVIOUS YEARS QUESTIONS **ANSWER KEY** EXERCISE –5(A)

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	3	4	4	2	4	3	1	2	1	3	2	2	2	4	4	4	2	2	2
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33							
Ans.	3	2	3	3	3	2	1	4	2	4	4	4	4							

Directions : Question No. 24 and 25 are based on the following paragraph.

Consider a block of conducting material of resistivey 'ρ' shown in the figure. Current 'I' enters at 'A' and leaves from 'D'. We apply superposition prinicple to find voltage 'ΔV' developed between 'B' and 'C'. The calculation is done in the following steps : **[AIEEE - 2008]**



(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'

24. For current entering at A, the electric field at a distance 'r' from A is

(1) $\frac{\rho I}{8\pi r^2}$ (2) $\frac{\rho I}{r^2}$ (3) $\frac{\rho I}{2\pi r^2}$ (4) $\frac{\rho I}{4\pi r^2}$

25. ΔV measured between B and C is

(1) $\frac{\rho I}{\pi a}-\frac{\rho I}{\pi(a+b)}$ (2) $\frac{\rho I}{a}-\frac{\rho I}{(a+b)}$ (3) $\frac{\rho I}{2\pi a}-\frac{\rho I}{2\pi(a+b)}$ (4) $\frac{\rho I}{2\pi(a+b)}$

26. **Statement–1 :** The temperature dependence of resistance is usually given as $R = R_0(1+\alpha\Delta t)$. The resistance of a wire changes from 100Ω to 150Ω when its temperature is increased from 27 C to 227 C. This implies that $\alpha = 2.5 \quad 10^{-3}/$ C. **[AIEEE - 2009]**

Statement–2 : $R = R_0(1 + \alpha\Delta t)$ is valid only when the change in the temperature ΔT is small and $\Delta R = (R - R_0) << R_0$.

(1) Statement–1 is true, Statement–2 is true; Statement–2 is not the correct explanation of Statement–1

(2) Statement–1 is false, Statement–2 is true

(3) Statement–1 is true, Statement–2 is false

(4) Statement–1 is true, Statement–2 is true; Statement–2 is the correct explanation of Statement–1

27. 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 : **[AIEEE - 2010]**

(1) $\frac{\alpha_1+\alpha_2}{2}, \frac{\alpha_1+\alpha_2}{2}$ (2) $\frac{\alpha_1+\alpha_2}{2}, \alpha_1+\alpha_2$ (3) $\alpha_1+\alpha_2, \frac{\alpha_1+\alpha_2}{2}$ (4) $\alpha_1+\alpha_2, \frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$

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

(1) decrease by 0.2% (2) decrease by 0.05% (3) increase by 0.05% (4) increase by 0.2%

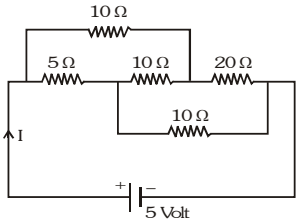
18. The resistance of bulb filament is 100 Ω at a temperature of 100 C. If its temperature coefficient of resistance be 0.005 per C, its resistance will become 200 Ω at a temperature of- **[AIEEE - 2006]**

(1) 300 C (2) 400 C (3) 500 C (4) 200 C

19. In a wheatstone's bridge, three resistances P, Q and R are 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- **[AIEEE - 2006]**

(1) $\frac{P}{Q} = \frac{2R}{S_1 + S_2}$ (2) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{S_1 S_2}$ (3) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{2S_1 S_2}$ (4) $\frac{P}{Q} = \frac{R}{S_1 + S_2}$

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

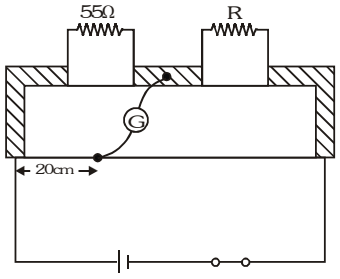


(1) 0.33 A (2) 0.5 A (3) 0.67 A (4) 0.17 A

21. The resistance of a wire is 5Ω at 50 C and 6 Ω at 100 C. The resistance of the wire at 0 C will be- **[AIEEE - 2007]**

(1) 2 Ω (2) 1 Ω (3) 4 Ω (4) 3 Ω

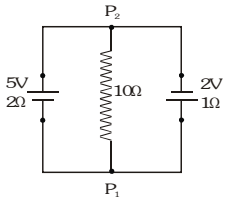
22. Shown in the figure below is a meter - bridge set up with null deflection in the galvanometer **[AIEEE - 2008]**



The value of the unknown resistor R is

(1) 13.75Ω (2) 220 Ω (3) 110Ω (4) 55Ω

23. A 5V battery with internal resistance 2Ω and a 2V battery with internal resistance1Ω are connected to a 10 Ω resistor as shown in the figure. The current in the 10Ω resistor is **[AIEEE - 2008]**



(1) 0.27 A P_2 to P_1 (2) 0.03 A P_1 to P_2 (3) 0.03 A P_2 to P_1 (4) 0.27 A P_1 to P_2

9. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. It the lengths and radii of the wires are in the ratio of 4/3 and 2/3, then the ratio of the currents passing through the wire will be- **[AIEEE - 2004]**

(1) 3 (2) 1/3 (3) 8/9 (4) 2

10. In a metre 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 4X against Y ? **[AIEEE - 2004]**

(1) 50 cm (2) 80 cm (3) 40 cm (4) 70 cm

11. The thermistor are usually made of **[AIEEE - 2004]**

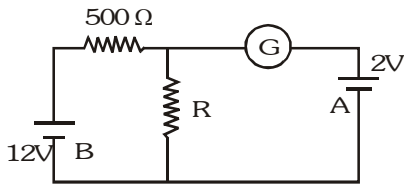
(1) metals with low temperature coefficient of resistivity

(2) metals with high temperature coefficient of resistivity

(3) metal oxides with high temperature coefficient of resistivity

(4) semiconducting materials having low temperature coefficient of resistivity

12. 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- **[AIEEE - 2005]**



(1) 200 Ω (2) 100 Ω (3) 500 Ω (4) 1000 Ω

13. Two sources of equal emf are connected to an external resistance R. The internal resistances of the two sources are R_1 and R_2 ($R_2 > R_1$). If the potential difference across the source having internal resistance R_2, is zero, then- **[AIEEE - 2005]**

(1) $R = \frac{R_2 \times (R_1 + R_2)}{(R_2 - R_1)}$ (2) $R = R_2 - R_1$ (3) $R = \frac{R_1 R_2}{(R_1 + R_2)}$ (4) $R = \frac{R_1 R_2}{(R_2 - R_1)}$

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

(1) equal to the resistance of the load (2) very large as compared to the load resistance

(3) zero (4) non-zero but less than the resistance of the load

15. 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- **[AIEEE - 2005]**

(1) 1 Ω (2) 0.5 Ω (3) 4 Ω (4) 2 Ω

16. 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- **[AIEEE - 2006]**

(1) conservation of charge, conservation of momentum (2) conservation of energy, conservation of charge

(3) conservation of momentum, conservation of charge (4) conservation of charge, conservation of energy

17. 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 I_B / I_A of their respective lengths must be- **[AIEEE - 2006]**

(1) 1 (2) $\frac{1}{2}$ (3) $\frac{1}{4}$ (4) 2

EXERCISE–05(A) PREVIOUS YEAR QUESTIONS

1. If an ammeter is to be used in place of a voltmeter, then we must connect with the ammeter a- **[AIEEE - 2002]**

(1) low resistance in parallel (2) high resistance in parallel

(3) high resistance in series (4) low resistance in series

2. By increasing the temperature, the specific resistance of a conductor and a semiconductor- **[AIEEE - 2002]**

(1) increases for both (2) decreases for both

(3) increases, decreases respectively (4) decreases, increases respectively

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

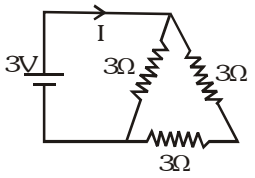
(1) $\frac{30E}{100.5}$ (2) $\frac{30E}{100-0.5}$

(3) $\frac{30(E-0.5i)}{100}$, where i is the current in the potentiometer wire (4) $\frac{30E}{100}$

4. An ammeter reads upto 1 A. Its internal resistance is 0.81 Ω. To increase the range to 10 A, the value of the required shunt is- **[AIEEE - 2003]**

(1) 0.03 Ω (2) 0.3 Ω (3) 0.9 Ω (4) 0.09 Ω

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

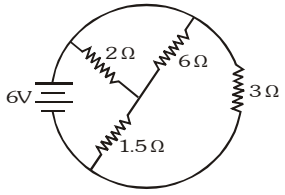


(1) 1 A (2) 1.5 A (3) 2 A (4) $\frac{1}{3}$ A

6. The length of a given cylindrical wire is increased by 100%. Due to the consequent decrease in diameter the change in the resistance of the wire will be- **[AIEEE - 2003]**

(1) 200 % (2) 100 % (3) 50 % (4) 300 %

7. The total current supplied to the circuit by the battery is- **[AIEEE - 2004]**

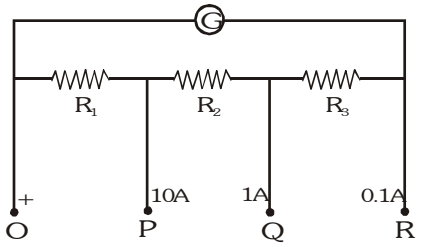


(1) 1 A (2) 2 A (3) 4 A (4) 6 A

8. The resistance of the series combination of two resistance is S. When they are joined in parallel, the total resistance is P. If S = nP, then the minimum possible value of n is- **[AIEEE - 2004]**

(1) 4 (2) 3 (3) 2 (4) 1

8. The resistance of the galvanometer G in the circuit is 25Ω. The meter deflects full scale for a current of 10 mA. The meter behaves as an ammeter of three different ranges. The range is 0–10A, if the terminals O and P are taken; range is 0–1 A between O and Q; range is 0–0.1 A between O and R. Calculate the resistance R_1, R_2 and R_3.



9. A galvanometer having 50 divisions provided with a variable shunt s is used to measure the current as a ammeter when connected in series with a resistance of 90 Ω and a battery of internal resistance 10Ω. It is observed that when the shunt resistance are 10Ω, 50Ω, respectively the deflection are respectively 9 & 30 divisions. What is the resistance of the galvanometer? Further if the full scale deflection of the galvanometer movement is 300 mA, find the emf of the cell.

10. A galvanometer (coil resistance 99Ω) is converted into a ammeter using a shunt of 1Ω and connected as shown in the figure (i). The ammeter reads 3A. The same galvanometer is converted into a voltmeter by connected a resistance of 101Ωin series. This voltmeter is connected as shown in figure (ii). Its reading is found to be 4/5 of the full scale reading. Find

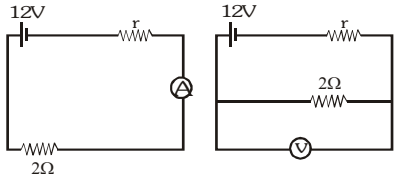


Fig. (i) Fig. (ii)

(i) internal resistance r of the cell

(ii) range of the ammeter and voltmeter

(iii) full scale deflection current of the galvanometer

BRAIN STORMING SUBJECTIVE EXERCISE — ANSWER KEY — EXERCISE-4(B)

1. $\frac{3r}{5}$ **2.** $\frac{3}{11}\alpha$ **3.** $\frac{7}{5}$ times the length of any side of the side

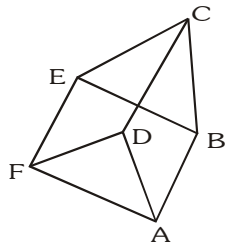
4. $\frac{(2+\pi)ar}{8}$ **5.** $\frac{Q^2\pi^2R}{8T}$ **6.** (i) $R=\frac{\rho_0 L}{A}\left(1-\frac{1}{e}\right)$, $I=\frac{V_0 A}{\rho_0 L}\left(\frac{e}{e-1}\right)$ (ii) $V=\frac{V_0\left(e^{-x/L}-e^{-1}\right)}{1-e^{-1}}$

7. 600Ω **8.** R_1=0.0278Ω, R_2=0.25Ω, R_3 = 2.5Ω

9. 233.3Ω, 144V **10.** (i) 1.01Ω (ii) 0-5 A, 0-10V, (ii) 0.05 A

EXERCISE–04 [B] BRAIN STORMING SUBJECTIVE EXERCISE

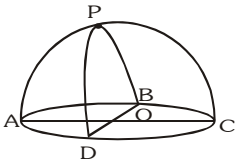
1. In the circuit shown in figure, all wires have equal resistance r. Find the equivalent resistance between A and B.



2. A triangle is constructed using the wires AB, BC & CA of same material and of resistance α, 2α & 3α respectively. Another wire of resistance $\alpha/3$ from A can make a sliding contact with wire BC. Find the maximum resistance of the network between points A and the point of sliding wire with BC.

3. A piece of resistive wire is made up into two squares with a common side of length 10 cm. A current enters the rectangular system at one of the corners and leaves at the diagonally opposite corners. Show that the current in the common side is 1/5th of the entering current. What length of wire connected between input and output terminals would have an equivalent effect.

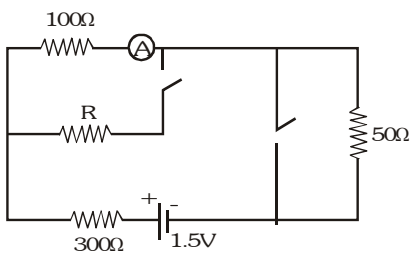
4. A hemisphere network of radius 'a' is made by using a conducting wire of resistance per unit length r. Find the equivalent resistance across OP.



5. A total charge Q flows across a resistor R during a time interval T in such a way that the current v/s time graph for $0 \rightarrow T$ is like the loop of a sin curve in the range $0 \rightarrow \pi$. What will be the total heat generated in the resistor.

6. A rod of length L and cross–section area A lies along the x–axis between x=0 and x=L. The material obeys Ohm's law and its resistivity varies along the rod according to $\rho(x) = \rho_0 e^{-x/L}$. The end of the rod at x=0 is at a potential V_0 and it is zero at x=L. (i) Find the total resistance of the rod and the current in the wire (ii) Find the electric potential in the rod as a function of x.

7. In the circuit shown in figure the reading of ammeter is the same with both switches open as with both closed. Then find the resistance R. (ammeter is ideal).



26. (i) The current density across a cylindrical conductor of radius R varies according to the equation $J = J_0\left(1-\frac{r}{R}\right)$, where r is the distance from the axis. Thus the current density is a maximum J_0 at the axis r=0 and decreases linearly to zero at the surface r=R. Calculate the current in terms of J_0 and the conductor's cross sectional area is $A = \pi R^2$. (ii) Suppose the instead the current density is a maximum J_0 at the surface and decreases linearly to zero at the axis so that $J=J_0r/R$. Calculate the current.

27. An accumulator of emf 2 volt and negligible internal resistance is connected across a uniform wire of length 10 m and resistance 30Ω. The appropriate terminals of a cell of emf 1.5 Volt and internal resistance 1Ω is connected to one end of the wire, and the other terminal of the cell is connected through a sensitive galvanometer to a slider on the wire. (i) What length of the wire will be required to produce zero deflection of the galvanometer? (ii) How will the balancing change (a) when a coil of resistance 5 Ω is placed in series with the accumulator, (b) the cell of 1.5 volt is shunted with 5Ω resistor?

CONCEPTUAL SUBJECTIVE EXERCISE — ANSWER KEY — EXERCISE-4(A)

1. I = 2.5 A, V=3.5 volt **2.** 11V, 9V, 6V **3.** 1Ω **4.** $\frac{22}{35}\Omega$

5. $\frac{8}{7}R$ **6.** 9Ω **7.** (i) V_{ab} = –12V (ii) 3A from b to a

8. (i) 3W (ii) 0.4 W (iii) 2.6W (iv) 2.6W **9.** 12A, –20W

10. $V = \frac{V_1r_2 - V_2r_1}{r_1+r_2}$, $r = \frac{r_1r_2}{r_1+r_2}$ **11.** $\sqrt{R_1R_2}$ **12.** 1Ω **13.** $R\left(\sqrt{3}-1\right)$

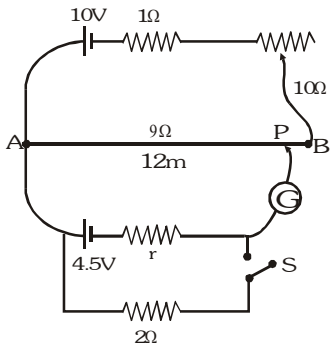
14. $\frac{25}{12}$ A **15.** 15A **16.** (i) $\frac{1}{2}i_0t_0$ (ii) $i = i_0\left(1-\frac{t}{t_0}\right)$ (iii) $\frac{Rt_0i_0^2}{3}$

17. 1A **18.** $\frac{20}{3}$ V **19.** 4Ω **20.** $\frac{10}{3}\Omega, 5\Omega$

21. (i) 6m (ii) 1Ω **22.** 12 **23.** 13

24. 4Ω **25.** 3.5 A **26.** (i) $\frac{J_0A}{3}$ (ii) $\frac{2J_0A}{3}$

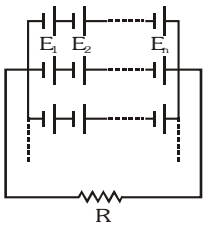
27. (i) 7.5 m (ii) (a) 8.75 m (b) 6.25 m



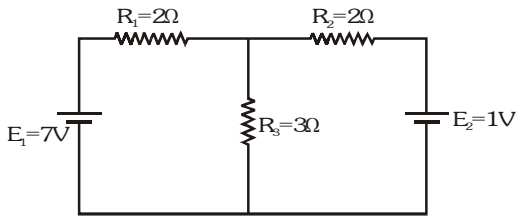
(i) Find the length AP of the wire such that the galvanometer shows zero deflection.

(ii) Now the rheostat is put at maximum resistance ($10\,\Omega$) and the switch S is closed. New balancing length is found to 8m. Find the internal resistance r of the 4.5V cell.

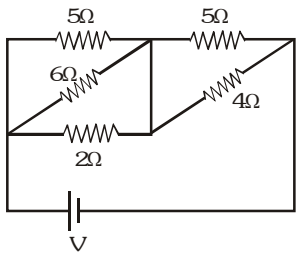
22. 324 identical galvanic cells, each of internal resistance 9Ω are arranged as several in-series groups of cells connected in parallel. The arrangement has been laid out so that power output in an externally connected resistance of value $4\ \Omega$ is maximum. If n cells are connected in every series group that form parallel combination, then find value of n.



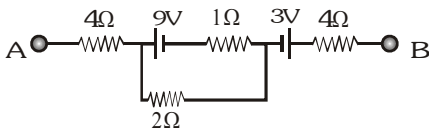
23. In given electrical circuit, let power supplied by battery E_1 be a and power supplied by battery E_2 be b then what is the value of a + b.



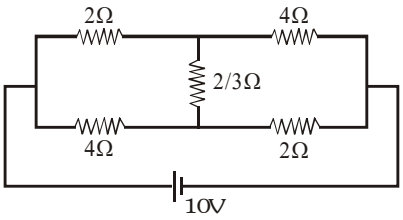
24. Find the resistor in which maximum heat will be produced.



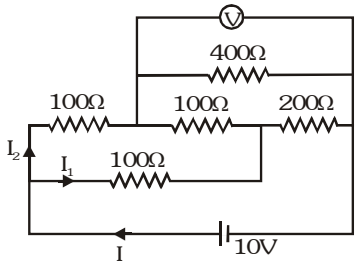
25. In the circuit shown in figure potential difference between point A and B is 16V. Find the current passing through 2Ω resistance.



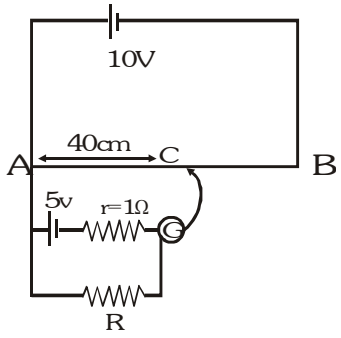
17. Find the current through $\frac{2}{3}\Omega$ resistance in the figure shown.



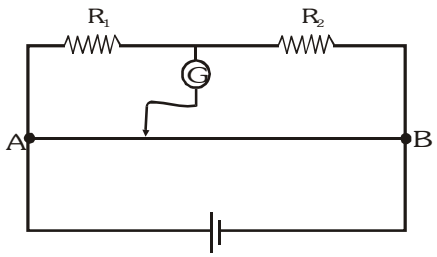
18. An electrical circuit is shown in figure. Calculate the potential difference across the resistor of 400Ω as will be measured by the voltmeter V of resistance 400Ω either by applying Kirchhoff's rules or otherwise.



19. A potentiometer wire AB is 100 cm long and has a total resistance of10 ohm. if the galvanometer shows zero deflection at the position C, then find the value of unknown resistance R.



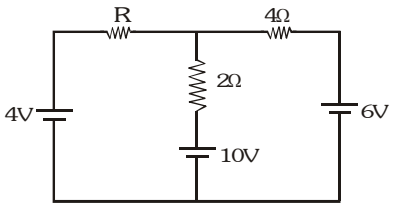
20. In the figure shown for gives values of R_1 and R_2 the balance point for Jockey is at 40 cm from A. When R_2 is shunted by a resistance of 10Ω, balance shifts to 50 cm. Find R_1 and R_2. (AB = 1m)



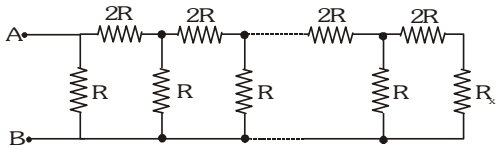
21. In the primary circuit of potentiometer for rheostat can be varied from 0 to 10Ω. Initially it is at minimum resistance (zero).

11. If a cell of constant E.M.F. produces the same amount of the heat during the same time in two independent resistors R_1 and R_2, when they are separately connected across the terminals of the cell, one after the another, Find the internal resistance of the cell.

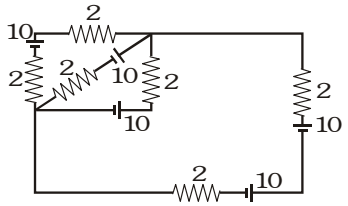
12. For what value of R in circuit, current through 4Ω resistance is zero ?



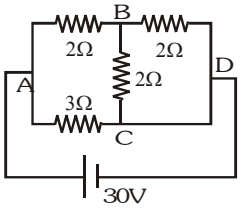
13. At what value of the resistance R_x in the circuit shown in figure will the total resistance between points A and B be independent of the number of loops ?



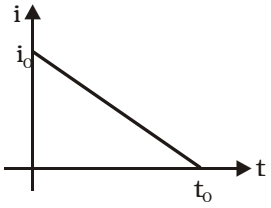
14. All batteries are having emf 10 volt and internal resistance negligible.All resistors are in ohms. Calculate the current in the right most 2Ω resistor.



15. Find current in the branch CD of the circuit (in ampere).



16. Relation between current in conductor and time is shown in figure then determine.

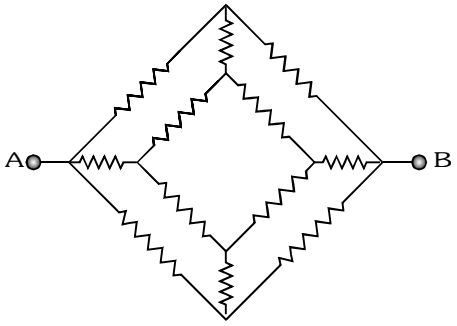


(i) Total charge flow through the conductor

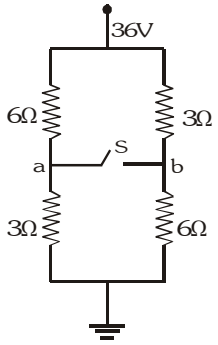
(ii) Write expression of current in terms of time

(iii) If resistance of conductor is R then total heat dissipated across resistance R is

6. The figure shows a network of resistor each heaving value 12Ω.Find the equivalent resistance between points A and B.



7. In the circuit shown in figure, calculate the following :

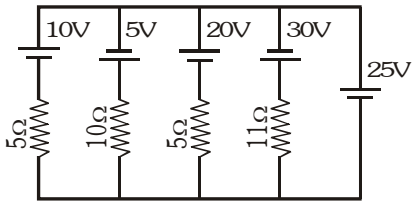


(i) Potential difference between points a and b when switch S is open.

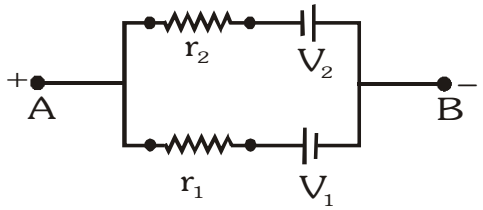
(ii) current through S in the circuit when S is closed.

8. A dry cell of emf 1.5 V and internal resistance 0.10 Ω is connected across a resistor in series with a very low resistance ammeter. When the circuit is switched on, the ammeter reading settles to steady value of 2 A. What is the steady (i) rate of chemical energy consumption of the cell (ii) rate of energy dissipation inside the cell (iii) rate of energy dissipation inside the resistor, and (iv) power output of the source ?

9. Find the current through 25V cell & power supplied by 20V cell in the figure shown.

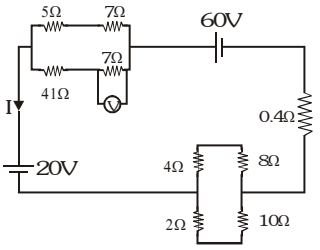


10. Find the emf (V) and internal resistance (r) of a single battery which is equivalent to a parallel combination of two batteries of emfs V_1 and V_2 and internal resistance r_1 and r_2 respectively, with polarities as shown in figure.

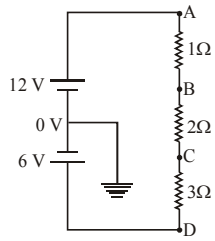


EXERCISE–04 [A] CONCEPTUAL SUBJECTIVE EXERCISE

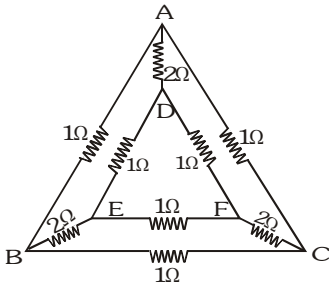
1. Find the current I & voltage V in the circuit shown.



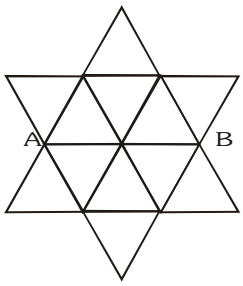
2. In the circuit shown what are the potential at B, C and D ?



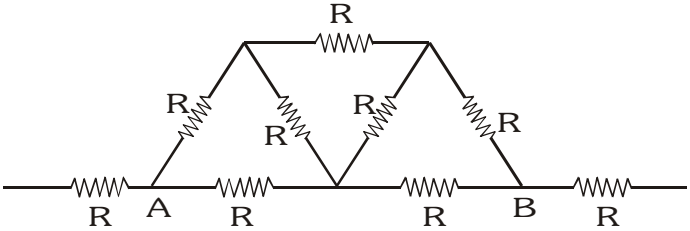
3. A network of nine conductors connects six points A, B, C, D, E and F as shown in figure. The figure denotes resistances in ohms. Find the equivalents resistance between A and D.



4. Find the equivalent resistance of the circuit between points A and B shown in figure is : (each branch is of resistance = 1Ω)

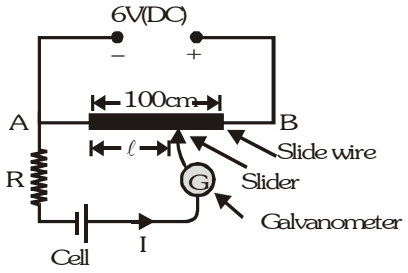


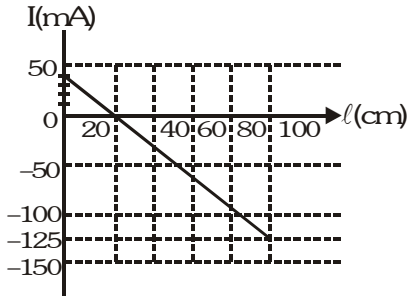
5. Find the effective resistance of the network (see figure) between the points A and B. Where R is the resistance of each part.



Comprehension#5

In the circuit shown, the internal resistance of the cell is negligible. The distance of the jockey (slider) from left hand end of the wire is ℓ. The adjoining graph shows the variation of current I (marked in figure) with length ℓ of the slide wire.





1. For balancing condition of the instrument value of ℓ is equal to-
(A) 40 cm (B) 20 cm (C) 100 cm (D) None of these

2. Value of the emf of cell, is-
(A) 0.98 V (B) 1.20 V (C) 1.86 V (D) 3 V

3. Value of the resistance R, is-
(A) 30 Ω (B) 40 Ω (C) 38 Ω (D) 45 Ω

Comprehension#6

A car battery with a 12V emf and an internal resistance of 0.04 Ω is being charged with a current of 50 A.

1. The potential difference V across the terminals of the battery are–
(A) 10V (B) 12V (C) 14V (D) 16V

2. The rate at which energy is being dissipated as heat inside the battery is–
(A) 100W (B) 500W (C) 600W (D) 700W

3. The rate of energy conversion from electrical to chemical is–
(A) 100W (B) 500W (C) 600W (D) 700W

MISCELLANEOUS TYPE QUESTION — ANSWER KEY — EXERCISE –3

- ***True / False***

1	2	3	4	5	6	7	8
F	T	T	F	T	T	F	T

- ***Fill in the Blanks*** **1.** 44% **2.** $\left(\frac{n}{m}\right)^2$ **3.** 9 V **4.** 1.66 Ω **5.** 20

- ***Assertion – Reason***

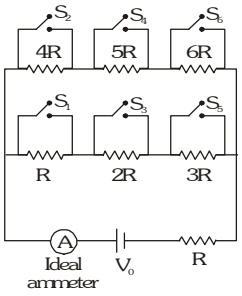
1	2	3	5	6	7	8	9
B	C	E	A	A	C	B	A

- ***Match the Column*** **1.** (A) q (B) p (C) p **2.** (A) p (B) p (C) q (D) q,s

- ***Comprehension Based***

Comprehension #1 :	**1.** A	**2.** B	**3.** B
Comprehension #2 :	**1.** A,C	**2.** B,D	**3.** A,B
Comprehension #3 :	**1.** C	**2.** A	**3.** B
Comprehension #4 :	**1.** B	**2.** B	**3.** D
Comprehension #5 :	**1.** B	**2.** B	**3.** A
Comprehension #6 :	**1.** C	**2.** A	**3.** C

Comprehension#3



For the circuit shown, answer the following questions

1. In which of the following case current shown by ammeter is maximum

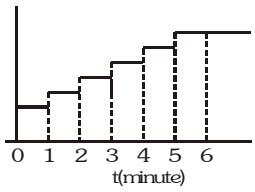
   (A) S_1, S_2,S_3 closed

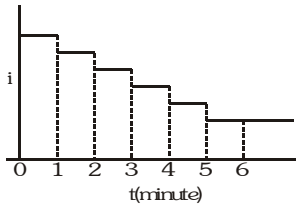
   (B) S_2, S_4,S_5 closed

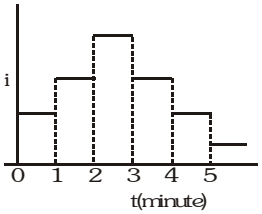
   (C) S_1,S_3,S_5 closed

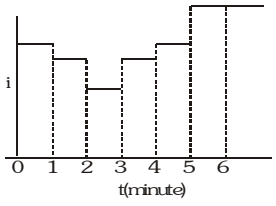
   (D) S_2, S_3,S_4 closed

2. Say switches S_1,S_2 and so on upto S_6 are closed at regular intervals of 1minute starting from t=0. The graph of current versus time is best represented as –

(A) 

(B) 

(C) 

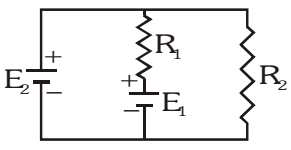
(D) 

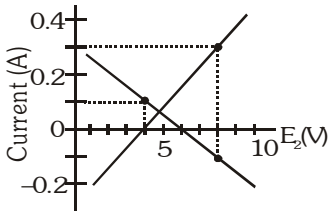
3. Ratio of power developed by battery when all switches are closed to that when all switches are open–

   (A) $\frac{37}{7}$ (B) $\frac{7}{37}$ (C) $\left(\frac{37}{7}\right)^2$ (D) $\left(\frac{7}{37}\right)^2$

Comprehension#4

In the circuit shown, both batteries are ideal. Electro motive force E_1 of battery 1 has a fixed value, but emf E_2 of battery 2 can be varied between 1 V and 10V. The graph gives the currents through the two batteries as a function of E_2, but are not marked as which plot corresponds to which battery. But for both plots, current is assumed to be negative when the direction of the current through the battery is opposite the direction of that battery's emf (direction from negative to positive).





1. The value of emf E_1 is–

   (A) 8V (B) 6V (C) 4V (D) 2V

2. The resistance R_1 has value–

   (A) 10Ω (B) 20Ω (C) 30Ω (D) 40Ω

3. The resistance R_2 is equal to–

   (A) 10Ω (B) 20Ω (C) 30Ω (D) 40Ω

COMPREHENSION TYPE QUESTIONS

Comprehension#1

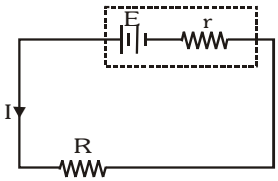
Important aspect of fuse wire and battery

Electric fuse a protective device used in series with an electric circuit or an electric appliance to save it from damage due to overheating produced by strong current in the circuit or appliance. Fuse wire is generally made from an alloy of lead and tin which has high resistance and low melting point. It is connected in series in an electric installation. If a circuit gets accidentally short–circuited, a large current flows, then fuse wire melts away which causes a break in the circuit.

The power through fuse (P) is equal to heat energy lost per unit area per unit time (h) (neglecting heat loses from ends of the wire). $P = I^2R = h \quad 2\pi r\ell$ ..... $\left[R = \frac{\rho\ell}{\pi r^2}\right]$ r and ℓ are the length and radius of fuse wire.

A battery is described by it's Emf (E) and internal resistance (r) Efficiency of battery is defined as the ratio of the output power and the input power $\eta = \frac{\text{output power}}{\text{input power}} \times 100$ %

but $I = \frac{E}{R+r}$, input power = EI , output power = $EI - I^2r$



then $\eta = \left(\frac{EI - I^2r}{EI}\right) \times 100 = \left(1 - \frac{Ir}{E}\right) \times 100 = 1 - \left(\frac{E}{R+r}\right)\left(\frac{r}{E}\right) \times 100 = \left(\frac{R}{R+r}\right) \times 100$

We know that output power of a source is maximum when the external resistance is equal to internal resistance, i.e., R = r.

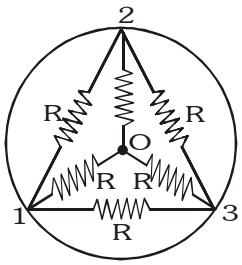
1. Two fuse wire of same material are having length ratio 1 : 2 and radius ratio 4 : 1. Then respective ratio of their current rating will be–
(A) 8 : 1 (B) 2 : 1 (C) 1 : 8 (D) 4 : 1

2. The maximum power rating of a 20.0 Ω fuse wire is 2.0 kW, then this fuse wire can be connected safely to a D.C. source (negligible internal resistance) of–
(A) 300 volt (B) 190 volt (C) 250 volt (D) 220 volt

3. Efficiency of a battery (non–ideal) when delivering maximum power is–
(A) 100 % (B) 50 % (C) 90 % (D) 40 %

Comprehension#2

Inside a super conducting ring six identical resistors each of resistance R are connected as shown in figure.



1. The equivalent resistance(s)
(A) between 1 & 3 is zero
(B) between 1 & 3 is R/2
(C) between 1 & 2, 2 & 3, 3 & 1 are all equal
(D) None of these

2. The equivalent resistance (s)
(A) between 0 & 1 is R (B) between 0 & 1 is R/3
(C) between 0 & 1 is 0 (D) between 0 & 1, 0 & 2 and 0 & 3 are all equal

3. Imaging a battery of emf E between the point 0 and 1, with its positive terminal connected with O.
(A) The current entering at O is equally divided into three resistances
(B) The current in the other three resistances R_{12}, R_{13}, R_{23} is zero
(C) The resistances R_{02} and R_{03} have equal magnitudes of current while the resistance R_{01} have different current
(D) Potential $V_2 = V_3 > V_1$

7. **Statement-1** : A steady current is flowing in a conductor hence there is an electric field within the conductor.

and

Statement-2 : In case of steady current, there can be no accumulation of charges, so no electric field can be established.

(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.

8. **Statement-1** : The coil of a heater is cut into two equal halves and only one of them is used into heater. The heater will new require half the time to produce the same amount of heat.

and

Statement-2 : Heat produced in a coil is directly proportional to square of the current, through it.

(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.

9. **Statement-1** : Current is passed through a metallic wire, heating it red. When cold water is poured over half of its portion, rest of the portion becomes more hot.

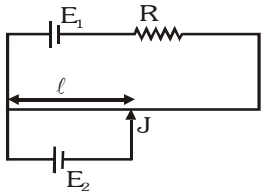
and

Statement-2 : Resistance decreases due to decrease in temperature so current through wire increases.

(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.

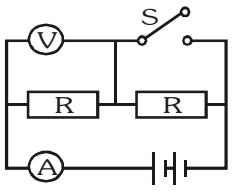
Match the Column

1. In the potentiometer arrangement shown in figure, null point is obtained at length ℓ.



	Column I		Column II
(A)	If E_1 is increased	(p)	ℓ should increase
(B)	If R is increased	(q)	ℓ should decrease
(C)	If E_2 is increased	(r)	ℓ should remain the same to again get the null point

2. The diagram shows a circuit with two identical resistors. The battery has a negligible internal resistance.What will the effect on the ammeter and voltmeter be if the switch S is closed ?



	Column I		Column II
(A)	Ammeter reading	(p)	Increases
(B)	Voltmeter reading	(q)	Decreases
(C)	Equivalent resistance of circuit	(r)	Does not change
(D)	Power dissipated across R in right branch	(s)	Becomes zero

Assertion-Reason

In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it . Of the statements mark the correct answer as

1. **Statement-1** : When an external resistor of resistance R (connected across a cell of internal resistance r) is varied, power consumed by resistance R is maximum when R = r.
   and
   Statement-2 : Power consumed by a resistor of constant resistance R is maximum when current through it is maximum.
   (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.

2. **Statement-1** : The electric bulb glows immediately when switch is on.
   and
   Statement-2 : The drift velocity of electrons in a metallic wire is very high.
   (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.

3. **Statement-1** : In a chain of bulbs, 50 bulbs are joined in series. One bulb is fused now. If the remaining 49 bulbs are again connected in series across the same supply then light gets decreased in the room.
   and
   Statement-2 : The resistance of 49 bulbs will be more than 50 bulbs.
   (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.

4. **Statement–1** : Electric field inside a current carrying wire is zero.
   and
   Statement–2 : Net charge on wire is zero.
   (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.

5. **Statement–1** : Kirchoff's loop rule indicates that electrostatic field is conservative.
   and
   Statement–2 : Potential difference between two points in a circuit does not depends on path.
   (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.

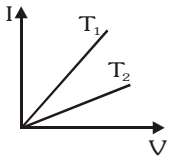
6. **Statement–1** : A metal has resistance and gets often heated by flow of current.
   and
   Statement–2 : When free electrons drift through a metal they makes occasional collisions with the lattice. These collisions inelastic and transfer energy to the lattice as internal energy
   (A) Statement–1 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.

EXERCISE–03 MISCELLANEOUS TYPE QUESTIONS

True/False

1. Electrons in a conductor have no motion in the absence of a potential difference across it.

2. The current–voltage graphs for a given metallic wire at two different temperatures T_1 and T_2 are shown in the figure. The temperature T_2 is greater than T_1.



3. It is easier to start a car engine on a warm day than on a chilld day.

4. It is not possible to construct two wires of the same length, but of different materials, (copper and iron) such that they have the same resistance at the same temperature.

5. Larger the current drawn from a cell, smaller is the potential difference across its terminals.

6. In a single battery circuit, the point of the lowest potential is the negative terminal of the battery.

7. In a single battery circuit, the current decreases steadily as we go around the circuit from the positive terminal.

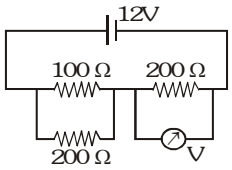
8. The emf of a cell is greater than the potential difference between its terminals as measured by a voltmeter.

Fill in the blanks

1. If a wire is stretched, so that its length is 20% more than its initial length, the percentage increase in the resistance of the wire is.....

2. You are given 'mn' wires of the same resistance. If 'm' wires are in series and n such combinations are in parallel, then the resistance is R_1, if 'n' wires are in series and m such combinations are in parallel, the resistance is R_2. Then $\left(\frac{R_2}{R_1}\right)$ is.....

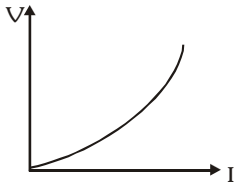
3. For the circuit shown in the figure the reading of the voltmeter will be.....

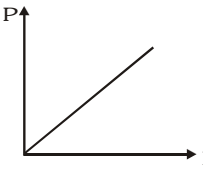


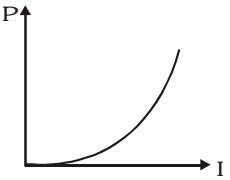
4. In a metre bridge experiment, the null deflection is obtained at a length 25 cm from left end. When a standard resistance of 5Ω is employed in the right gap, the value of resistance in the left gap to be determined is.....

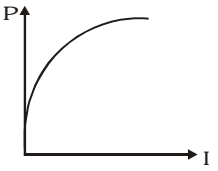
5. An electric bulb rated for 500 W at 100 V is used in a circuit having a 200 V supply. The resistance R that must be put in series with the bulb, so that the bulb delivers 500 W is .....Ω

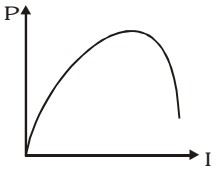
28. The variation of current (I) and voltage (V) is as shown in figure. The variation of power P with current I is best shown by which of the following graph



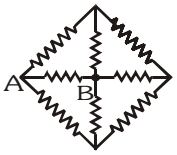
(A) 

(B) 

(C) 

(D) 

29. In the circuit diagram each resistor of resistance 5Ω. The points A and B are connected to the terminals of a cell of electromotive force 9 volt and internal resistance 2/3Ω.



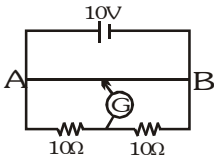
(A) The heat produced in the cell is 6W.

(B) The current in the resistor connected directly between A and B is 1.4A.

(C) The current in the resistor connected directly between A and B is 1.8 A.

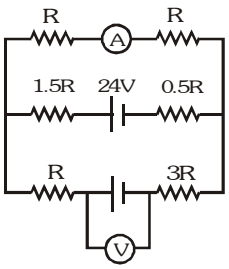
(D) None of the above is correct.

30. The wire AB of a meter bridge changes linearly from radius r to 2r from left end to right end. Length of wire is 1m. Where should the free end of the galvanometer be connected on AB so that the deflection in the galvanometer is zero?



(A) $\frac{2}{3}$m from end B (B) $\frac{1}{3}$m from end A (C) $\frac{1}{4}$m from end A (D) $\frac{3}{4}$m from end B

31. If the reading of ammeter is 2A then the reading of voltmeter



(A) Depends on R

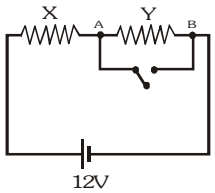
(B) Independent on R

(C) Zero for certain value of R

(D) can't be determined

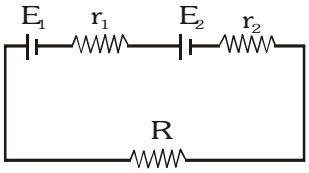
BRAIN TEASERS					ANSWER KEY														EXERCISE –2
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	AD	ACD	AC	AC	A	AB	B	D	ACD	D	ABC	A	D	A	AC	AC	BC	ABC	A	C
Que.	21	22	23	24	25	26	27	28	29	30	31									
Ans.	D	B	C	B	D	C	B	B	AB	AB	AC									

23. When an ammeter of negligible internal resistance is inserted in series with circuit it reads 1A. When the voltmeter of very large resistance is connected across X it reads 1V. When the point A and B are shorted by a conducting wire, the voltmeters measures 10V across the battery. The internal resistance of the battery is equal to



(A) zero (B) 0.5Ω (C) 0.2Ω (D) 0.1Ω

24. Under what condition current passing through the resistance R can be increased by short circuiting the battery of emf E_2. The internal resistances of the two batteries are r_1 and r_2 respectively.

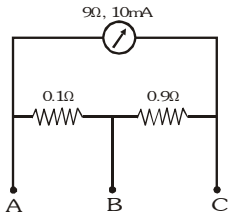


(A) $E_2r_1 > E_1 (R+r_2)$ (B) $E_1r_2 > E_2(R+r_1)$ (C) $E_2r_2 > E_1(R+r_2)$ (D) $E_1r_1 > E_2(R+r_1)$

25. n identical cells are joined in series with its two cells A and B in the loop with reversed polarities. EMF of each cell is E and internal resistance r. Potential difference across cell A or B is (here n >4)

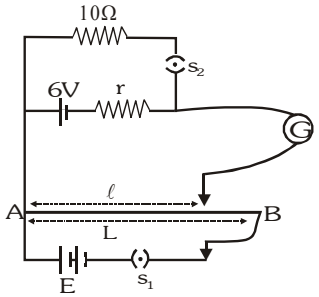
(A) $\frac{2E}{n}$ (B) $2E\left(1-\frac{1}{n}\right)$ (C) $\frac{4E}{n}$ (D) $2E\left(1-\frac{2}{n}\right)$

26. A milliammeter of range 10mA and resistance 9Ω is joined in a circuit as shown. The metre gives full–scale deflection for current I when A and B are used as its terminals, i.e., current enters at A and leaves at B (C is left isolated). The value of I is



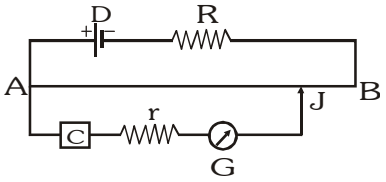
(A) 100 mA (B) 900 mA (C) 1A (D) 1.1 A

27. In the arrangement shown in figure when the switch S_2 is open, the galvanometer shows no deflection for $\ell = \frac{L}{2}$. When the switch S_2 is closed, the galvanometer shows no deflection for $\ell = \frac{5L}{12}$. The internal resistance (r) of 6V cell, and the emf E of the other battery are respectively



(A) 3Ω, 8V (B) 2Ω, 12V (C) 2Ω, 24V (D) 3Ω, 12V

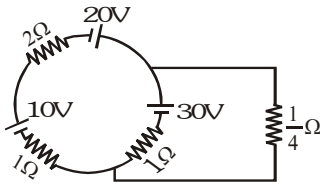
19. In the given potentiometer circuit, the resistance of the potentiometer wire AB is R_0. C is a cell of internal resistance r. The galvanometer G does not give zero deflection for any position of the jockey J. Which of the following cannot be a reason for this?



(A) $r > R_0$ (B) $R >> R_0$

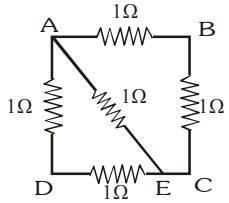
(C) Emf of C> emf of D (D) The negative terminal of C is connected to A

20. In the following circuit diagram, the current flowing through resistor of $1/4\ \Omega$ is



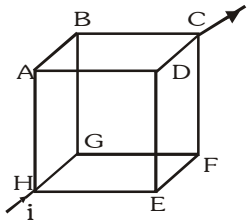
(A) 1 A (B) 60 A (C) 30 A (D) None of these

21. ABCD is a square where each side is a uniform wire of resistance 1Ω. A point E lies on CD such that if a uniform wire of resistance 1Ω is connected across AE and constant potential difference is applied across A and C then B and E are equipotential. Then-



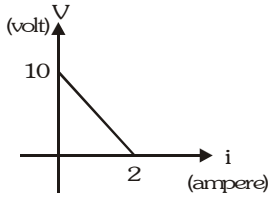
(A) $\frac{CE}{ED}=1$ (B) $\frac{CE}{ED}=2$ (C) $\frac{CE}{ED}=\frac{1}{\sqrt{2}}$ (D) $\frac{CE}{ED}=\sqrt{2}$

22. In the box shown current i enters at H and leaves at C. If $i_{AB}=\frac{i}{6}$, $i_{DC}=\frac{2i}{3}$, $i_{HA}=\frac{i}{2}$, $i_{GF}=\frac{i}{6}$, $i_{HE}=\frac{i}{6}$, Choose the branch in which current is zero



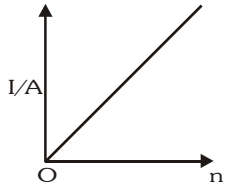
(A) BG (B) FC (C) ED (D) None

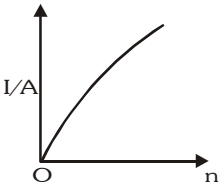
12. A battery of emf E and internal resistance r is connected across a resistance R. Resistance R can be adjusted to any value greater than or equal to zero. A graph is plotted between the current (i) passing through the resistance and potential difference (V) across it. Select the correct alternative(s)

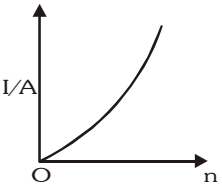


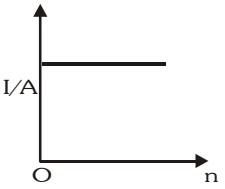
(A) Internal resistance of battery is 5Ω
(B) Emf of the battery is 20V
(C) Maximum current which can be taken from the battery is 4A
(D) V–i graph can never be a straight line as shown in figure

13. A battery consists of a variable number n of identical cells having internal resistance connected in series. The terminals of the battery are short circuited and the current I measured. Which one of the graph below shows the correct relationship between I and n?

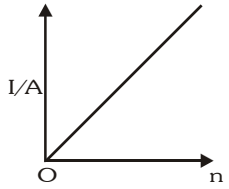
(A) 

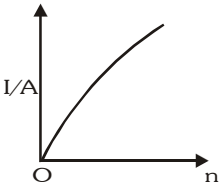
(B) 

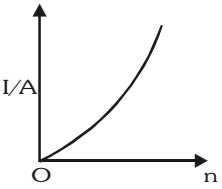
(C) 

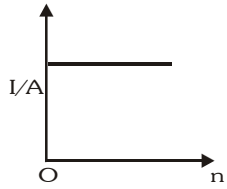
(D) 

14. In previous problem, if the cell had been connected in parallel (instead of in series) which of the above graphs would have shown the relationship between total current I and n?

(A) 

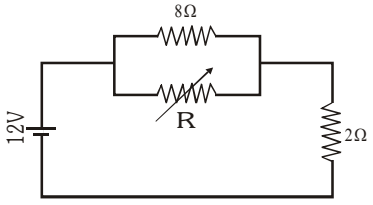
(B) 

(C) 

(D) 

15. Two identical fuses are rated at 10A. If they are joined
(A) in parallel, the combination acts as a fuse of rating 20A
(B) in parallel, the combination acts as a fuse of rating 5A
(C) in series, the combination acts as a fuse of rating 10A
(D) in series, the combination acts as a fuse of rating 20A

16. The value of the resistance R in figure is adjusted such that power dissipated in the 2Ω resistor is maximum. Under this condition
(A) R=0
(B) R= 8Ω
(C) power dissipated in the 2Ω resistors is 72W
(D) power dissipated in the 2Ω resistor is 8W

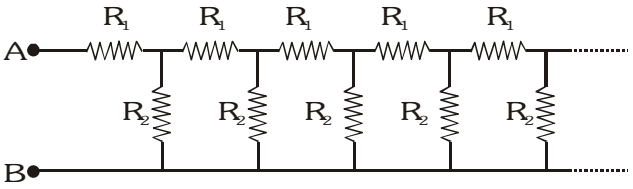


17. A microammeter has a resistance of 100Ω and a full scale range of 50 μA. It can be used as a voltmeter or a higher range ammeter provided a resistance is added to it. Pick the correct range and resistance combination(s).
(A) 50V range with 10 kΩ resistance in series.
(B) 10V range with 200 kΩ resistance in series.
(C) 5 mA range with 1 Ω resistance in parallel.
(D) 10 mA range with 1 kΩ resistance in parallel.

18. In a potentiometer wire experiment the emf of a battery in the primary circuit is 20V and its internal resistance is 5Ω. There is a resistance box in series with the battery and the potentiometer wire, whose resistance can be varied from 120Ω to 170Ω. Resistance of the potentiometer wire is 75 Ω. The following potential differences can be measured using this potentiometer.
(A) 5V (B) 6V (C) 7V (D) 8V

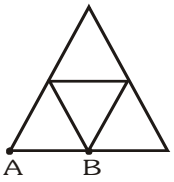
6. In a potentiometer arrangement E_1 is the cell establishing current in primary circuit E_2 is the cell to be measured. AB is the potentiometer wire and G is a galvanometer. Which of the following are the essential condition for balance to be obtained
(A) The emf of E_1 must be greater than the emf of E_2
(B) Either the positive terminals of both E_1 and E_2 or the negative terminals of both E_1 and E_2 must be joined to one end of potentiometer wire
(C) The positive terminals of E_1 and E_2 must be joined to one end of potentiometer wire
(D) The resistance of G must be less than the resistance of AB

7. Consider an infinite ladder network shown in figure. A voltage V is applied between the points A and B. This applied value of voltage is halved after each section. Then-



(A) $\frac{R_1}{R_2}=1$ (B) $\frac{R_1}{R_2}=\frac{1}{2}$ (C) $\frac{R_1}{R_2}=2$ (D) $\frac{R_1}{R_2}=3$

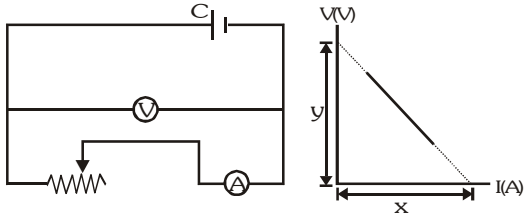
8. In the diagram resistance between any two junctions is R. Equivalent resistance across terminals A and B is



(A) $\frac{11R}{7}$ (B) $\frac{18R}{11}$ (C) $\frac{7R}{11}$ (D) $\frac{11R}{18}$

9. In a balanced wheat stone bridge, current in the galvanometer is zero. It remains zero when
(A) battery emf is increased (B) all resistances are increased by 10 ohms
(C) all resistances are made five times (D) the battery and the galvanometer are interchanged

10. The diagram besides shows a circuit used in an experiment to determine the emf and internal resistance of the cell C. A graph was plotted of the potential difference V between the terminals of the cell against the current I, which was varied by adjusting the rheostat. The graph is shown on the right; x and y are the intercepts of the graph with the axes as shown. What is the internal resistance of the cell?



(A) x (B) y (C) $\frac{x}{y}$ (D) $\frac{y}{x}$

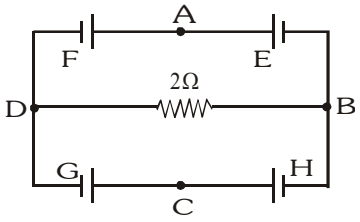
11. A battery is of emf E is being charged from a charger such that positive terminal of the battery is connected to terminal A of charger and negative terminal of the battery is connected to terminal B of charger. The internal resistance of the battery is r
(A) Potential difference across points A and B must be more than E
(B) A must be at higher potential than B
(C) In battery, current flows from positive terminal to the negative terminal
(D) No current flows through battery

EXERCISE–02 BRAIN TEASURES

Select the correct alternatives (one or more than one correct answers)

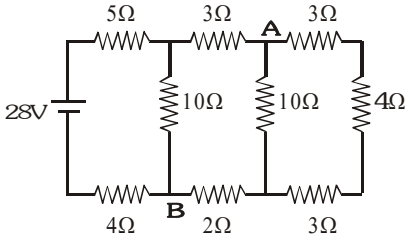
1. A current passes through a wire of nonuniform cross section. Which of the following quantities are independent of the cross–section?
(A) The charge crossing in a given time interval (B) Drift speed
(C) Current density (D) Free–electron density

2. In the circuit shown E, F, G and H are cells of e.m.f. 2V, 1V, 3V and 1V respectively and their internal resistances are 2Ω, 1Ω, 3Ω and 1Ω respectively then-



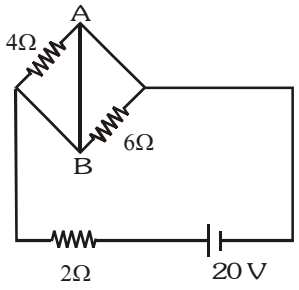
(A) $V_D - V_B = -2/13V$
(B) $V_D - V_B = 2/13$ V
(C) $V_G = 21/13V$ = potential difference across G
(D) V_H = 19/13 V = potential difference across H

3. Consider the circuit shown in the figure



(A) The current in the 5Ω resistor is 2A (B) The current in the 5Ω resistor is 1A
(C) The potential difference $V_A - V_B$ is 7V (D) The potential difference $V_A - V_B$ is 5V

4. In the circuit shown in figure–

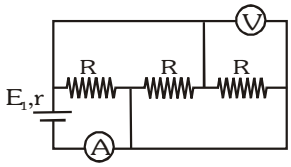


(A) Power supplied by the battery is 200 watt
(B) Current flowing in the circuit is 5 A
(C) Potential difference across 4 Ω resistance is equal to the potential difference across 6Ω resistance
(D) Current in wire AB is zero

5. The charge flowing through a resistance R varies with time as $Q = 2t - 8t^2$. The total heat produced in the resistance is (for $0 \le t \le \frac{1}{8}$)

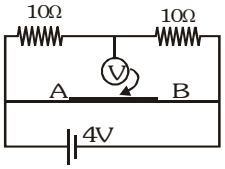
(A) $\frac{R}{6}$ joules (B) $\frac{R}{3}$ joules (C) $\frac{R}{2}$ joules (D) R joules

32. In the circuit shown in figure, ammeter and voltmeter are ideal. If E = 4V, R = 9Ω and r = 1Ω, then readings of ammeter and voltmeter are



(A) 1A, 3V (B) 2A, 3V (C) 3A, 4V (D) 4A, 4V

33. In the adjacent circuit, AB is a potentiometer wire of length 40 cm and resistance per unit length 50 Ω/m. As shown in the figure, the free end of an ideal voltmeter is touching the potentiometer wire. What should be the velocity of the jockey as a function of time so that reading in the voltmeter varies with time as (2 sin πt)?



(A) (10 π sin πt) cm/s (B) (10 π cos πt) cm/s (C) (20π sin πt) cm/s (D) (20 π cos πt) cm/s

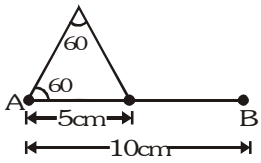
34. In the diagram shown, all the wires have resistance R. The equivalent resistance between the upper and lower dots shown in the diagram is

(A) R/8 (B) R (C) 2R/5 (D) 3R/8

35. An electric bell has a resistance of 5Ω and requires a current of 0.25 A to work it. Assuming that the resistance of the bell wire is 1Ω per 15m and that the bell push is 90m distance from the bell. How many cells each of emf1.4V and internal resistance 2Ω, will be required to work the circuit-

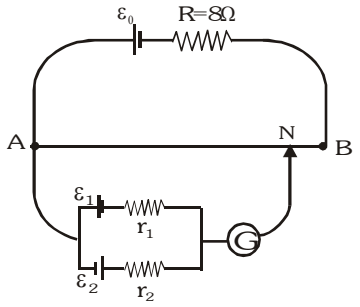
(A) 3 (B) 4 (C) 5 (D) Can't be determined

36. A wire has resistance of 24 Ω is bent in the following shape. The effective resistance between A and B is-



(A) 24 Ω (B) 10 Ω (C) $\frac{16}{3}\Omega$ (D) None of these

CHECK YOUR GRASP					ANSWER KEY							EXERCISE -1							
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	C	D	C	D	C	C	C	C	B	B	A	B	A	C	D	C	B	C	D	D
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36				
Ans.	B	B	B	A	C	B	A	B	B	B	A	A	D	D	C	B				



(A) $\frac{1}{6}$m (B) $\frac{1}{3}$m (C) 25cm (D) 50cm

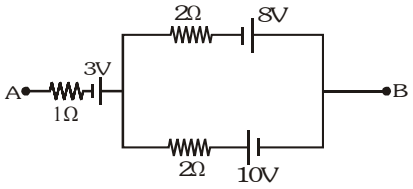
26. A constant voltage is applied between the two ends of a uniform metallic wire. Some heat is developed in it. The heat developed is doubled if
(A) both the length and the radius of the wire are halved
(B) both the length and the radius of the wire are doubled
(C) the radius of the wire is doubled
(D) the length of the wire is doubled

27. Two bulbs rated (25W– 220V) and (100W–220V) are connected in series to a 440 V line. Which one is likely to fuse?
(A) 25W bulb (B) 100 W bulb (C) both bulbs (D) None

28. If the length of the filament of a heater is reduced by 10%, the power of the heater will
(A) increase by about 9% (B) increase by about 11%
(C) increase by about 19% (D) decrease by about 10%

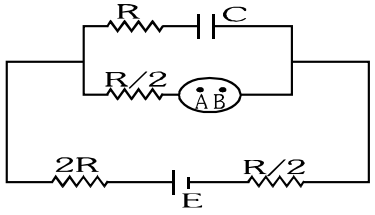
29. The equivalent resistance of a group of resistances is R. If another resistance is connected in parallel to the group, its new equivalent becomes R_1 and if it is connected in series to the group, it new equivalent becomes R_2 we have
(A) $R_1>R$ or $R_2>R$ (B) $R_1<R$ or $R_2>R$ (C) $R_1>R$ or $R_2<R$ (D) $R_1<R$ or $R_2<R$

30. The net emf and internal resistance of three batteries as shown in figure is :



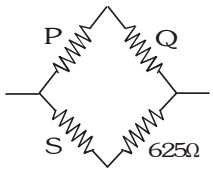
(A) 2V, 1Ω (B) 2V, 2Ω (C) 2V, 1.5Ω (D) 4V, 2Ω

31. A conducting solid sphere is joined in an electrical circuit as shown in figure. Two imaginary points A and B are taken inside the sphere. For given conditions-



(A) $V_A > V_B$ (B) $V_A < V_B$ (C) $V_A = V_B$ (D) Data insufficient

21. A Wheatstone's bridge is balanced with a resistance of 625Ω in the third arm, where P, Q and S are in the 1st, 2nd and 4th arm respectively. If P and Q are interchanged, the resistance in the third arm has to be increased by 51Ω to secure balance. The unknown resistance in the fourth arm is

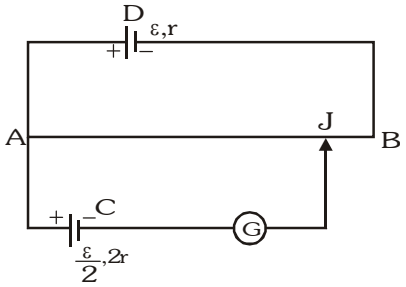


(A) 625 Ω (B) 650Ω (C) 676Ω (D) 600Ω

22. The length of a potentiometer wire is ℓ. A cell of emf E is balanced at a length $\ell/3$ from the positive end of the wire. If the length of the wire is increased by $\ell/2$ at what distance will the same cell give a balanced point

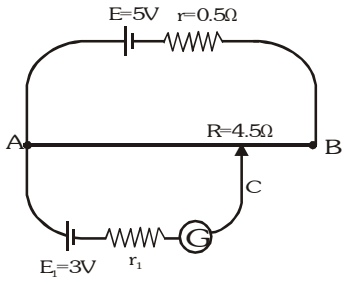
(A) $\frac{2\ell}{3}$ (B) $\frac{\ell}{2}$ (C) $\frac{\ell}{6}$ (D) $\frac{4\ell}{3}$

23. In the figure, the potentiometer wire AB of length L and resistance 9r is joined to the cell D of emf ε and internal resistance r. The cell C's emf is $\frac{\varepsilon}{2}$ and its internal resistance is 2r. The galvanometer G will show no deflection when the length AJ is



(A) $\frac{4L}{9}$ (B) $\frac{5L}{9}$ (C) $\frac{7L}{18}$ (D) $\frac{11L}{18}$

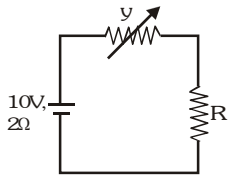
24. In the given potentiometer circuit length of the wire AB is 3m and resistance is R=4.5Ω. The length AC for no deflection in galvanometer is



(A) 2m (B) 1.8m (C) dependent on r_1 (D) None of these

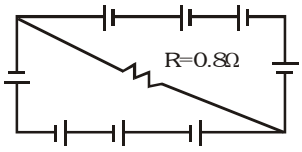
25. A battery of emf E_0 =12V is connected across a 4m long uniform wire having resistance $\frac{4\Omega}{m}$. The cells of small emfs ε_1=2V and ε_2=4V having internal resistance 2Ω and 6Ω respectively, are connected as shown in the figure. If galvanometer shows no deflection at the point N, the distance of point N from the point A is equal to

15. In the figure shown the power generated in y is maximum when y=5Ω then R is



(A) 2Ω (B) 6Ω (C) 5Ω (D) 3Ω

16. A circuit is comprised of eight identical batteries and a resistor R = 0.8Ω. Each battery has an emf of 1.0 V and internal resistance of 0.2Ω. The voltage difference across any of the battery is



(A) 0.5 V (B) 1.0V (C) 0V (D) 2V

17. A galvanometer has a resistance of 20Ω and reads full-scale when 0.2V is applied across it. To convert it into a 10A ammeter, the galvanometer coil should have a

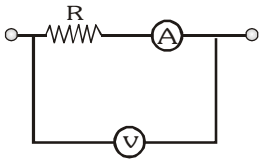
(A) 0.01 Ω resistor connected across it (B) 0.02 Ω resistor connected across it

(C) 200 Ω resistor connected in series with it (D) 2000 Ω resistor connected in series with it

18. A galvanometer coil has a resistance 90Ω and full scale deflection current 10mA. A 910 Ω resistance is connected in series with the galvanometer to make a voltmeter. If the least count of the voltmeter is 0.1V, the number of divisions on its scale is

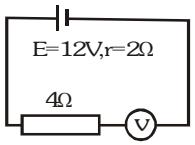
(A) 90 (B) 91 (C) 100 (D) None

19. In the circuit shown the resistance of voltmeter is 10,000 ohm and that of ammeter is 20 ohm. The ammeter reading is 0.10 Amp and voltmeter reading is 12 volt. Then R is equal to



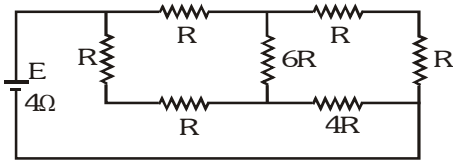
(A) 122 Ω (B) 140Ω (C)116 Ω (D) 100Ω

20. By error, a student places moving-coil voltmeter V (nearly ideal) in series with the resistance in a circuit in order to read the current, as shown. The voltmeter reading will be



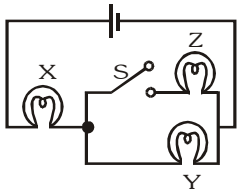
(A) 0 (B) 4V (C) 6V (D) 12V

9. A battery of internal resistance 4Ω is connected to the network of resistance as shown. In order that the maximum power can be delivered to the network, the value of R in Ω should be :–



(A) $\frac{4}{9}$ (B) 2 (C) $\frac{8}{3}$ (D) 18

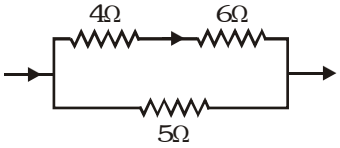
10. If X, Y and Z in figure are identical lamps, which of the following changes to the brightness of the lamps occur when switch S is closed?



(A) X stays the same, Y decreases
(B) X increases, Y decreases
(C) X increases, Y stays the same
(D) X decreases, Y increases

11. A battery of internal resistance 2Ω is connected to a variable resistor whose value can vary from 4Ω to 10 Ω. The resistance is initially set at 4Ω. If the resistance is now increased then–
(A) power consumed by it will decrease
(B) power consumed by it will increase
(C) power consumed by it may increase or may decrease
(D) power consumed will first increase then decrease

12. In the circuit shown in figure the heat produced in the 5Ω resistor due to the current flowing through it is 10 cal/s. The heat generated in the 4Ω resistor is :



(A) 1 cal/s (B) 2 cal/s (C) 3 cal/s (D) 4 cal/s

13. Two heating coils, one of fine wire and the other of thick wire made of same material and of same length are connected in series and then in parallel. Which of the following statements is correct
(A) In series fine wire liberates more energy while in parallel thick wire liberates more energy
(B) In series fine wire liberates less energy while in parallel thick wire liberates less energy
(C) In series thick wire liberates more energy while in parallel it liberates less energy
(D) Both wires liberates equal energies in series and in parallel

14. A storage battery is connected to a charger for charging with a voltage of 12.5 volts. The internal resistance of the storage battery is 1Ω.When the charging current is 0.5 A, the emf of the storage battery is
(A) 13 volts (B) 12.5 volts (C) 12 volts (D) 11.5 volts

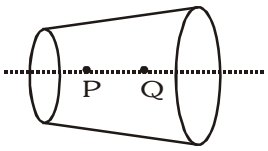
EXERCISE–01 CHECK YOUR GRASP

SELECT THE CORRECT ALTERNATIVE (ONLY ONE CORRECT ANSWER)

1. Two wires each of radius of cross section r but of different materials are connected together end to end (in series). If the densities of charge carries in the two wires are in the ratio 1:4, the drift velocity of electrons in the two wires will be in the ratio :
(A) 1:2 (B) 2:1 (C) 4:1 (D) 1:4

2. A current I flows through a uniform wire of diameter d when the mean electron drift velocity is v. The same current will flow through a wire of diameter d/2 made of the same material if the mean drift velocity of the electron is
(A) v/4 (B) v/2 (C) 2v (D) 4v

3. A wire has a non–uniform cross–section as shown in figure. A steady current flows through it. The drift speed of electrons at points P and Q is v_P and v_Q



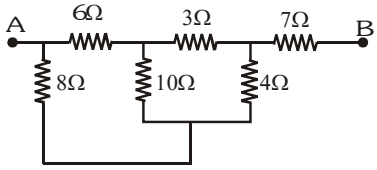
(A) $v_P = v_Q$ (B) $v_P < v_Q$ (C) $v_P > v_Q$ (D) data insufficient

4. An insulating pipe of cross–section area 'A' contains an electrolyte which has two types of ions : their charges being –e and +2e. A potential difference applied between the ends of the pipe result in the drifting of the two types of ions, having drift speed = v (–ve ion) and v/4 (+ve ion). Both ions have the same number per unit volume = n. The current flowing through the pipe is
(A) nev A/2 (B) nev A/4 (C) 5nev A/2 (D) 3nev A/2

5. Three copper wires have their lengths in the ratio 5 : 3 : 1 and their masses are in the ratio 1 : 3 : 5. Their electrical resistance will be in the ratio
(A) 5 : 3 : 1 (B) 1 : 3 : 5 (C) 125 : 15 : 1 (D) 1 : 15 : 125.

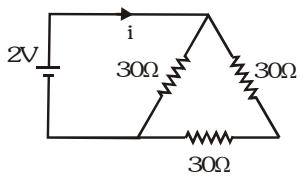
6. A wire of resistance R is stretched to double its length. Its new resistance is
(A) R (B) R/2 (C) 4R (D) R/4

7. The equivalent resistance between the points A and B is–



(A) $\frac{36}{7}\Omega$ (B) 10 Ω (C) $\frac{85}{7}\Omega$ (D) none of these

8. The current i in the circuit (see figure) is :



(A) $\frac{1}{45}$ A (B) $\frac{1}{15}$ A (C) $\frac{1}{10}$ A (D) $\frac{1}{5}$ A