UNIT 03

CURRENT ELECTRICITY

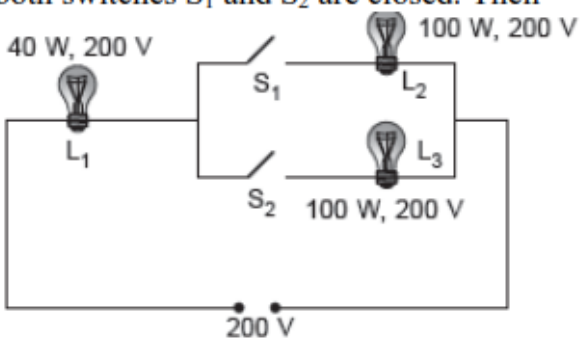
SECTION – A

Questions 1 to 10 carry 1 mark each.

1. A current of 0.8 A flows in a conductor of 40 W for 1 minute. The heat produced in the conductor will be

(a) 1445 J (b) 1536 J (c) 1569 J (d) 1640 J

2. In the figure given below, both switches S_1 and S_2 are closed. Then



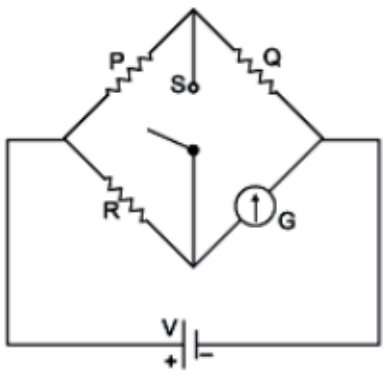
(a) L_1 will be brighter than L_2 or L_3. (b) L_1 will be dimmer than L_2 or L_3.

(c) L_1 will be as bright as L_2 or L_3. (d) none of the above.

3. Power P_s is dissipated through a series combination and power P_p is dissipated through the parallel combination of 3 equal resistors. The ratio of P_p to P_s is

(a) 9 (b) 1/9 (c) 1 (d) 6

4. In the circuit given below P ≠ R and the reading of the galvanometer is same with switch S open or closed. Then:



(a) $I_Q = I_R$ (b) $I_R = I_G$ (c) $I_P = I_G$ (d) $I_Q = I_G$

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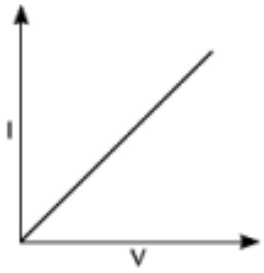
5. When a potential difference V is applied across a conductor at temperature T, the drift velocity of the electrons is proportional to:
(a) T (b) $\sqrt{T}$ (c) V (d) $\sqrt{V}$

6. The resistances of two wires having same length and same area of cross-section are 2 Ω and 8 Ω respectively. If the resistivity of 2 Ω wire is 2.65×10^{-8} Ω-m then the resistivity of 8 Ω wire is:
(a) 10.60×10^{-8} Ω-m (b) 8.32×10^{-8} Ω-m
(c) 7.61×10^{-8} Ω-m (d) 5.45×10^{-8} Ω-m

7. Two wires A and B, of the same material having length in the ratio 1 : 2 and diameter in the ratio 2 : 3 are connected in series with a battery. The ratio of the potential differences (V_A / V_B) across the two wires respectively is:
(a) 1/3 (b) 3/4 (c) 4/5 (d) 9/8

8. The given figure shows I – V graph of a copper wire whose length and area of cross-section are L and A respectively. The slope of this curve becomes:



(a) less if the length of the wire is increased.
(b) more if the length of the wire is increased.
(c) more if a wire of steel of same dimension is used.
(d) more if the temperature of wire is increased.

In the following questions 9 and 10, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

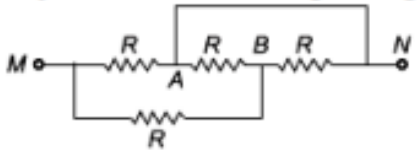
9. **Assertion (A):** Kirchhoff's junction rule is vaild for only three number of lines meeting at a point in an electrical circuit.
Reason (R): When there is a flow of varying current, then there is no accumulation of charge at the junction.

10. **Assertion (A):** When a resistance of given material is cut into half, its resistance reduces to half of its original value.
Reason (R): The resistivity of a conductor changes with dimensions, temperature and material of conductor.

SECTION – B

Questions 11 to 14 carry 2 marks each.

11. Calculate the resistance across the points *M* and *N* in the given figure.



12. Wheatstone bridge method is considered unsuitable for the measurement of very low resistances. Why?

13. A cell of emf 'E' and internal resistance 'r' is connected across a variable resistor 'R'. Plot a graph showing variation of terminal voltage 'V' of the cell versus the current I. Using the plot, show how the emf of the cell and its internal resistance can be determined.

14. Explain the term 'drift velocity' of electrons in a conductor. Hence obtain the expression for the current through a conductor in terms of 'drift velocity'.

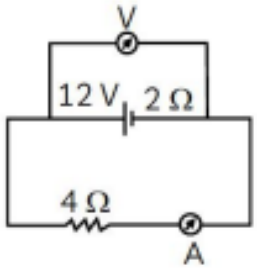
SECTION – C

Questions 15 to 17 carry 3 marks each.

15. (a) Define the term 'conductivity' of a metallic wire. Write its SI unit.
(b) Using the concept of free electrons in a conductor, derive the expression for the conductivity of a wire in terms of number density and relaxation time. Hence, obtain the relation between current density and the applied electric field

16. Two heating elements of resistances R_1 and R_2 when operated at a constant supply of voltage, V, consume powers P_1 and P_2 respectively. Deduce the expressions for the power of their combination when they are, in turn, connected in (i) series and (ii) parallel across the same voltage supply.

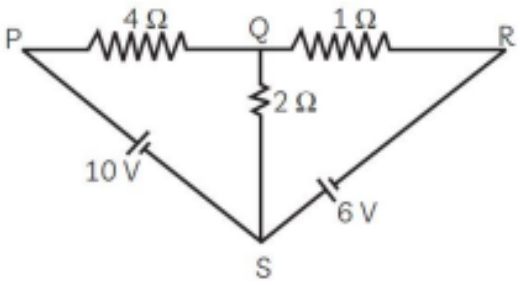
17. A battery of emf 12 V and internal resistance 2 Ω is connected to a 4 Ω resistor as shown in the figure.
(a) Show that a voltmeter when placed across the cell and across the resistor, in turn, gives the same reading.
(b) To record the voltage and the current in the circuit, why is voltmeter placed in parallel and ammeter in series in the circuit?



SECTION – D

Questions 18 carry 5 marks.

18. (a) State Kirchhoff's law for an electrical network. Using Kirchhoff 's rules, obtain the balance condition in terms of the resistances of four arms of wheatstone bridge.
(b) Using Kirchhoff's laws, calculate the current flowing through 4 Ω, 1 Ω, and 2 Ω resistors in the circuit shown.

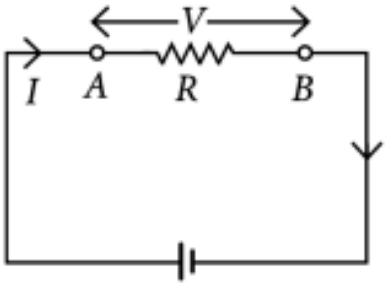


SECTION – E (Case Study Based Questions)

Questions 19 to 20 carry 4 marks each.

19. Heat produced by electric Current

Whenever an electric current is passed through a conductor, it becomes hot after some time. The phenomenon of the production of heat in a resistor by the flow of an electric current through it is called heating effect of current or Joule heating. Thus, the electrical energy supplied by the source of emf is converted into heat. In purely resistive circuit, the energy expended by the source entirely appears as heat. But if the circuit has an active element like a motor, then a part of the energy supplied by the source goes to do useful work and the rest appears as heat. Joule's law of heating form the basis of various electrical appliances such as electric bulb, electric furnace, electric press etc.



(i) Which of the following is a correct statement?
(a) Heat produced in a conductor is independent of the current flowing.
(b) Heat produced in a conductor varies inversely as the current flowing.
(c) Heat produced in a conductor varies directly as the square of the current flowing.
(d) Heat produced in a conductor varies inversely as the square of the current flowing.

(ii) If the coil of a heater is cut to half, what would happen to heat produced?
(a) Doubled (b) Halved (c) Remains same (d) Becomes four times

(iii) A 25 W and 100 W are joined in series and connected to the mains. Which bulbs will glow brighter?
(a) 100 W (b) 25 W (c) both bulbs will glow brighter (d) none will glow brighter

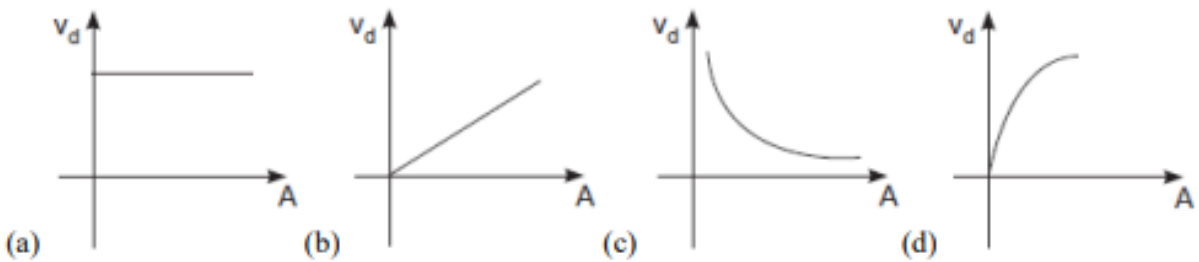
OR

(iv) A rigid container with thermally insulated wall contains a coil of resistance 100 W, carrying current 1 A. Change in its internal energy after 5 min will be
(a) 0 kJ (b) 10 kJ (c) 20 kJ (d) 30 kJ

(v) The heat emitted by a bulb of 100 W in 1 min is
(a) 100 J (b) 1000 J (c) 600 J (d) 6000 J

20. When a conductor does not have a current through it, its conduction electrons move randomly, with no net motion in any direction. When the current flows through the conductor, these electrons actually still move randomly, but now they tend to drift with the drift speed v_d. The drift speed is very less as compared to speeds in random thermal motion.

(i) A steady current I flows through a metallic conductor whose area of cross-section (A) increases continuously from one end to the other. The drift velocity of free electron (v_d) as a function of A will be:



(a) (b) (c) (d)

(ii) For Ohm's law is obeyed, then what is the relation between electric field(E) and drift velocity (vd)?

(a) $v_d \propto E^2$

(b) $v_d \propto E$

(c) $v_d \propto \frac{E}{2}$

(d) $v_d \propto \sqrt{E}$

(iii) When a current flows in a conductor, the order of magnitude of drift velocity of electrons through it is

(a) 10^{-7} cm/s

(b) 10^{-2} cm/s

(c) 10^{4} mm/s

(d) 0.5 mm/s

(iv) Two nichrome wires of equal lengths but having radii in the ratio 1 : 3 are connected in series across an electric cell. The drift velocities of free electrons through them will be in the ratio of

(a) 3 : 1

(b) 1 : 3

(c) 4 : 9

(d) 9 : 1

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