PRACTICE PAPER 03
CHAPTER 03 CURRENT ELECTRICITY

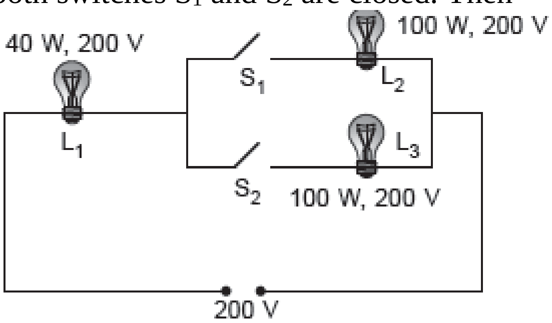
SUBJECT: PHYSICS | **MAX. MARKS : 40**
CLASS : XII | **DURATION : 1½ hrs**

General Instructions:
(i). **All** questions are compulsory.
(ii). This question paper contains 2**0** questions divided into five Sections A, B, C, D and E.
(iii). **Section A** comprises of **10 MCQs** of **1 mark** each. **Section B** comprises of 4 questions of **2 marks** each. **Section C** comprises of 3 questions of **3 marks** each. **Section D** comprises of 1 question of **5 marks** each and **Section E** comprises of 2 Case Study Based Questions of **4 marks** each.
(iv). There is no overall choice.
(v). Use of Calculators is not permitted

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

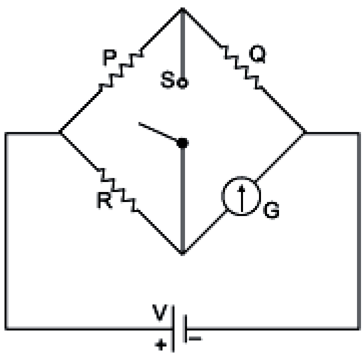
2. In the figure given below, both switches S_1 and S_2 are closed. Then



(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:



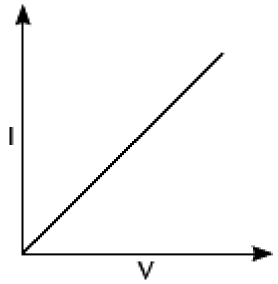
(a) $I_Q = I_R$ (b) $I_R = I_G$ (c) $I_P = I_G$ (d) $I_Q = I_G$

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.

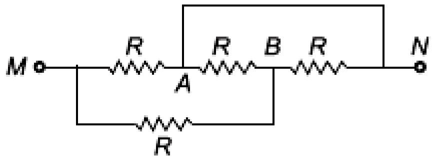
9. **Assertion (A):** Kirchhoff's junction rule is vaild for only three number of lines meeting at a point in an electrical circuit.
Reason (R): When there is a flow of varying current, then there is no accumulation of charge at the junction.

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'.

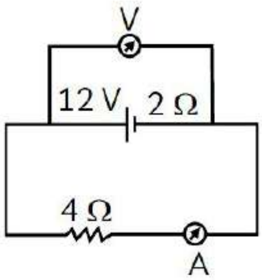
SECTION – C

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.

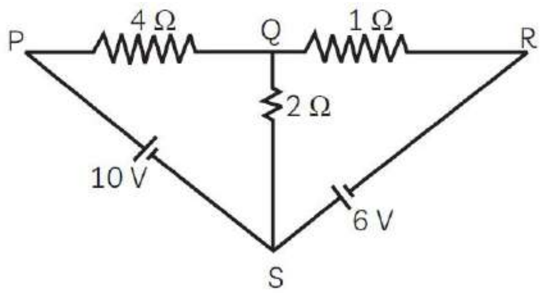
17. A battery of emf 12 V and internal resistance 2 Ω is connected to a 4 Ω resistor as shown in the figure.
(a) Show that a voltmeter when placed across the cell and across the resistor, in turn, gives the same reading.
(b) To record the voltage and the current in the circuit, why is voltmeter placed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

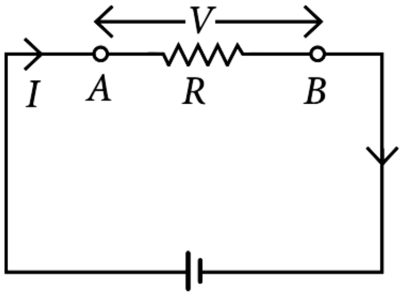


SECTION – E (Case Study Based Questions)

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

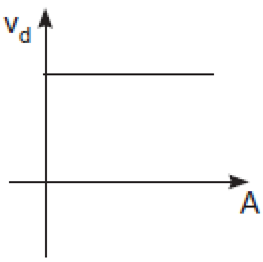
OR

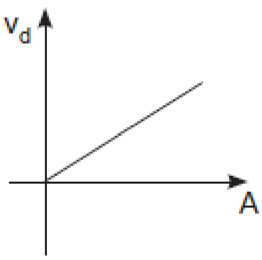
(iv) A rigid container with thermally insulated wall contains a coil of resistance 100 W, carrying current 1 A. Change in its internal energy after 5 min will be
(a) 0 kJ (b) 10 kJ (c) 20 kJ (d) 30 kJ

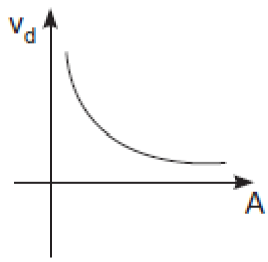
(v) The heat emitted by a bulb of 100 W in 1 min is
(a) 100 J (b) 1000 J (c) 600 J (d) 6000 J

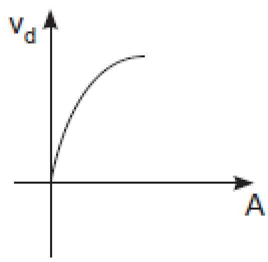
20. When a conductor does not have a current through it, its conduction electrons move randomly, with no net motion in any direction. When the current flows through the conductor, these electrons actually still move randomly, but now they tend to drift with the drift speed v_d. The drift speed is very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

PRACTICE PAPER 03
CHAPTER 03 CURRENT ELECTRICITY
(ANSWERS)

SUBJECT: PHYSICS | **MAX. MARKS : 40**
CLASS : XII | **DURATION : 1½ hrs**

General Instructions:

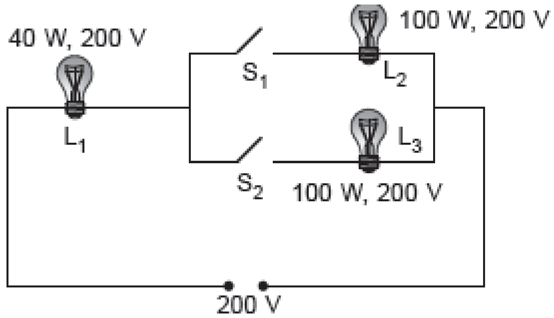
(i). **All** questions are compulsory.
(ii). This question paper contains 2**0** questions divided into five Sections A, B, C, D and E.
(iii). **Section A** comprises of **10 MCQs** of **1 mark** each. **Section B** comprises of 4 questions of **2 marks** each. **Section C** comprises of 3 questions of **3 marks** each. **Section D** comprises of 1 question of **5 marks** each and **Section E** comprises of 2 Case Study Based Questions of **4 marks** each.
(iv). There is no overall choice.
(v). Use of Calculators is not permitted

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
Ans: (b) 1536 J
By Joule's law of heating, $H = I^2Rt$
$H = (0.8)2\ (40)\ (60) = 1536$ 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.
Ans: (a) L_1 will be brighter than L_2 or L_3.

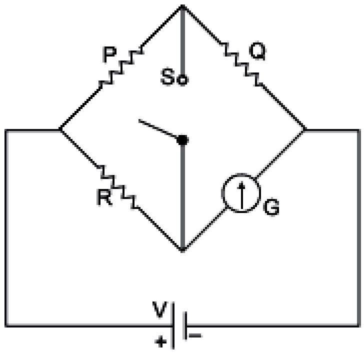
3. Power P_s is dissipated through a series combination and power P_p is dissipated through the parallel combination of 3 equal resistors. The ratio of P_p to P_s is
(a) 9 (b) 1/9 (c) 1 (d) 6
Ans: (a) 9
Equivalent $R_s = 3r$

Power dissipated by battery of voltage V in series combination is $P_s = \frac{V^2}{3r}$

Equivalent $R_p = \frac{r}{3}$

Power dissipated by battery of voltage V in parallel combination is $P_P = \frac{V^2}{\left(\frac{r}{3}\right)}, \frac{P_P}{P_S} = 9$

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) $I_Q = I_G$

Ans: (d) $I_Q = I_G$

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) $\sqrt{V}$

Ans: (c) 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

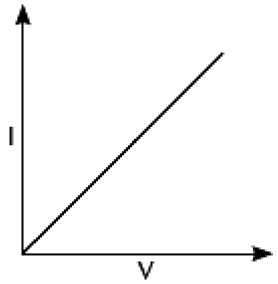
Ans: (a) 10.60×10^{-8} Ω-m

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

Ans: (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.

Ans: (a) less if the length of the 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).
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(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

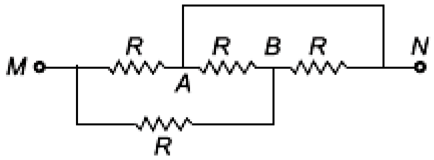
9. Assertion (A): Kirchhoff's junction rule is vaild for only three number of lines meeting at a point in an electrical circuit.
Reason (R): When there is a flow of varying current, then there is no accumulation of charge at the junction.
Ans. (d) Assertion (A) is false but reason (R) is true.

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.
Ans. (c) Assertion (A) is true but reason (R) is false.

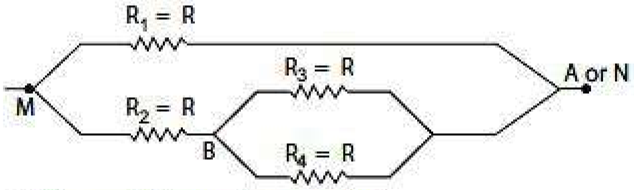
SECTION – B

Questions 11 to 14 carry 2 marks each.

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



Ans: In this case, points *A* and *N* are at same potential, but points *M* and *B* are at different potentials. The above circuit can therefore be redrawn.



$\because R_3$ and R_4 are in parallel

$$\therefore \qquad R_{34} = \frac{R_3 \times R_4}{R_3 + R_4} = \frac{R \times R}{R + R} = \frac{R^2}{2R} = \frac{R}{2}$$

$\because R_{34}$ and R_2 are in series

$$\therefore \qquad R_{234} = R_{34} + R_2 = \frac{R}{2} + R = \frac{3R}{2}$$

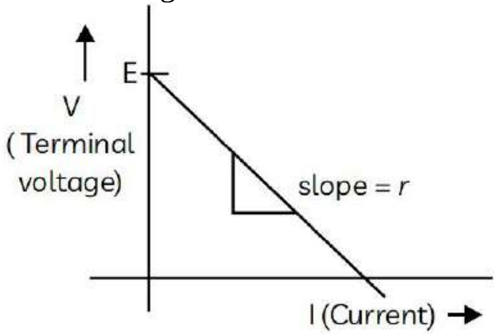
$\because R_{234}$ and R_1 are in parallel, so equivalent resistance is calculated as

$$R_{eq} = \frac{R_{234} \times R_1}{R_{234} + R_1} = \frac{\frac{3R}{2} \times R}{\frac{3R}{2} + R} = \frac{\frac{3R^2}{2}}{\frac{5R}{2}} = \frac{3R}{5}$$

12. Wheatstone bridge method is considered unsuitable for the measurement of very low resistances. Why?
Ans. (i) For measuring a low resistance, all other resistances used should have a low value to ensure the sensitivity of the bridge.
(ii) A galvanometer of very low resistance is required which of course be very insensitive.
(iii) The end resistances and the resistances of connecting wire become comparable to the resistance being measured.
All these factors introduce an error in the result.

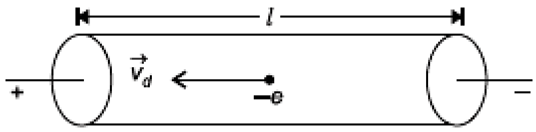
13. A cell of emf 'E' and internal resistance 'r' is connected across a variable resistor 'R'. Plot a graph showing variation of terminal voltage 'V' of the cell versus the current I. Using the plot, show how the emf of the cell and its internal resistance can be determined.
Ans. The terminal voltage 'V' of the cell is given by: V = E – Ir
where, E is the emf of the cell, r is the internal resistance of the cell and, I is the current through the circuit.

Comparing with the equation of a straight line: y = mx + c,
we get, y = V; x = I; m = – r ; c = E
Graph showing variation of terminal voltage 'V' of the cell versus the current 'I'.



Emf of the cell = Intercept on V axis.
Internal resistance = slope of the line.

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'.
Ans. Drift velocity is defined as the average velocity with which free electrons in a conductor get drifted in a direction opposite to the direction of the applied electric field.
Consider a conductor of length *l*, area of cross-section *A* and having number density of free electrons *n*.



On establishing the potential difference across the conductor, suppose the electrons drift from lower potential to higher potential side with velocity $\vec{v_d}$. The volume of the conductor covered by an electron in unit time is

$V = v_d A$ …(*i*)

[Volume = Al and $l = v_d \times t$, $t = 18$ $l = v_d$]

Electrons occupying the volume in unit time is

$N = nv_d A$ …(*ii*)

Thus, the charge flow through any cross-section of the conductor in unit time is

$q = env_d A$ …(iii)

According to the definition, the electric current is the rate of flow of charge through any cross-section of the conductor. Hence,

$I = \frac{q}{t}$ ($t = 1$ s)

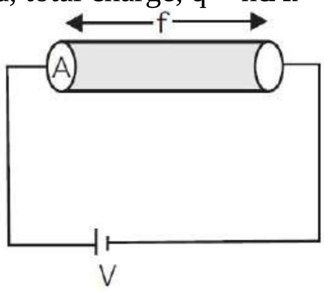
$I = env_d A$ …(*iv*)

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
Ans. (a) Conductivity of a metallic wire is defined as its ability to allow electric charges or heat to pass through it. Numerically, conductivity of a material is reciprocal of its resistivity.
SI unit: oh m^{-1} m^{-1} or mho m^{-1} or Siemen m^{-1}
(b) Consider a potential difference V be applied across a conductor of length l and cross section A.
Electric field inside the conductor, E = V/*l*.
Due to the external field the free electrons inside the conductor drift with velocity v_d.

Let, number of electrons per unit volume = n, charge on an electron = e
Total electrons in length, l = nAl and, total charge, q = neAl



And current, $I = \frac{q}{t} = \frac{neAl}{\frac{l}{v_d}} \Rightarrow I = neAv_d$

Therefore, current per unit area, i.e., current density, $J = \frac{I}{A} = nev_d$

$\Rightarrow J = ne\left(\frac{eE\tau}{m}\right) = \left(\frac{ne^2\tau}{m}\right)E \Rightarrow J = \sigma E$

which is the required expression.

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.

Ans. We know $P = \frac{V^2}{R}$

(i) When resistors are connected in series, equivalent resistance is given by
$R_s = R_1 + R_2$
Power consumed is given by

$$P_s = \frac{V^2}{R_s} = \frac{V^2}{R_1 + R_2}$$

As $$R_1 = \frac{V^2}{P_1} \text{ and } R_2 = \frac{V^2}{P_2}$$

∴ $$P_s = \frac{V^2 P_1 P_2}{V^2(P_1 + P_2)} = \frac{P_1 P_2}{P_1 + P_2} \quad \text{or} \quad \frac{1}{P_s} = \frac{1}{P_1} + \frac{1}{P_2}$$

(ii) When resistors are connected in parallel, then

$$P_P = \frac{V^2}{R_P} \qquad \ldots (i)$$

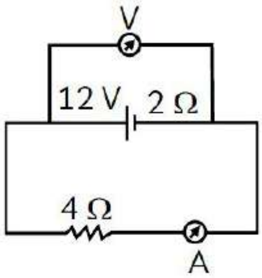
Here, $$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{V^2}(P_1 + P_2) \Rightarrow R_P = \frac{V^2}{P_1 + P_2}$$

Substituting in equation (i),

we get $$P_P = \frac{V^2}{\left(\frac{V^2}{P_1 + P_2}\right)} = P_1 + P_2$$

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?

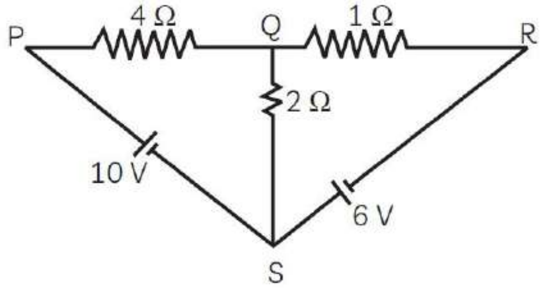


Ans. (a) Effective resistance of the circuit R_E = 6 W
∴ I = 12/6 = 2 A
Terminal potential difference across the cell can be calculated as,
V = E – Ir = 12 – 2 × 2
⇒ V = 12 – 4 = 8 V
Also, potential difference across 4 W resistor can be calculated as,
V = IR = 2 × 4 = 8 V.
So, a voltmeter when placed across the cell and across the resistor, gives the same reading.
(b) An ammeter is connected in series because it has very low resistance. So, when, an ammeter is connected in series, then there is not much increase in the resistance of the circuit and hence the current through the circuit unchanged.

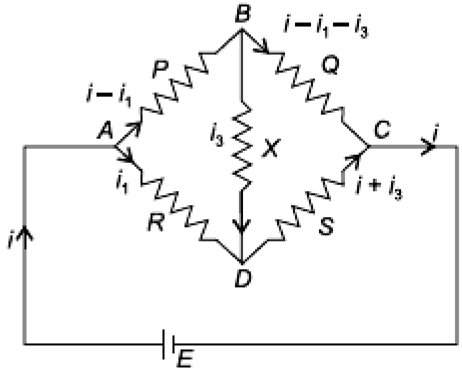
SECTION – D

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.



Ans. Kirchhoff 's rules:
Kirchhoff's first law (junction rule) - In an electrical circuit , the algebraic sum of currents meeting at a junction , is always zero .
Kirchhoff's second rule (loop rule) - In any closed mesh of an electrical circuit , the algebraic sum of the e.m.fs. is equal to the algebraic sum of products of resistances and current flowing through them .
Let us consider a wheatstone bridge.
Take loop *ABDA*,
$P(i - i_1) + Xi_3 - Ri_1 = 0$ …(*i*)



Take loop BCDB

$Q(i - i_1 - i_3) - S(i_1 + i_3) - Xi_3 = 0$

$Q(i - i_1) - Qi_3 - Si_1 - (S + X)i_3 = 0$ …(*ii*)

When the point *B* and *D* are at same potential, the bridge is said to be balanced.

As in balanced state, $i_3 = 0$, from equations (i) and (ii), we get

$P(i - i_1) = Ri_1$

$Q(i - i_1) = Si_1$

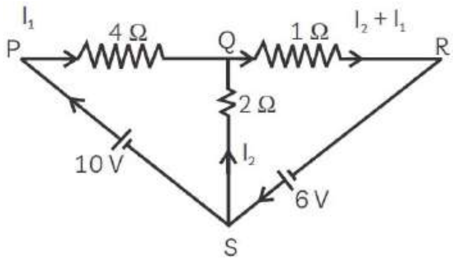
$$\frac{P}{Q} = \frac{R}{S}$$

(b) By using Kirchhoff's second law for closed-loop PQS we get

$-4I_1 + 2I_2 + 10 = 0$

$\Rightarrow 4I_1 - 2I^2 = 10$

$\Rightarrow 2I_1 - I_2 = 5$



By using Kirchhoff's second law for closed loop QRS we get

$-(I_1 + I_2)1 + 6 - 2I_2 = 0$

$\Rightarrow I_1 + 3I_2 = 6$ ...(ii)

solving (i) and (ii), we get $7I_1 = 21$

$\Rightarrow I_1 = 3$ A

$\Rightarrow I_2 = 1$ A

$\Rightarrow I_1 + I_2 = 3 + 1 = 4$ A

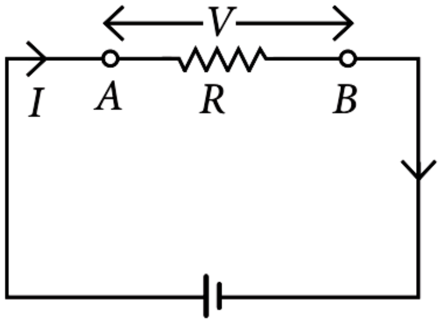
Therefore, the current across 4 Ω resistor is 3 A, across 2 Ω resistor is 1 A, and across 1 Ω resistor is 4 A.

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
Ans. (i) (c) According to Joule's law of heating, Heat produced in a conductor, $H = I^2Rt$
where, I = Current flowing through the conductor
R = Resistance of the conductor
t = Time for which current flows through the conductor.
$\therefore H \propto I^2$

(ii) (a): If the coil is cut into half, its resistance is also halved.

$$H = \frac{V^2}{R}t \Rightarrow H' = 2$$

(iii) (b): $P = V^2/R$ or $R = V^2/P$
The bulbs are joined in series. Current in both the bulbs will same.
$\therefore$ The heat produced in them is given by $H = I^2Rt$ or $H \propto R \Rightarrow H \propto 1/P$
Therefore, the bulb with low wattage or high resistance will glow brighter or we can say the 25 W bulb will glow brighter than the 100 W bulb.

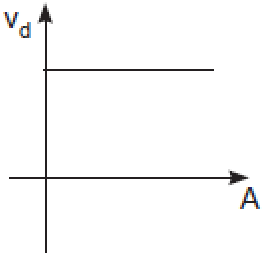
OR

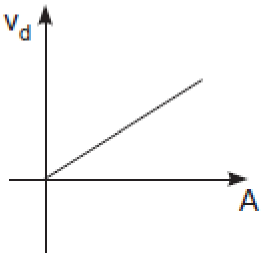
(iv) (d): R = 100 W; I = 1 A; t = 5 min. = 5 × 60 = 300 s
change in internal energy = heat generated in coil = $I^2Rt = ((1)^2 \times 100 \times 300)$ J = 30000 J = 30 kJ

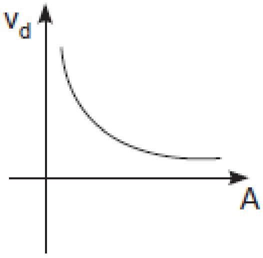
(v) (d): Here, P = 100 W, t = 1 min = 60 s
Heat developed in time t, H = P × t = (100 W)(60 s) = 6000 J

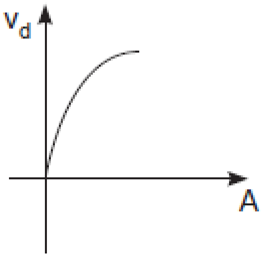
20. When a conductor does not have a current through it, its conduction electrons move randomly, with no net motion in any direction. When the current flows through the conductor, these electrons actually still move randomly, but now they tend to drift with the drift speed v_d. The drift speed is very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

Ans.

(i) (c) Reason: $\because \quad I = neAv_d$

$\therefore \quad v_d \propto \frac{1}{A}$

(ii) (b) Reason: $\vec{v}_d = -\frac{e\vec{E}\tau}{m}$

(iii) (b)

(iv) (d) $\left(v_d \propto \frac{1}{A}\right)$