UNIT – IV

Effects of Current

CHAPTER

12 ELECTRICITY

Syllabus

➢ *Electric current, potential difference and electric current, Ohm's law; Resistance, Resistivity, Factors on which the resistance of a conductor depends. Series combination of resistors, parallel combination of resistors and its application in daily life. Heating effect of electric current and its applications in daily life. Electric power, Interrelation between P, V, I and R.*

Quick Review

➢ Electric charge is the property of matter due to which it produces and experience electrical and magnetic effects. There exist two types of charge in nature :
(i) Positive charge **(ii)** Negative charge
SI unit of charge is coulomb (C).

➢ **Fundamental law of electrostatics :** Like charges repel and unlike charges attract each other.

➢ **Coulomb's Law :** The force of attraction or repulsion between two point charges is **(i)** directly proportional to the product $(q_1\ q_2)$ of the two charges and **(ii)** inversely proportional to the square of the distance (r) between them.
Mathematically,

$$F = \frac{Kq_1q_2}{r^2}$$

The value of K depends on the nature of the medium between the two charges and the system of units chosen. For charges in vacuum, $K = 9 \times 10^9\ Nm^2/C^2$.

➢ **Law of Conservation of Charge :** Electric charges can neither be created nor destroyed, they can only be transferred from one body to another.

➢ **Static and Current Electricity :** Static electricity deals with the electric charges at rest while the current electricity deals with the electric charges in motion.

➢ **Electric Current :** The electric current is defined as the rate of flow of electric charge through any section of a conductor.

$$\text{Electric current} = \frac{\text{Charge}}{\text{Time}} \quad \text{or} \quad I = \frac{Q}{t}$$

Electric current is a scalar quantity.

➢ **Ampere :** It is the SI unit of current. If one coulomb of charge flows through any section of a conductor in one second, then current through is said to be of one ampere.

➢ **Electric circuit :** The closed path along which an electric current flows is called an 'electric circuit'.

➢ **Conventional direction of current :** Conventionally, the direction of motion of positive charges through the conductor is taken as the direction of current. The direction of conventional current is opposite to that of the negatively charged electrons.

➢ **Electric field :** It is the region around a charged body within which its influence can be experienced.

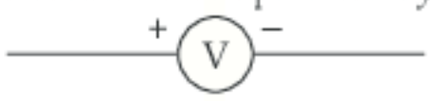
➢ **Potential Difference (V) :** Work done to move a unit charge from one point to another.

$$V = \frac{W}{Q}$$

- **1 Volt :** When 1 joule work is done in carrying one Coulomb charge then potential difference is called 1 volt.
  S. I. unit of Potential difference = Volt (V)

$$1\,V = 1\,JC$$

- Voltmeter has high resistance and always connected in parallel. Symbol is



- **Potential difference between two points :** The potential difference between two points in an electric field is the amount of work done in bringing a unit positive charge from one point to another.

$$\text{Potential difference} = \frac{\text{Work done}}{\text{Charge}} \quad \text{or} \quad V = \frac{W}{Q}$$

- **One volt potential difference :** The potential difference between two points in an electric field is said to one volt if one joule of work has to be done in bringing a positive charge of one coulomb from one point to another.

$$1\ \text{volt} = \frac{1\ \text{joule}}{1\ \text{coulomb}} \quad \text{or} \quad 1\,V = \frac{1\,J}{1\,C}$$

- **Electrochemical or voltaic cell :** It is a device which converts chemical energy into electrical energy.
- **Galvanometer :** It is a device to detect current in an electric circuit.
- **Ammeter :** It is a device to measure current in a circuit. It is a low resistance galvanometer and is always connected in series in a circuit.
- **Voltmeter :** It is a device to measure the potential difference. It is a high resistance galvanometer and is always connected in parallel to the component across which the potential difference is to be measured.
- **Ohm's Law :** Potential difference across the two points of a metallic conductor is directly proportional to current through the circuit provided that temperature remains constant.

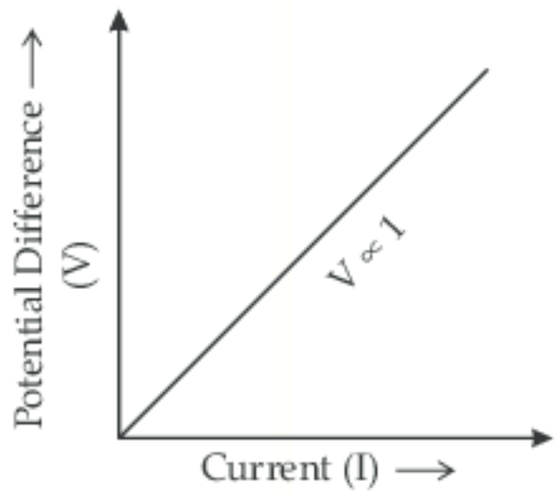
  (i) Mathematical expression for Ohm's law :

  $V \propto I$

  $V = IR$

  R is a constant called resistance for a given metal.

  (ii) V-I graph for Ohm's law :



- **Resistance (R) :** It is the property of a conductor to resist the flow of charges through it.

  (i) Ohm (Ω) : S. I. unit of resistance.

  (ii)

$$\text{ohm} = \frac{1\ \text{volt}}{1\ \text{ampere}}$$

- When potential difference is 1 V and current through the circuit is 1 A, then resistance is 1 ohm.
- **Rheostat :** Variable resistance is a component used to regulate current without changing the source of voltage.
- **Factors on which the Resistance of a Conductor depends :** Resistance of a uniform metallic conductor is

  (i) directly proportional to the length of conductor,

  (ii) inversely proportional to the area of cross-section,

  (iii) directly proportional to the temperature and

  (iv) depend on nature of the material.
- **Resistivity (P) :** It is defined as the resistance offered by a cube of a material of side 1 m when current flows perpendicular to its opposite faces.

  (i) Its S.I. unit is ohm-metre (Ωm).

  (ii) Resistivity does not change with change in length or area of cross-section but it changes with change in temperature.

  (iii) Range of resistivity of metals and alloys is 10^{-8} to 10^{-6} Ωm.

(iv) Range of resistivity of insulators is 10^{12} to 10^{17} Ωm.

(v) Resistivity of alloy is generally higher than that of its constituent metals.

(vi) Alloys do not oxidize (burn) readily at high temperature, so they are commonly used in electrical heating devices.

(vii) Copper and aluminium are used for electrical transmission lines as they have low resistivity.

- **Resistances in series :** When two or more resistances are joined end to end so that same current flows through each one of them in turn, they are said to be connected in series. Here, the total resistance is equal to the sum of the individual resistances.

$$R_s = R_1 + R_2 + R_3 + ...$$

- **Resistances in parallel :** When two or more resistances are connected across two points so that each one of them provides a separate path for current, they are said to be connected in parallel. Here the reciprocal of their combined resistance is equal to the sum of the reciprocals of the individual resistances.

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$$

- **Heating effect of current** : When an electric current is passed through a conductor, heat is produced in it. This is known as heating effect of current.
- **Joule's law of heating :** It states that the heat produced in a conductor is directly proportional to **(i)** the square of the current I through it, **(ii)** its resistance R and **(iii)** the time *t*, for which current is passed. Mathematically, it can be expressed as

$$H = I^2 Rt \text{ joule} = \frac{I^2 Rt}{4.18} \text{cal}$$

or

$$H = VIt \text{ joule} = \frac{VIt}{4.18} \text{cal}$$

- **Practical application of the heating effect of electric current :**
  It is utilised in the electrical heating appliances such as electric iron, room heaters, water heaters etc. The electric heating is also used to produce light as in an electric-bulb.
- **Electric energy :** It is the total work done in maintaining an electric current in an electric circuit for a given time.
  Electric energy, $W = VIt = I^2Rt$ joule
- **Electric Fuse :** It is a safety device that protects our electrical appliances in case of short circuit or overloading.
  (i) Fuse is made up of pure tin or alloy of copper and tin.
  (ii) Fuse is always connected in series with live wire.
  (iii) Fuse has low melting point.
  (iv) Current capacity of fuse is slightly higher than of the appliance.
- **Electric Power :** The rate at which electric energy is consumed or dissipated in an electric circuit.

$$P = VI$$

$$P = I^2R = \frac{V^2}{R}$$

- S.I. unit of power = Watt (W)
  1 Watt = 1 Volt × 1 ampere
- Commercial unit of electric energy = Kilo Watt hour (KWh)
  1 KWh = 3.6×10^6 J
  1 KWh = 1 unit of electric energy
- **Electrical power :** Electrical power is the rate at which electric energy is consumed by an appliance.

$$P = \frac{W}{t} = VI = I^2R = \frac{V^2}{R}$$

- **Watt :** It is the SI unit of power. The power of an appliance is 1 watt if one ampere of current flows through it on applying a potential difference of 1 volt across its ends.

$$1 \text{ watt} = \frac{1 \text{ joule}}{1 \text{ second}} = 1 \text{ volt} \times 1 \text{ ampere}$$

or

$$1 \text{ W} = \text{Js}^{-1} = 1\text{VA}$$

1 kilowatt = 1000 W.

- **Kilowatt hour :** It is the commercial unit of electrical energy. One kilowatt hour is the electrical energy consumed by an appliance of 1000 watts when used for one hour.

  $1 \text{ kilowatt hour (kWh)} = 3{\cdot}6 \times 10^6 \text{ J}$

- **Power rating :** The power rating of an appliance is the electric energy consumed per second by the appliance when connected across the marked voltage of the mains.
- **Efficiency of an electrical device :** It is the ratio of the output power to the input power.

$$\text{Efficiency, } \eta = \frac{\text{Output power}}{\text{Input power}}$$

Know the Terms

- **Frictional Electricity :** It is the electricity produced by rubbing two suitable bodies and flow of electrons from one body to other.
- **Electricity :** A fundamental form of energy observable in positive and negative forms that occurs naturally (as in lightning) or is produced (as in a generator) and that is expressed in terms of the movement and interaction of electrons.
- **Positive and Negative Charges :** The charge acquired by a glass rod when rubbed with silk is called positive charge and the charge acquired by an ebonite rod when rubbed with wool is called negative charge.
- **Charge Conservation :** When a glass rod is rubbed on silk, the glass rod acquires positive charge. But it is not created. The negative charges from glass rod are shifted to silk leaving a net positive charge on glass rod. The net charge in them remains the same. So, charges are not created or destroyed but can be transferred from one place to another or remain conserved.
- **Coulomb :** It is the SI unit of charge. One coulomb is defined as that amount of charge which repels an equal and similar charge with a force of 9×10^9 N when placed in vacuum at a distance of 1 meter from it. Charge on an electron $= 1.6 \times 10^{-19}$ coulomb.
- **Conductor :** A substance which allows passage of electric charges through it easily is called a conductor. A conductor offers very low resistance to the flow of current. For example, Copper, Silver, Aluminium etc.
- **Insulator :** A substance that has infinitely high resistance does not allow electric current to flow through it. It is called insulator.
- **Electric Potential Energy :** It is defined as the work required to be done to bring the charges to their respective location against the electric field with the help of a source of energy. This work done gets stored in the form of potential energy of charge.
- **Ohm :** It is the SI unit of resistance. A conductor has a resistance of one ohm if a current of one ampere flows through it on applying a potential difference of 1 volt across its ends.

$$1 \text{ ohm} = \frac{1 \text{volt}}{1 \text{ ampere}} \quad \text{or} \quad 1\,\Omega = \frac{1\text{V}}{1\text{ A}}$$

- **Resistor :** A conductor which has some appreciable resistance is called a 'resistor'.
- **Resistivity :** It is defined as the resistance offered by a cube of a material of side 1m, when current flows perpendicular to its opposite faces. Its SI unit is ohm-metre (Ωm).

  Resistivity, $\rho = \frac{RA}{L}$

- For a material irrespective of length and area, the resistivity is constant. It is otherwise called specific resistance of the material. It is also defined as the resistance offered by a cube of a material of side 1m when current flows perpendicular to the opposite faces.
- Rheostat is a device which changes the magnitude of current in the circuit, by changing the resistance. It is connected in series in the circuit. It is also used as a potential divider in the circuit.
- **Semiconductors :** Materials having resistivity between that of an insulator and a conductor are called semiconductors. They are used in making integrated circuits.
- **Superconductors :** These are certain materials that lose their resistivity at low temperature. Such materials are called as superconductors. The phenomenon of complete loss of resistivity by substances below a certain temperature is called superconductivity.
- **Fuse Wire :** The wire which melts, breaks the circuit and prevents the damage of various appliances in the household connections. It is connected in series and its thickness determines the maximum current that can be drawn. It is made of an alloy of Aluminium, Copper, Iron and Lead.

TOPIC-1

Electric Current

Very Short Answer Type Questions (1 mark each)

R Q. 1. **Define the SI unit of potential difference.**
[Board Term I, Set-1ZHNPNO, 2016] [DDE 2017]

Ans. If amount of work done in bringing a one coulomb charge from one point to the other is 1 joule then potential difference between two points is said to be 1 volt. **[CBSE Marking Scheme, 2016]**

R Q. 2. **What is meant by potential difference between two points ? [Board Term I, Set (21) 2011]**

Ans. Potential difference between two points in an electric field is the amount of work done to move a unit charge from one point to other. 1

R Q. 3. **Name the device that helps to maintain a potential difference across a conductor.**
[Board Term I, Set-NS9SX1D, 2016]

Ans. A battery is used to maintain potential difference across a conductor. 1

R Q. 4. **Name the physical quantity which is same in all the resistors when they are connected in series.**
[Board Term I, Set (42) 2011]

Ans. Electric current. 1

R Q. 5. **State the relationship between 1 ampere and 1 coulomb. [Board Term I, Set (36), 2011]**

Ans. 1 ampere $= \frac{1 \text{ coulomb}}{1 \text{ second}}$. 1

R Q. 6. **State in brief the meaning of an electric circuit.**
[Board Term I, Set (34); 2010 (C2), 2011]

Ans. A closed conducting path through which electric charge may flow. 1

R Q. 7. **Name the physical quantity whose unit is volt/ampere. [Board Term I, Set (15) 2011]**

Ans. Resistance. 1

A Q. 8. **A charge of 150 coulomb flows through a wire in one minute. Find the electric current flowing through it. [Board Term I, Set-5X7289R, 2014]**

Ans. Charge (Q) = 150 coulomb
Time (t) = 1 minute = 60 sec.
Current (I) = ?

$$I = \frac{Q}{t}$$

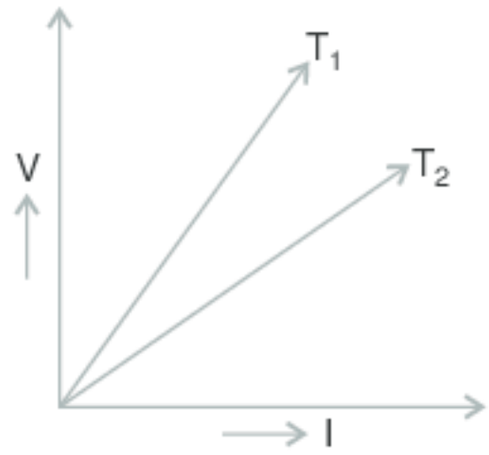
$$= \frac{150}{60} = 2.5 \text{ Amp.} \quad 1$$

A Q. 9. **A given length of a wire is doubled of itself and this process is repeated once again. By what factor does the resistance of the wire changes ?**
[Board Term I, Set (16), 2011]

Ans. Length $\frac{1}{4}$ and area 4 times.

$$R = \rho\frac{l}{A} = \rho\frac{l}{4 \times 4A} = \frac{R}{16}(\text{decreases}) \quad 1$$

A Q. 10. **The voltage-current (V-I) graph of a metallic conductor at two different temperatures T_1 and T_2 is shown below. At which temperature is the resistance higher ?[Board Term I, Set (13), 2011]**



Ans. At temperature T_1, because its slope is greater. 1

U Q. 11. **Through which of the two wires, the electric current will flow more easily ?**
(i) a thick wire or (ii) a thin wire of the same material, and of the same length when connected to the same source ? [Board Term I, Set (32), 2011]

Ans. A thick wire. 1

U Q. 12. **The resistance of a resistor is kept constant and the potential difference across its two ends is decreased to half of its former value. State the change that will occur in the current through it.**
[Board Term I, Set (40), 2011]

Ans. Current will be half of its former value. 1

U Q. 13. **What happens to the resistance of a conductor when its area of cross-section is increased ?**
[Board Term I, Set (29), 2011]

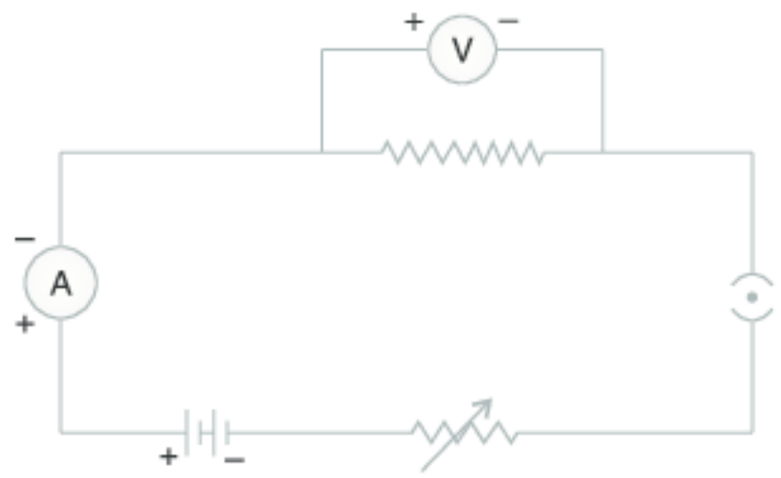
Ans. Resistance is decreased. 1

A Q. 14. **Calculate the number of electrons constituting one coulomb of charge.**
(Charge on 1 electron = $1{\cdot}6 \times 10^{-19}$ C)
[Board Term I, Set-3R6QRQL, 2013]

Ans. $n = \frac{q}{e} = \frac{1}{1.6 \times 10^{-19}} = 6.25 \times 10^{-18}$ C ½ + ½

U Q. 15. **State in brief the meaning of a variable resistor. Draw a circuit diagram to illustrate its function specially in the study of variation in current with the potential difference across a resistor.**
[Board Term I, Set (38), 2011]

Ans.



A device to regulate current without changing the voltage source in an electric circuit is called a variable resistor or a rheostat. ½ + ½

A **Q. 15. 400 J of heat is produced in 4 s in a 4 Ω resistor. Find potential difference across the resistor.**
[Board Term I, Set (17), 2011]

Ans. $\frac{V^2}{R} \times t = 400$

or $V^2 = 400$

or $V = 20$ Volt. 1

Short Answer Type Questions-I

(2 marks each)

R **Q. 1. Define electric current. Name the particles that constitute electric current flowing through the metallic wires.**
[Board Term I, Set-3R6WRQL 2013]

Ans. The flow of electric charges across a cross-section of a conductor in unit time constitutes an electric current.
Electrons. 1 + 1
[CBSE Marking Scheme, 2013]

R **Q. 2. Define '1 Volt'. State the relation between work, charge and potential difference for an electric circuit. Calculate the potential difference between the two terminals of the battery if 100 joules of work is required to transfer 20 coulombs of charge from one terminal of the battery to the other.[Board Term I, Set (48), 2012]**

Ans. 1 volt is the potential difference between two points in a current carrying conductor when 1 joule of work is done to move a charge of 1 coulomb from one point to another. 1

$$\text{Potential difference} = \frac{\text{Work done (W)}}{\text{Charge transferred (Q)}} \quad ½$$

$$= \frac{100\ \text{J}}{20\ \text{C}} = 5\ \text{V} \quad ½$$

[CBSE Marking Scheme, 2012]

R **Q. 3. State the physical quantity which is equal to the ratio of potential difference and current. Define its SI unit.** **[Board Term I, Set (44), 2012]**

Ans. Electrical Resistance, $R = \frac{V}{I}$ ½

The resistance of a conductor is said to be one ohm if the potential difference applied across its ends is 1 volt and a current of 1 A flows through it. It SI unit is ohm (Ω) 1

$$1\ \text{ohm} = \frac{1\ \text{volt}}{1\ \text{ampere}} \quad ½$$

[CBSE Marking Scheme, 2014]

R **Q. 4. List in a tabular form two differences between a voltmeter and an ammeter.**
[Board Term I, Set (43), 2012]

Ans.

S. No.	Voltmeter	Ammeter
(i)	Used to measure the potential difference.	Used to measure the current.
(ii)	Connected in parallel in the electric circuit.	Connected in series in the electric circuit.
(iii)	Has high resistance.	Has low resistance.

[CBSE Marking Scheme, 2012] 1 + 1

U **Q. 5. How the voltmeter and ammeter are connected in a circuit ?** **[DDE 2017]**

Ans. A voltmeter is connected in parallel with device to measure its voltage, while an ammeter is connected in series with a device to measure its current. 1 + 1

U **Q. 6. State the factors on which at a given temperature the resistance of a cylindrical conductor depends. State the SI unit of resistivity.**

[Board Term I, Set (36), 2012]

Ans. Factors on which the resistance of a cylindrical conductor depends :
(i) Area of cross-section of the conductor. ½
(ii) Nature of the material. ½
SI unit of resistivity is ohm-m. 1
[CBSE Marking Scheme, 2012]

A **Q. 7. Calculate the resistance of a metal wire of length 2 m and area of cross section $1{\cdot}55 \times 10^{-6}$ m^2, if the resistivity of the metal be $2{\cdot}8 \times 10^{-8}$ Ωm ?**

[Board Term I, Set-WJ7QPA9, 2013]

Ans. $R = \frac{\rho l}{A}$ ½

$$= \frac{2{\cdot}8 \times 10^{-8} \times 2}{1{\cdot}55 \times 10^{-6}} \quad ½$$

$$= \frac{2{\cdot}8 \times 2 \times 10^{-8-(-6)}}{1{\cdot}55}$$

$$= \frac{2{\cdot}8 \times 2}{1{\cdot}55} \times 10^{-2} = 0{\cdot}036\ \Omega$$

[CBSE Marking Scheme, 2013] 1

A **Q. 8. A battery of 12 V is connected to a series combination of resistors 3 Ω, 4 Ω, 5 Ω and 12 Ω. How much current would flow through the 12 W resistor ? [Board Term I, Set (37), 2012]**

Ans. Current remains same in series combination ½

$$R_{series} = R_1 + R_2 + R_3 + R_4$$

$$(3 + 4 + 5 + 12) = 24\Omega \quad 1$$

$$V = 12V$$

$$I = \frac{V}{R} = \frac{12V}{24\Omega} = \frac{1}{2} = 0.5A \quad ½$$

[CBSE Marking Scheme, 2012]

U **Q. 9. On what factors does resistance of a conductor depend ? [DDE 2017]**

Ans. There are four factor that influence the resistance in a conductor.

Thickness, length, temperature, conductivity of the material is used. ½ + ½ + ½ + ½

U **Q. 10. Three incandescent bulbs of 100 W each are connected in series in an electric circuit. In another circuit another set of three bulbs of the same wattage are connected in parallel to the same source.**

(a) Will the bulb in the two circuits glow with the same brightness? Justify your answer.

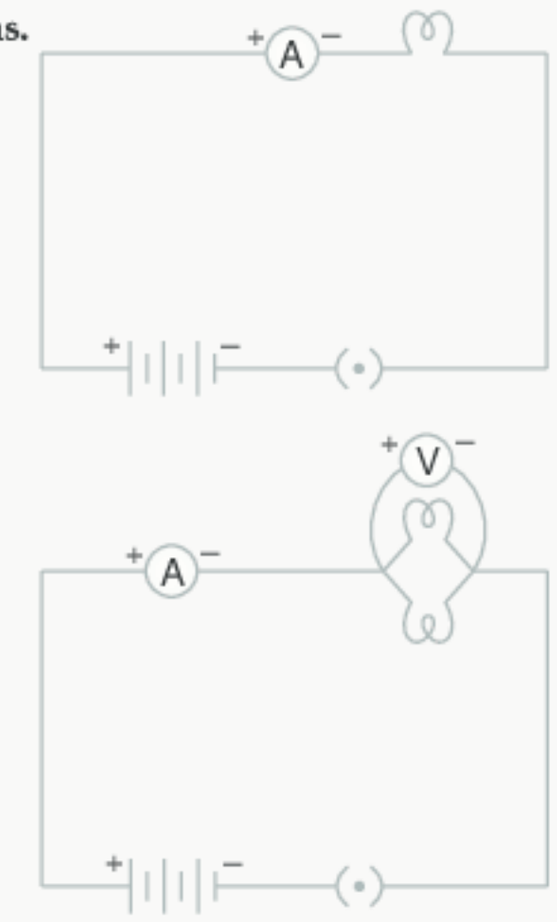
(b) Now let one bulb the circuits get fused. Will the rest of the bulbs continue to glow in each circuit? Give reason. [NCERT Exemplar 2017]

Ans. (a) No. The resistance of the bulbs in series will be three times the resistance of single bulb. Therefore, the current in the series combination will be one-third compared to current in each bulb in parallel combination. The parallel combination bulbs will glow more brightly.

(b) The bulbs in series combination will stop glowing as the circuit is broken and current is zero. However the bulbs in parallel combination shall continue to glow with the same brightness. 1 + 1

U **Q. 11. Draw a schematic diagram of an electric circuit comprising of 3 cells and an electric bulb, ammeter, plug-key in the ON mode and another with same components but with two bulbs in parallel and a voltmeter across the combination. [Board Term I, Set (40), 2012]**

Ans.



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[CBSE Marking Scheme, 2012]

U **Q. 12. Mention the condition under which charges can move in a conductor. Name the device which is used to maintain this condition in an electric circuit. [Board Term I, Set (46), 2012]**

Ans. Charges can move if there is a difference of electric pressure or potential difference along the conductor. 1

Electric cell or a battery consisting of two or more cells. 1

[CBSE Marking Scheme, 2012]

A **Q. 13. (i) Calculate the electrical energy consumed by a 1200 W toaster in 30 minute.**

(ii) What will be the cost of using the same for 1 month if one unit of electricity costs ₹ 4 ?

[Board Term I, Set (37), 2012]

Ans. (i) P = 1200 W t = 30 min = 0.5 h

Electrical energy (E) = P × t

= 1200 × 0.5

= 600W/h = 0.6 kWh. 1

(ii) Energy consumed is 30 days

= 0.6 × 30 = 18 kWh

Cost of using 18 units = ₹ 4 × 18 = ₹ 72 1

[CBSE Marking Scheme, 2012]

A **Q. 14. Calculate the work done in moving a charge of 2 coulombs across two points having a potential difference of 12 V. [Board Term I, Set (41), 2012]**

Ans.

q = 2C

V = 12V

W = V × q

= 12V × 2C

= 24 J. 2

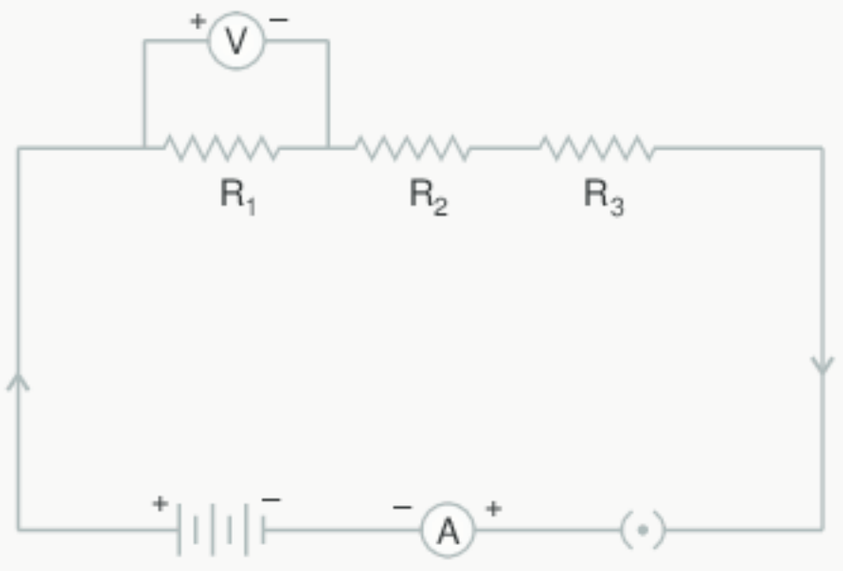
[CBSE Marking Scheme, 2012]

A Q. 15. **Draw a schematic circuit diagram for a circuit in which three resistors R_1, R_2 and R_3, a plug key under closed condition, an ammeter are joined in series with a 5V battery. Also a voltmeter is connected to measure the potential difference across the resistor R_1.**

[Board Term I, Set (47), 2012]

Ans. Circuit diagram to show R_1, R_2 and R_3 connected in series with a battery, ammeter and a key. Voltmeter V is connected parallel to R_1. ½

Direction of current. ½



[CBSE Marking Scheme, 2012] 1

Short Answer Type Questions-II

(3 marks each)

R Q. 1. **Define resistance. Write the SI unit of resistance. Match the correct range of resistivity with the materials given :**

(i) Conductors	**(a) 10^{-6} Ωm**
(ii) Alloys	**(b) 10^{12} to 10^{17} Ωm**
(iii) Insulators	**(c) 10^{-6} to 10^{-8} Ωm**

[Board Term I, Set (40), 2012]

Ans. Electrical resistance of a conductor may be considered as a measure of the opposition offered by it for the flow of electric charge through it. **1**

SI unit of resistance is ohm. ½

(i) Conductors — 10^{-6} to 10^{-8} Ωm ½

(ii) Alloys — 10^{-6} Ωm ½

(iii) Insulators — 10^{12} to 10^{17} Ωm. ½

[CBSE Marking Scheme, 2012]

R Q. 2. **Name and define S.I. unit of resistance. Calculate the resistance of a resistor if the current flowing through it is 200 mA, when the applied potential difference is 0.8 V.**

[Board Term I, Set (41), 2012]

Ans. The SI unit of resistance is ohm. ½

One ohm is the resistance offered by a conductor when the current passing through it is one ampere and the potential difference across its ends is one volt. **1**

By Ohm's law, V = IR ½

$$R = \frac{V}{I} = \frac{0.8V}{0.2A} = 4 \text{ ohm} \qquad \mathbf{1}$$

[CBSE Marking Scheme, 2012]

R Q. 3. **Draw symbol of :**

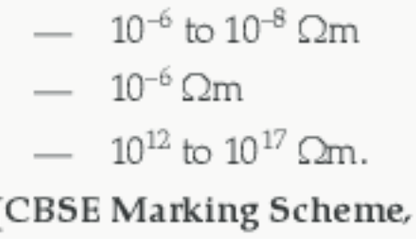
(i) Rheostat, (ii) Voltmeter,

(iii) Electric bulb

[NCT-2014]

Ans. (i) Rheostat

(ii) Voltmeter



(iii) Electric bulb

1 + 1 + 1

R Q. 4. **(i) What is meant by the statement : The potential difference between two points is 1 volt ?**

(ii) What do the symbols given below represent in a circuit ? Write one function of each. [DDE - 2014]

Ans. (i) Potential difference of 1 volt means the amount of work done when a unit charge moves from one point to the other point in an electric field.

(ii) First symbol is variable resistance and second is ammeter.

Variable resistance changes the magnitude of current in the circuit, by variation in resistance. Ammeter is used to find current.

(a)

(b) + A

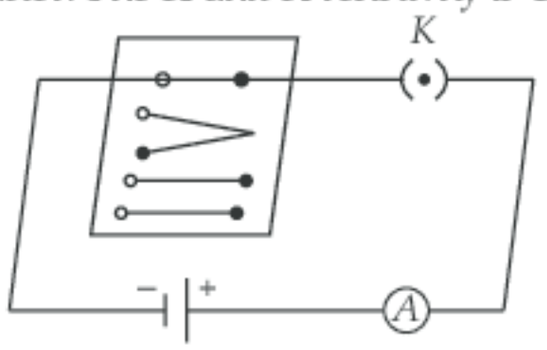
1 + 1 + 1

U Q. 5. **What is electrical resistivity of a material? What is its unit? Describe an experiment to study the factors on which the resistance of conducting wire depends. [NCERT Exemplar 2017]**

Ans. If l is the length of the conductor, A its area of cross-section and R its total resistance then,

$$R \propto \frac{l}{A} \text{ or } R = P\frac{l}{A}$$

Where P is a constant of proportionality and is called the electrical resistivity of the material of the conductor. The SI unit of resistivity is Ohm meter.



Now, plug the key. Note the current in the ammeter. Now replace the wire by a thicker nichrome wire, of the same length. A thicker wire has a larger cross-sectional area. Again note down the current through the circuit. Instead of taking a nichrome

wire, connect a copper wire in the circuit. Again note down the current. **3**

U **Q. 6. (a) Nichrome wire of length L and radius 'R' has resistance of 10Ω. How would the resistance of the wire change when :**

(i) Only length of the wire is doubled ?

(ii) Only diameter of the wire is doubled ? Justify your answer.

(b) Why element of electrical heating devices are made up of alloys ? [Board Term I, Set (15), 2012]

Ans. (a) (i) $R \propto L$

So resistance becomes two times *i.e.*, $R = 20\ \Omega$ **1**

(ii) $R \propto \frac{1}{A} \propto \frac{1}{d^2}$

So when diameter is doubled, resistance becomes one-fourth of the original *i.e.*, $R = 2.5\ \Omega$ **1**

(b) Elements of heating devices are made up of alloys because :

(i) They have high melting points.

(ii) They have high resistances, so when even a small magnitude of current passes through them, they get heated up enormously.

(iii) They do not oxidise readily. **1**

[CBSE Marking Scheme, 2012]

U **Q. 7. A wire of length l and area of cross-section A was drawn into a wire of double its length by melting it. If its original resistivity and resistance were ρ and R respectively, what will be its new resistivity and resistance ?**

[Board Term I, Set (23), 2012]

Ans. We know, $R = \rho \frac{l}{A}$

When a wire is doubled by melting, its length would become double and area of cross-section would be halved *i.e.*, length of wire $= 2l$ and area of cross-section $= \frac{A}{2}$. **1**

Thus, we have $R_1 = \frac{2\rho l}{\frac{A}{2}} = \frac{4\rho l}{A}$

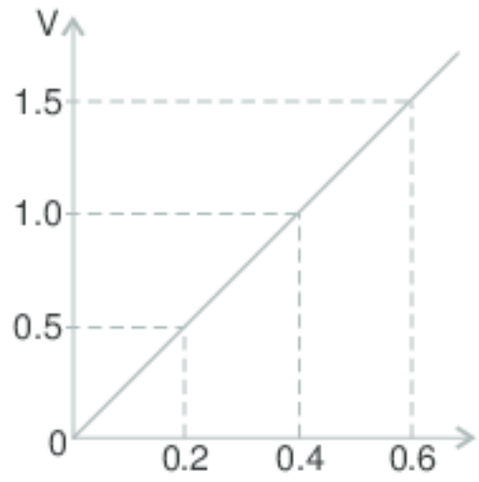
where R_1 is the new resistance. **1**

Therefore, the new resistance of the wire is 4 R.

As resistivity of a material is the characteristic of a given material, hence it remains unchanged. **1**

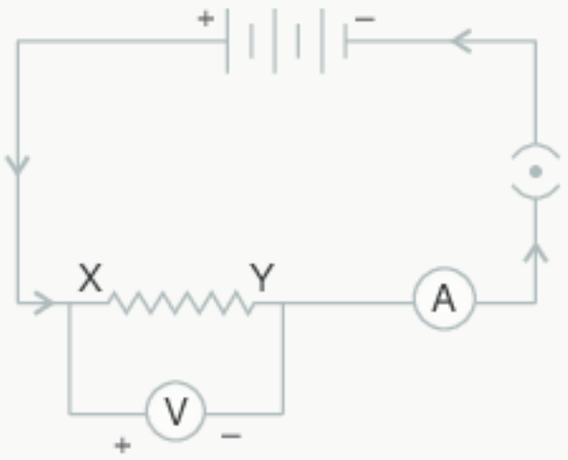
[CBSE Marking Scheme, 2012]

U **Q. 8. An electric circuit consisting of a 0.5 m long nichrome wire XY, an ammeter, a voltmeter, four cells of 1.5V each and a plug key was set up. Draw a diagram of this circuit in the 'ON' position. Following graph was plotted between the value of potential difference (V) and electric current (I). State the conclusion that you draw about the relation between V and I from this graph. [Board Term I Set (49) 2011]**



Ans. Placement of ammeter, voltmeter, direction of current 4 cells in series with a closed key.

½+½+½+½



Relation : For a given resistance, current flowing through a conductor is directly proportional to potential difference across it, if other physical conditions remain constant *i.e.*, $V \propto I$. **1**

[CBSE Marking Scheme, 2011]

U **Q. 9. Derive an expression for electric energy consumed in a device in terms of V, I and t, where V is the potential difference applied to it, I is the current drawn by it and t is the time for which the current flows ?**

[Board Term I, Set-3R6WRQL, 2013]

Ans. We know that work done $= W = QV$

$$\therefore \quad P = \frac{W}{t}$$

Now, $P = \frac{QV}{t}$

$V = IR$ **1**

$$\therefore \quad P = \frac{Q}{t} IR = I^2R$$

$$\text{Energy} = P \times t$$

$= I^2R \times t$ **1**

$$= \frac{V}{R^2} \times R \times t$$

$$= \frac{V^2}{R} t$$

$$\boxed{\text{Energy} = \frac{V^2}{R} t}$$

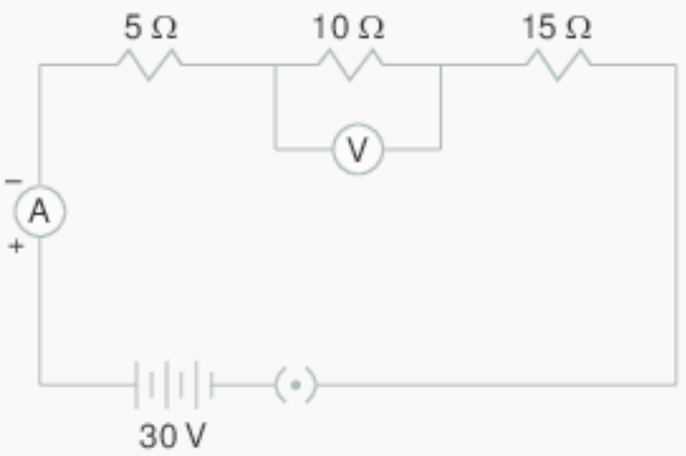
Where, V = voltage, R = resistance, t = time. **1**

[CBSE Marking Scheme, 2013]

A **Q. 10. Three resistors of 5 Ω, 10 Ω and 15 Ω are connected in series and the combination is connected to the battery of 30 V. Ammeter and voltmeter are connected in the circuit. Draw a circuit diagram to connect all the devices in proper correct order. What is the current flowing and potential difference across 10 Ω resistance ?**

[Board Term I, Set (15), 2012]

Ans.



1

$R = R_1 + R_2 + R_3 = 30\ \Omega$ 1

$I = V/R = 30/30 = 1\ A$ ½

V across $10\Omega = IR_2 = 1 \times 10 = 10\ V$ ½

[CBSE Marking Scheme, 2012]

A **Q. 11. The resistance of a wire of 0.01 cm radius is 10 Ω. If the resistivity of the material of the wire is 50×10^{-8} ohm meter, find the length of the wire.**

[Board Term I, Set-5X7289R, 2014]

Ans. Given, Radius $= 0.01\ cm = 0.01 \times 10^{-2} m.$

Resistivity $\rho = 50 \times 10^{-8}\ \Omega m.$

Resistance $R = 10\ \Omega$

$$R = \rho \frac{l}{A} = \rho \frac{l}{\pi r^2}$$

$$l = \frac{R\pi r^2}{\rho}$$

$$= \frac{10 \times 3.14 \times 0.01 \times 10^{-2} \times 0.01 \times 10^{-2}}{50 \times 10^{-8}}$$

$$= \frac{314 \times 10^{-4}}{50 \times 10^{-8} \times 10^{5}}$$

$$\text{Length} = \frac{6.28 \times 10^{-4}}{10^{-3}} = 0.628\ m. \qquad 3$$

A **Q. 12. In an electric field the work done in bringing a 2 coulomb charge from infinity to a point A is 10 joules and in bringing the same charge to some another point B is 20 joules. Find the potential difference between two points A and B. What would be the work done if the same charge is brought directly from A to B ?**

[Board Term I, Set-WH1SGOB, 2014]

Ans. Work done = 10 Joule

Charge = 2 Coulomb

$$\text{Potential of point A} = V_A = \frac{10\ J}{2\ C} = 5\ V$$

Given, work done = 20 Joule

Charge = 2 coulomb.

$$\text{Potential of Point B} = V_B = \frac{20\ J}{2\ C} = 10\ V$$

Potential difference between two point A and B is

$$V = V_B - V_A$$

$$= 10\ V - 5\ V = 5\ V.$$

Work done directly from A to B.

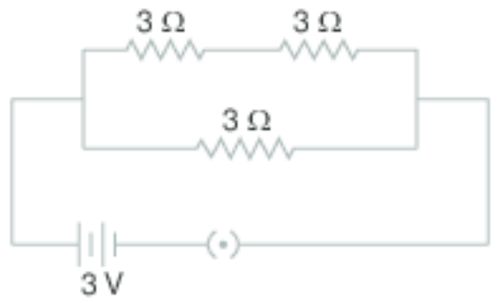
Work done = Potential difference × charge

$= 5\ V \times 2\ C$

$= 10$ Joule $\qquad 2 + 1$

[CBSE Marking Scheme, 2014]

A **Q. 13. Three resistors of 3 Ω each are connected to a battery of 3 V as shown. Calculate the current drawn from the battery.**



[Board Term I, Set WH1SGOB, 2014]

Ans.

$$R_4 = R_1 + R_2 = 3\ \Omega + 3\ \Omega = 6\ \Omega$$

$$\frac{1}{R_5} = \frac{1}{R_4} + \frac{1}{R_3} = \frac{1}{6} + \frac{1}{3} = \frac{1+2}{6} = \frac{3}{6} = \frac{1}{2}.$$

$$R_5 = 2\Omega$$

$$\text{Current } I = \frac{V}{R_5} = \frac{3V}{2\Omega} = 1.5\ \text{Amp}$$

[CBSE Marking Scheme, 2014] 3

A **Q. 14. The resistance per metre length of a wire is 10 Ω. It the resistivity of the material of the wire is 50×10^{-8} ohm metre, find the area of cross-section of the wire.**

[Board Term-I, Set-JYNE6XG, 2015]

Ans.

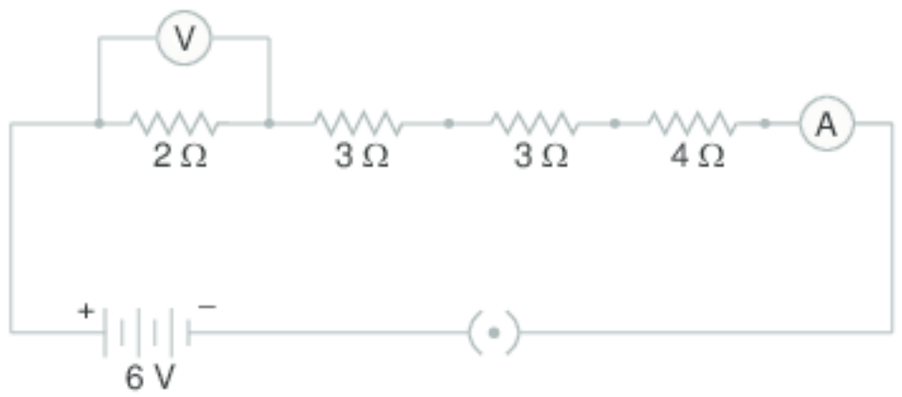
$$R = \frac{\rho l}{A}$$

$$10 = \frac{50 \times 10^{-8} \times 1}{A}$$

$$A = \frac{50 \times 10^{-8} \times 1}{10} = 5 \times 10^{-8}\ m^2 \qquad 3$$

A **Q. 15. Find out the reading of ammeter and voltmeter in the circuit given below :**

[Board Term I, Set (36), 2012]



Ans. Equivalent resistance $R = (2 + 3 + 3 + 4)\ \Omega$

$= 12\Omega$ **1**

Total current drawn = Ammeter reading $= \frac{V}{R}$

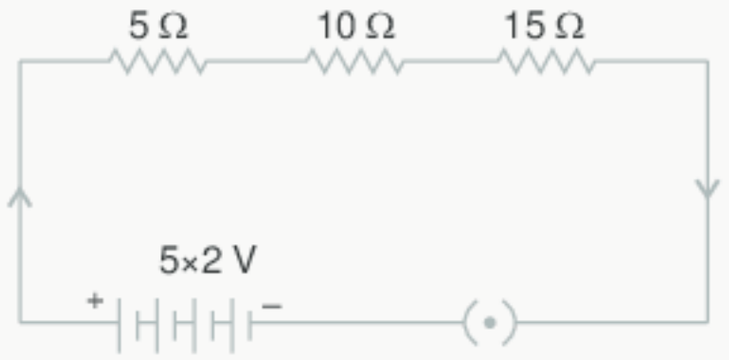
$= \frac{6}{12} = 0.5A$ **1**

Voltmeter reading $= IR_1 = 0.5 \times 2 = 1V$ **1**

[CBSE Marking Scheme, 2012]

A **Q. 16. Draw schematic diagram of a circuit consisting of a battery of five 2V cells, a 5 ohm, a 10 ohm and a 15 ohm resistor and a plug key, all connected in series. Calculate the electric current passing through the above circuit when the key is closed. [Board Term I, Set (42), 2012]**

Ans. The required circuit diagram is :



Applied potential difference **1½**

$V = 5 \times 2 = 10\ V$

Total resistance

$R = 5 + 10 + 15 = 30\ \Omega$

Current, $I = \frac{V}{R} = \frac{10}{30} = 0.33\ A$ **1½**

[CBSE Marking Scheme, 2012]

A **Q. 17. An electric bulb is rated at 60W, 240V. Calculate its resistance. If the voltage drops to 192V, calculate the power consumed and the current drawn by the bulb. (Assume that the resistance of the bulb remains unchanged).**

[Board Term I, Set (48), 2011]

Ans. $P = \frac{V^2}{R} \therefore R = \frac{V^2}{P} = \frac{(240V)^2}{60W} = 960\ \Omega$ **1**

$P = \frac{V^2}{R} = \frac{(192V)^2}{960\ \Omega} = 38.4\ W$ **1**

$I = \frac{V}{R} = \frac{192V}{960\Omega} = 0.2\ A$ **1**

[CBSE Marking Scheme, 2011]

Long Answer Type Questions

(5 marks each)

R **Q. 1. What does an electric circuit mean ? Name a device that helps to maintain a potential difference across a conductor in a circuit. When do we say that the potential difference across a conductor is 1 volt ? Calculate the amount of work done in shifting a charge of 2 coulombs from a point A to B having potentials 110 V and 25 V respectively.**

[Board Term I, Set-L7ZSVLH, 2016]

Ans. Electric circuit : The closed path along which an electric current flows is called an 'electric circuit'. The device that helps to maintain a potential difference across a conductor in a circuit are—

Electric cell, electric battery, electric generator

1 Volt: The potential difference between two points in an electric field is said to one volt if one joule of work has to be done in bringing a positive charge of one coulomb from one point to another.

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ Coulomb}} \text{ or } 1\ V = \frac{1\ J}{1\ C}$$

Work done = V (Potential difference) × Q (Coulombs)

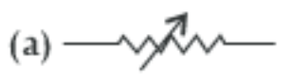
$W = V \times Q$

$= 85 \times 2$

$= 170$ Joule. **2 + 3**

R **Q. 2. (i) Name an instrument that measures electric current in a circuit. Define unit of electric current.**

(ii) What are the following symbols mean in an electric circuit.

(a) 

(b) 

(iii) Draw a closed circuit diagram consisting of 0.5 m long nichrome wire XY, an ammeter, a voltmeter, four cells of 1.5 V and a plug key.

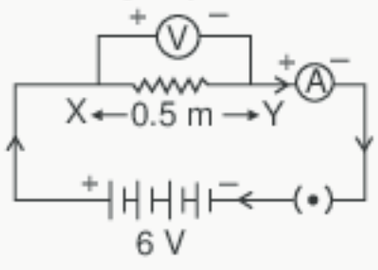
[Board Term I, Set-OQKPLGV, 2016]

Ans. (i) ammeter

The current is said to be one ampere if 1 coulomb of charge flows through a cross section of conductor per second.

(ii) (a) Rheostat **(b)** Plug key (closed)

(iii)



[CBSE Marking Scheme, 2016] 2 + 3

U Q. 3. (i) Draw a labelled circuit diagram to study a relationship between potential difference (V) across the two ends of a conductor and the current (I) flowing through it. State the formula to show how I in a conductor varies when V across it is increased step wise. Show this relationship also on a schematic graph.

(ii) Calculate the resistance of a conductor if the current flowing through it is 0.25 A when the applied potential difference is 1.0 V.

[Board Term I, Set-1ZHNPNO, 2016]

Ans. (i) Refer Ans. 8 (Short Answer Type)-II.

(ii) $V = 1.0V$

$I = 0.25\ A$

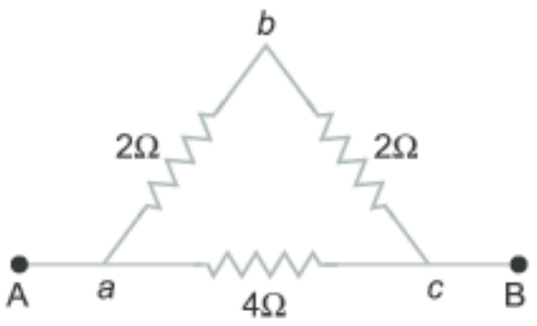
$V = IR$

$R = \frac{V}{I} = 4\Omega$

$= \frac{1}{0.25} = 4\Omega$ 1 + 2 + 2

[CBSE Marking Scheme, 2016]

U Q. 4.



With the help of a circuit diagram prove that when a number of resistors are connected in parallel, the reciprocal of equivalent resistance of the combination is equal to the sum of the reciprocals of the individual resistances of the resistors.

Find the resistance between A and B in the following network.

[Board Term I, Set-JYNE6XG, 2015]

Ans. If there are two resistances in parallel *i.e.* R_1 and R_2

∴ Equivalent resistance R :

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

Where $R_1 = 2\Omega + 2\Omega = 4\Omega$

$$\frac{1}{R} = \frac{R_2 + R_1}{R_1 R_2}$$

Now $$R = \frac{R_1 R_2}{R_1 + R_2}$$

Resistance across A and B :

$$R = \frac{4 \times 4}{4 + 4} = \frac{16}{8} = 2\Omega$$ 3 + 2

U Q. 5. (a) Two identical resistors each of resistance 10 ohm are connected in :

(i) series, (ii) parallel.

in turn to a battery of 6V. Calculate the ratio of power consumed by the combination of resistor in the two cases.

(b) List two factors on which the resistance of a conductor depends.

(c) Write a difference between an ammeter and voltmeter. [Board Term I, Set (45), 2012]

Ans. (a) $R_1 = R_2 = 10\ \Omega$

(i) When connected in series

$R_S = R_1 + R_2 = 20\ \Omega$

$P_S = \frac{V^2}{R_S} = \frac{6 \times 6}{20} = 1.8\ W$ 1

(ii) When connected in parallel

$R_P = \frac{R_1 R_2}{R_1 + R_2} = \frac{10 \times 10}{10 + 10} = 5\ \Omega$ 1

$P_P = \frac{V^2}{R_P} = \frac{6 \times 6}{5} = 7.2\ W$

$\frac{P_S}{P_P} = \frac{1.8W}{7.2W} = \frac{1}{4} = 1 : 4$ 1

(b) Resistance of a conductor depends on :

(i) length of the conductor ½

(ii) area of cross section ½

(c)

S. No.	Ammeter	Voltmeter
(i)	Is is used to measure the current.	It is used to measure the potential difference.
(ii)	It is connected in series in the circuit.	It is always connected in parallel in the circuit.

(Any one difference) 1

[CBSE Marking Scheme, 2012]

A Q. 6. (i) How will you convert a given set of resistors so that the equivalent resistance is increased ? Give reason for your answer.

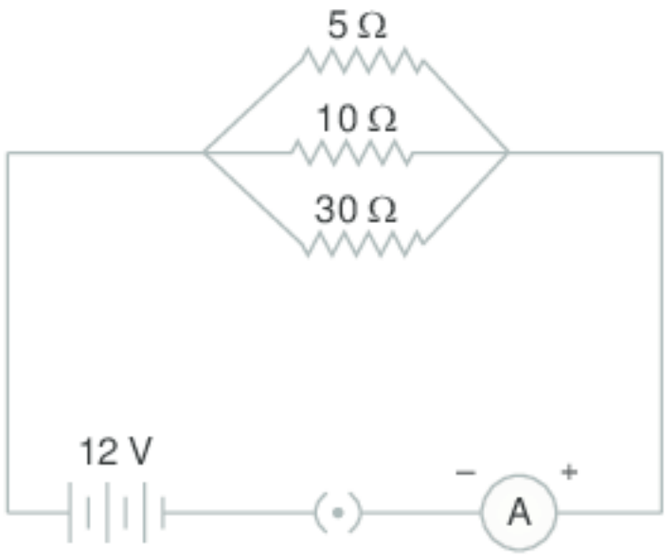
(ii) In the given circuit diagram, calculate :

(a) the value of current through each resistor

(b) the total current in the circuit

(c) the total effective resistance of the circuit.

[Board Term I, Set (40), 2012]



Ans. (i) In series because $R = R_1 + R_2 + R_3$
$= 5 + 10 + 30 = 45\ \Omega$ 1

(ii) (a) $I_1 = \frac{V}{R_1} = \frac{12}{5} = 2.4\ A$ ½

$I_2 = \frac{V}{R_2}$ ½

$I_3 = \frac{V}{R_3} = \frac{12}{30} = 0.4\ A$ ½

(b) Total current $I = I_1 + I_2 + I_3$
$= 2.4\ A + 1.2\ A + 0.4\ A$ 1
$= 4\ A$

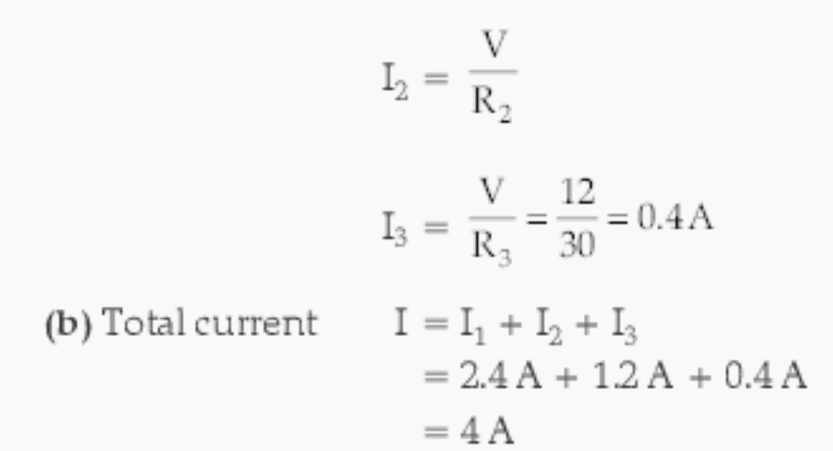
(c) Total effective resistance $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ ½

$= \frac{1}{5} + \frac{1}{10} + \frac{1}{30}$

$= \frac{10}{30} = 3\ \Omega$ 1

[CBSE Marking Scheme, 2012]

A **Q. 7. (a) Two students perform experiments on two given resistors R_1 and R_2 and plot the following V-I graphs. If $R_1 > R_2$, which of the two diagrams correctly represent the situation on the plotted curves ? Justify your answer.**



(b) An electric lamp of 24 Ω and a conductor of 6 Ω are connected in parallel to a 12 V battery. Calculate :

(i) Total resistance

(ii) Total current in the circuit

(iii) Potential difference across the conductor.

[Board Term I, Set (38), 2012]

Ans. (a) $R_1 > R_2$

Hence, diagram 1 is correct as R_1 is large so the slope of V – I graph $\left(\frac{V}{I}\right)$ is greater in Diagram 1

and is correctly represented as R_1. 2

(b) $R_1 = 24\Omega, R_2 = 6\Omega, V = 12\ V$

(i) $R = \frac{R_1 R_2}{R_1 + R_2} = \frac{6 \times 24}{30} = 4.8\ \Omega$ 1

(ii) $I = \frac{V}{R} = \frac{12V}{4.8} = \frac{10}{4} A = 2.5\ A$ 1

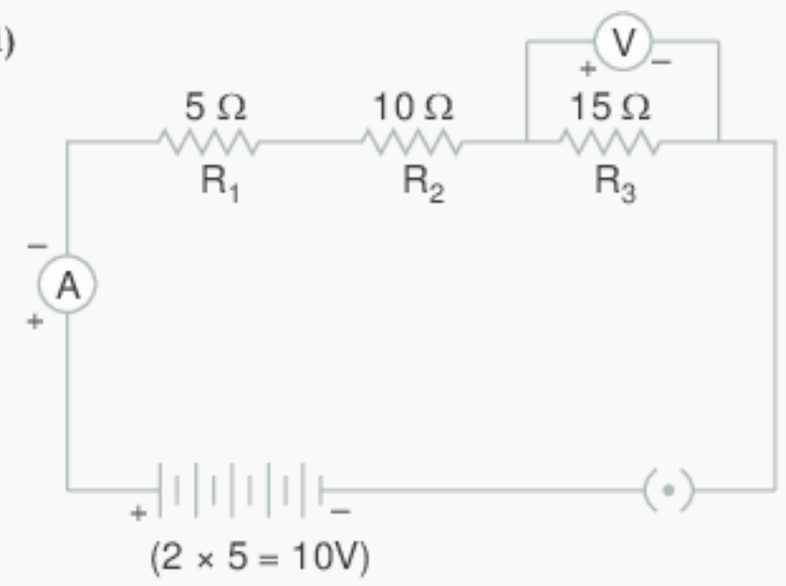
(iii) Potential difference across the conductor will be 12V because these are joined across the battery. **[CBSE Marking Scheme, 2012]** 1

U **Q. 8. Draw a circuit diagram for a circuit consisting of a battery of five cells of 2 volts each, a 5 Ω resistor, a 10 Ω resistor and a 15 Ω resistor, an ammeter and a plug key; all connected in series. Also connect a voltmeter to record the potential difference across the 15 Ω resistor and calculate :**

(i) the electric current passing through the above circuit and

(ii) potential difference across 5Ω resistor when the key is closed. [Board Term I, Set (51), 2012]

Ans. (i)



½ + ½

10 V battery; Rest components 1

Equivalent resistance $= R_1 + R_2 + R_3$ ½
$= 5 + 10 + 15$
$= 30\ \Omega$ ½

Current in the circuit, $I = \frac{V}{R}$ ½

$I = \frac{10V}{30\Omega} = \frac{1}{3} A$ or $0.33\ A$ ½

(ii) Potential difference across 5Ω resistor, $V = IR$ ½

$= \frac{1}{3} A \times 5\ \Omega$

$= 1.67\ V$ ½

[CBSE Marking Scheme, 2012]

TOPIC-2

Resistance in Series and Parallel Combination, Electric Power and Heating Effect

Very Short Answer Type Questions (1 mark each)

R Q. 1. **Write SI unit of resistivity.**
[Board Term I, Set-2ZGOVVV, 2015] [DDE 2017]

Ans. Ohm metre (Ωm). 1

R Q. 2. **What is commercial unit of energy ?**
[Board Term I, Set (23), 2011]

Ans. Kilowatt hour or kWh. 1

R Q. 3. **What is electric power ? State its SI unit.**
[Board Term I, Set-33, 2011]

Ans. Rate at which energy is consumed is called electric power. Its unit is watt. ½ + ½

R Q. 4. **Name the instrument used for measuring :**
(i) Potential difference (ii) Current.
[Board Term I, Set-24, 2011]

Ans. (i) Voltmeter **(ii)** Ammeter. ½ + ½

R Q. 5. **On what principle is an electric bulb based ?**
[NCERT Exemplar]

Ans. Heating effect of current. 1

U Q. 6. **Mention one reason why tungsten is exclusively used for making filaments of electric lamps.**
[DDE-2014]

Ans. Tungsten has a high resistivity and a high melting point. So, most of the power consumed by this, is dissipated in the form of heat. 1

U Q. 7. **How is an ammeter connected in a circuit to measure the current flowing through it ?**
[Board Term I, Set-26 2011]

Ans. In series. 1

U Q. 8. **What determines the rate at which energy is delivered by a current ?** **[NCERT]**

Ans. Electric power determines the rate at which energy is delivered by a current. 1

R Q. 9. **In a circuit if two resistors of 5 Ω and 10 Ω are connected in series. Compare the current passing through the two resistors.**
[Board Term I, Set-22, 2011]

Ans. In a series connection of resistors, same current passes through all the resistors. Hence, current will be same. Ratio of the current will be 1 : 1. 1

U Q. 10. **Why are coils of electric toasters and electric irons made of alloy rather than pure metals ?**
[NCERT Exemplar]

Ans. Alloys are preferred to make coils of toasters and irons because they have higher resistivity and do not oxidise easily at high temperature. 1

A Q. 11. **Find the minimum resistance that can be made using five resistors, each of 5Ω.**
[NCERT Exemplar]

Ans. By connecting resistors in parallel, resistance 1Ω is obtained

$$R_{eq} = \frac{R}{n} = \frac{5\Omega}{5} = 1\Omega \qquad 1$$

A Q. 12. **Write the relation between resistance (R) of filament of a bulb, its power (P) and a constant voltage V applied across it.**
[Board Term I, Set-WJ7QPA9, 2013]

Ans. $R = \frac{V^2}{P}$. 1

A Q. 13. **Which is having more resistance—a 220 V, 100 W bulb or a 220 V, 60 W bulb.**
[Board Term I, Set 19, 2011]

Ans. 60 W bulb, because $R \propto \frac{1}{P}$. 1

Short Answer Type Questions-I (2 marks each)

R Q. 1. **Define least count with one example.**
[Board Term-I Set 2ZGOVVV 2015]

Ans. The smallest value that can be measured by the measuring instrument is called its least count.

For example : if an instrument have 10 division starting from zero up to mark 1 i.e. least count

$$= \frac{1}{10} = 0.1 \qquad 1 + 1$$

R Q. 2. **State the factors on which the heat produced in a current carrying conductor depends. Give one practical application of this effect. $H = I^2Rt$**
[Board Term I, Set-51, 2012]

Ans. Factors — square of current, resistance of the given conductor, time on which the current flows. 1½

Application — electric heating devices like electric iron or any other/electric bulb/electric fuse. ½

[CBSE Marking Scheme, 2012]

U **Q. 3. (i) Why are electric bulbs filled with chemically inactive nitrogen or argon ?**
(ii) What is meant by the statement that the rating of a fuse in a circuit is 5A ? [Board Term I, Set-15, 2012]

Ans. (i) To prolong the life of filament. **1**
(ii) The maximum current that should flow in the circuit is 5A. If it exceeds this, the fuse will be blown off. **1**
[CBSE Marking Scheme, 2012]

U **Q. 4. Why the filament of bulb has high melting point ? [DDE 2017]**

Ans. A filament is made up of a substance having high melting point because a bulb lights up heating the filament. The heated filament is the source of light and if the melting point of filament's substance is low, it may melt. **2**

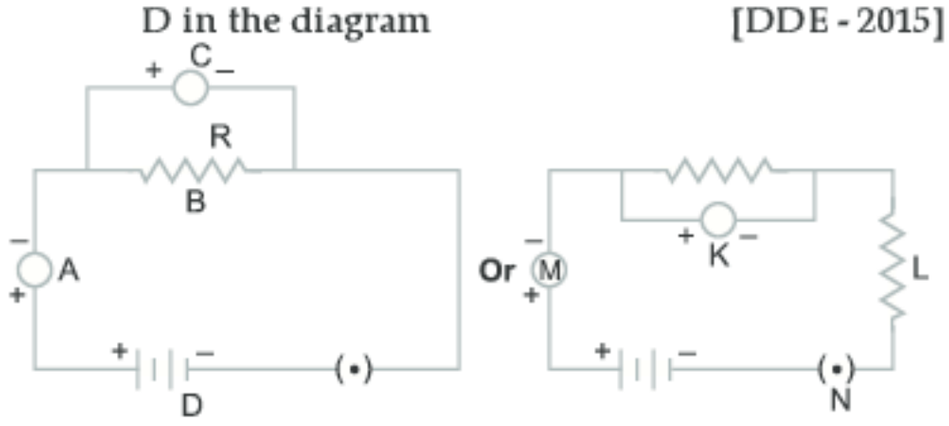
R **Q. 5. Name the physical quantity that determines the rate at which energy is delivered by an electric current. State and define the unit of this physical quantity. [Board Term I, Set-50, 2012]**

Ans. Quantity — Electric power ½
Unit — Watt ½
1 Watt is the power consumed by a device that carries 1 A of current when operated at a potential difference of 1 V. **[CBSE Marking Scheme, 2012] 1**

U **Q. 6. Explain two disadvantages of series arrangement for household circuit.**
[Board Term I, Set-38, 2012]

Ans. (i) Current is constant in series combination, so it is impractical to connect a bulb and an electric heater in series. **1**
(ii) When one component fails, the circuit is broken and none of the components work. **1**
[CBSE Marking Scheme, 2012]

A **Q. 7. A student draws the following circuit diagrams for the experiment on studying the dependence of current on potential difference (V) across a resistor. Name the parts labelled as A, B, C and D in the diagram [DDE - 2015]**



Ans. M or A = Ammeter, L or B = Resistance, K or C = Voltmeter, D = Potential difference, N = Key
½+½+½+½

U **Q. 8. How does fuse wire protect electrical appliances ?**
[NCERT Exemplar] [DDE 2017]

Ans. The fuse breaks the circuit if a fault in an appliance causes too much current flow. This protects the wiring and the appliance if something goes wrong. The fuse contains a piece of wire that melts easily. If the current going through the fuse is too great, the wire heats up until it melts and breaks the circuit. **2**

U **Q. 9. Give reasons for the following :**
(i) Electric bulbs are usually filled with chemically inactive gases like nitrogen and argon.
(ii) Fuse wire is placed in series with the device.
[Board Term I, Set-38, 2012]

Ans. (i) So that the filament does not burn on heating. **1**
(ii) It melts and stops the flow of any unduly high electric current and breaks the circuit. **1**
[CBSE Marking Scheme, 2012]

A **Q. 10. While experimentally verifying ohm's law a student observed that pointer of the voltmeter coincide with 15^{th} division when the voltmeter has a least count of 0.05 V. Find the observed reading of voltmeter.**
[DDE-2015] [Board Term I, Set-JYNE6XG, 2015]

Ans. Reading of voltmeter = 15×0.05
$= 0.75$ volt. **2**

A **Q. 11. An electric heater rated 800 W operates 6h/day. Find the cost of energy to operate it for 30 days at ₹ 3.00 per unit. [Board Term I, Set-(15), 2012]**

Ans. Energy consumed $= P \times t = 800 \times 6 \times 30$
$= 144000$ Wh
$= 144$ kWh.
Cost of electricity $= 144 \times 3 = ₹ 432$. **2**
[CBSE Marking Scheme, 2012]

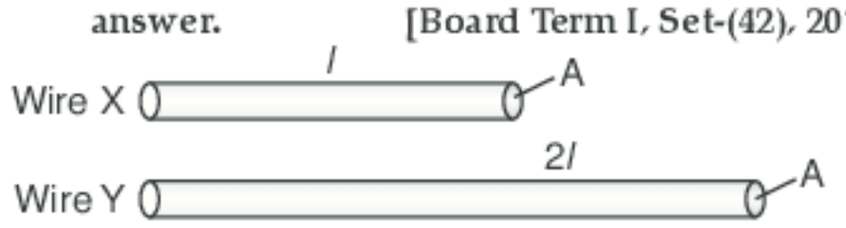
A **Q. 12. How much current will an electric bulb draw from 220 V source if the resistance of the bulb is 1200 Ω? If in place of a bulb, a heater of resistance 100 Ω is connected to the sources, calculate the current drawn by it. [Board Term I, Set-(18), 2012]**

Ans. $I_1 = V/R_1 = \frac{220\,V}{1200\,\Omega} = 0.18$ Amp.

$I_2 = V/R_2 = \frac{220\,V}{100\,\Omega} = 2.2$ Amp. **1 + 1**

[CBSE Marking Scheme, 2012]

A **Q. 13. Out of the two wires X and Y shown below, which one has greater resistance. Justify your answer. [Board Term I, Set-(42), 2012]**



Ans. Wire Y, because $R \propto l$ ½
Resistance of a conductor is directly proportional to the length of the conductor, whose area of cross-section is the same. **1½**
[CBSE Marking Scheme, 2012]

A **Q. 14. An electric iron takes a current of 5 A and develops 1.5×10^4 J of heat energy in 30s. Calculate the resistance of the electric iron.**
[Board Term I, Set-(54), 2012]

Ans. $I = 5A$, $H = 1.5 \times 10^4$ J, $t = 30$ s, $R = ?$

$R = \frac{H}{I^2 t} = \frac{1.5 \times 10^4}{5 \times 5 \times 30} = \frac{1.5 \times 10^4}{25 \times 30}$

$= 20\Omega$ **2**

[CBSE Marking Scheme, 2012]

Short Answer Type Questions-II (3 marks each)

R Q. 1 **(i) Define electric power. A device of resistance R is connected across a source of V voltage and draws a current I. Derive an expression for power in terms of voltage and resistance.**

(ii) An electric bulb is connected to a 220 V generator. The current is 0.5 A. What is the power of the bulb ? [Board Term I, Set-18, 2012]

Ans. (i) Rate at which electric energy is dissipated in an electric circuit. **1**

$$P = \frac{V.Q}{t} = V.I = V \times \frac{V}{R} = \frac{V^2}{R}$$ **1**

(ii) $P = VI = 220\ V \times 0.5\ A = 110\ J/s = 110\ W$ **1**

[CBSE Marking Scheme, 2012]

R Q. 2. **(i) State one difference between Kilowatt and Kilowatt hour. Express 1 kWh in joules.**

(ii) A bulb is rated 5V; 500 mA. Calculate the rated power and resistance of the bulb when it glows.

[Board Term I, Set-52, 2012]

Ans. (i) Kilowatt (kW)—large unit of electric power ½
Kilowatt hour (kWh)—commercial unit of electric energy. ½

$1\ kWh—3.6 \times 10^6$ joules ½

(ii) Potential difference 5V; current 500 mA $= 500 \times 10^{-3}$ A

$$P = VI$$
$$= 5V \times 500 \times 10^{-3}\ A = 2.5\ W$$
$$R = \frac{V}{I} = \frac{5V}{500 \times 10^{-3}\ A} \times 10\Omega$$ **1½**
$$R = 100\ \Omega$$

[CBSE Marking Scheme, 2012]

R Q. 3. **What is an electric fuse ? Why it is used in electric circuits ? Should it be placed on natural wire or on live wire ? Justify your answer.**

Ans. An electric fuse is a low resistance resistor that provides protection in the event of a overload current.

Rest answer refer to know the terms fuse-wire. It is should be placed on live wire. **1+1**

R Q. 4. **Define electric power. An electric motor is rated at 2kW. Calculate the cost of using it for 2 hours daily for the month of September if each unit costs ₹ 6.00. [Board Term I, Set-55, 2012]**

Ans. Rate at which electric energy is consumed / dissipated in an electric circuit. **1**

$E = P \times t \times$ no. of days $= 2kW \times 2h \times 30 = 120$ kWh = 120 unit **1**

$\therefore$ Cost = ₹ 6×120 = ₹ 720. **1**

[CBSE Marking Scheme, 2012]

R Q. 5. **State Ohm's Law. Draw a circuit diagram to verify this law indicating the positive and negative terminals of the battery and the meters. Also show the direction of current in the circuit.**

[Board Term I, Set-OQKPLGV, 2016]

Ans. Statement to Ohm's Law
Circuit diagram with
Polarity of battery, ammeter and voltmeter
Direction of current by arrow

[CBSE Marking Scheme, 2016] 3

Detailed Answer :

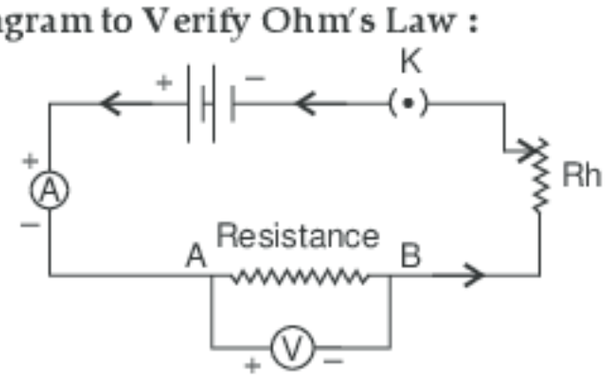
Ohm's Law : It states that "Physical conditions remaining same, the current flowing through a conductor is directly proportional to the potential difference across its two ends".

i.e., $V \propto I$

$V = IR$

where the constant of proportionality R is called the electrical resistance or resistance of the conductor.

Diagram to Verify Ohm's Law :



2 + 1

U Q. 6. **Give reason for the following :**

(i) Why are copper and aluminium wires used as connecting wires ?

(ii) Why is tungsten used for filament of electric lamps?

(iii) Why is lead-tin alloy used for fuse wires ?[Board Term-I-2015, Set A85V2IL,L7ZSVLH, 2016]

Ans. (i) These are good conductors of electricity/low resistance, low resistivity.

(ii) Very high melting point and high resistivity.

(iii) Low melting point. **1+1+1**

[CBSE Marking Scheme, 2016]

U Q. 7. **V-I graph for a conductor is as shown in figure.**

(i) What do you infer from this graph ?

(ii) State the law expressed here.

(iii) Name the physical quantity represented by the slope of this graph and state its SI unit.

[Board Term I, Set-A85V2IL, 2015]

Ans. (i) Inference V α I

(ii) The states that the current passing through a conductors is directly proportional to the potential difference across its ends, provided the physical conditions like temperature, density, etc, remain unchanged. This is ohm's law.

(iii) Slope : Resistance, unit ohm. **1+1+1**

(CBSE Marking Scheme 2015)

U **Q. 8. Which is the better way to connect lights and other appliances in domestic wiring and why ?**

[DDE 2017]

Ans. Parallel connection is a better way to connect lights and other appliance in domestic circuit.

It is because—

(a) When we connect a number of devices in parallel combination, each devices in parallel combination, each device gets the same potential as provided by the battery and it keeps on working even if other devices stops working.

(b) Parallel connection is helpful when each device has different resistances and requires different current for its operation as in this case the current divides itself through different devices. **1 ½ + 1 ½**

U **Q. 9. Show four different ways in which three resistors of '*r*' ohm each may be connected in a circuit. In which case is the equivalent resistance of the combination :** [DDE-2015]

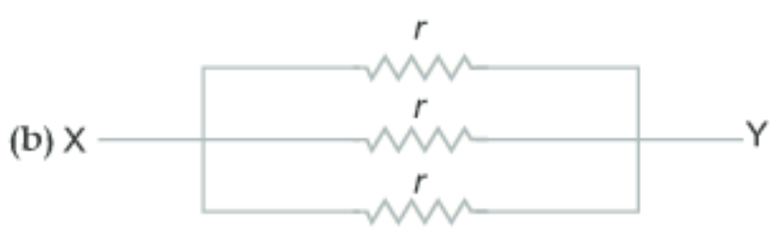
(i) Maximum

(ii) Minimum **[Board Term I, Set-5X7289R, 2014]**

Ans. (a)

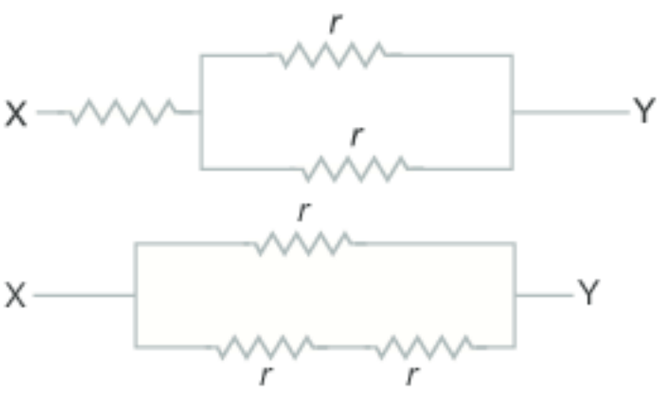
½

(b)



½

(c)



½

(d)

½

(i) Circuit (a) have maximum resistance ½

(ii) Circuit (b) have minimum resistance ½

U **Q. 10. Electrical resistivities of some substances, in ohm-meter, at 20°C are given as follows :**

Silver	1.60×10^{-8}
Copper	1.62×10^{-8}
Tungsten	5.2×10^{-8}
Mercury	94×10^{-8}
Iron	10×10^{-8}
Nichrome	10×10^{-6}

(i) Out of the silver and copper, which is a better conductor of electric current and why ?

(ii) Which substance is preferred to be used for electrical transmission lines ? Give reason.

(iii) Name the material that you would advise to be used in the heater elements of electric heating device and why ? **[Board Term I, Set-50, 2012]**

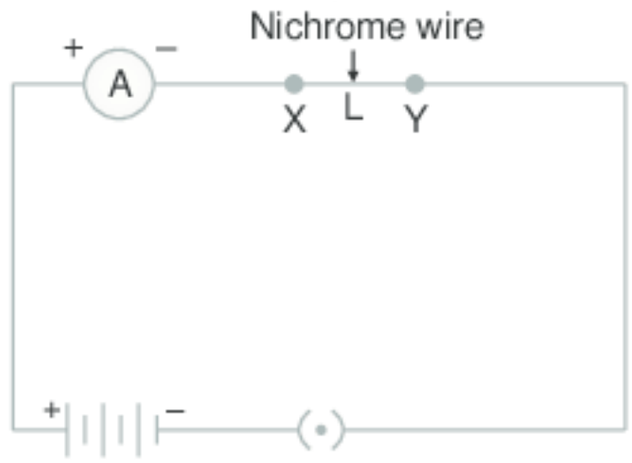
Ans. (i) Silver is a better conductor, lower resistivity. ½ + ½

(ii) Copper, economical / low resistivity. ½ + ½

(iii) Nichrome; Very high resistivity / as it is an alloy, it does not oxidize readily at high temperature. ½+½

[CBSE Marking Scheme, 2012]

U **Q. 11. (a) In the above circuit, connect a nichrome wire of length 'L' between points X and Y and note the ammeter reading.**



(i) When this experiment is repeated by inserting another nichrome wire of the same thickness but twice the length (2L), what changes are observed in the ammeter reading ?

(ii) State the changes that are observed in the ammeter reading if we double the area of cross-section without changing the length in the above experiment.

Justify your answer in both the cases.

(b) "Potential difference between points A and B in an electric field is 1 V". Explain the above statement.

[Board Term I, Set-51, 2012]

Ans. (a) (i) The ammeter reading will decrease (becomes half). This is because with the increase in length, resistance of the circuit increases, hence current decreases. **1**

(ii) The ammeter reading will increase (becomes two times). This is because as area increases, resistance decreases and hence current increases. **1**

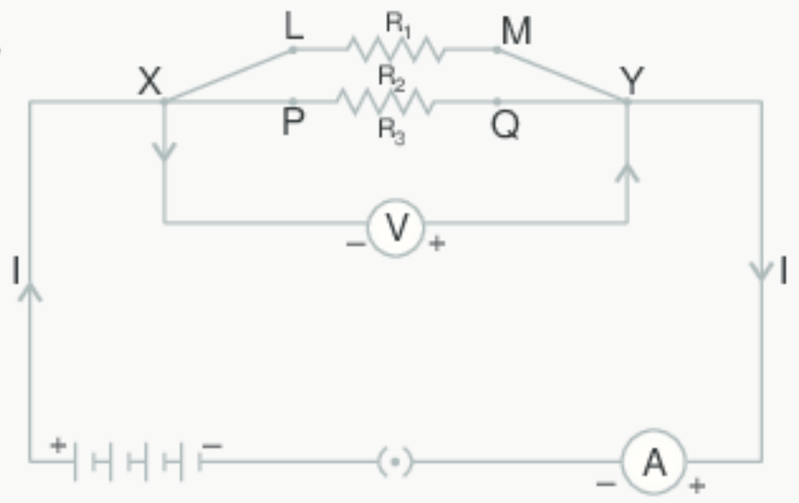
(b) It means that 1 J of work is being done to move a charge of 1 coulomb from point A to point B. **1**

[CBSE Marking Scheme, 2012]

U **Q. 12. Derive the relation for equivalent resistance when three resistances are connected in parallel.**

[Board Term I, Set-WJ7QPA9, 2013]

Ans.



½

It is observed that the total current I, is equal to the sum of the separate currents through each branch of the combination.

$$I = I_1 + I_2 \qquad ½$$

Let R_p be the equivalent resistance of the parallel combination of resistors. By applying Ohm's law to the parallel combination of resistors, we have

$$I = V/R_p \qquad ½$$

On applying Ohm's law to each resistor, we have

$$I_1 = V/R_1; I_2 = V/R_2; \qquad ½$$

From eqns., we have

$$V/R_p = V/R_1 + V/R_2 \qquad ½$$

or $$1/R_p = 1/R_1 + 1/R_2 \qquad ½$$

Thus, we may conclude that the reciprocal of the equivalent resistance of a group of resistances joined in parallel is equal to the sum of the reciprocals of the individual resistances.

[CBSE Marking Scheme, 2013]

U **Q. 13. Explain the following :**

(i) The elements of electric heating devices such as bread-toasters and electric iron are made of an alloy rather than of a pure metal.

(ii) Series arrangement is not used for domestic circuits.

(iii) Copper and aluminium wires are usually employed for electricity transmission.

[Board Term I, Set-(36), 2012]

Ans. (i) Resistivity of an alloy is generally higher and it does not oxidize easily. **1**

(ii) In series arrangement, same current will flow through all the appliances which is not required and the equivalent resistance becomes higher, hence the current drawn becomes less. **1**

(iii) They are extremely good conductors having a low value of resistivity. **1**

[CBSE Marking Scheme, 2012]

U **Q. 14. Can you run electric geysor with power rating 2 kW; 220 V on a 5 A line ? Give reason to justify your answer.**

[Board Term-I, Set-2ZGOVVV, 2015]

Ans. $I = \frac{P}{V} = \frac{2000}{220} = 9.09\ A$

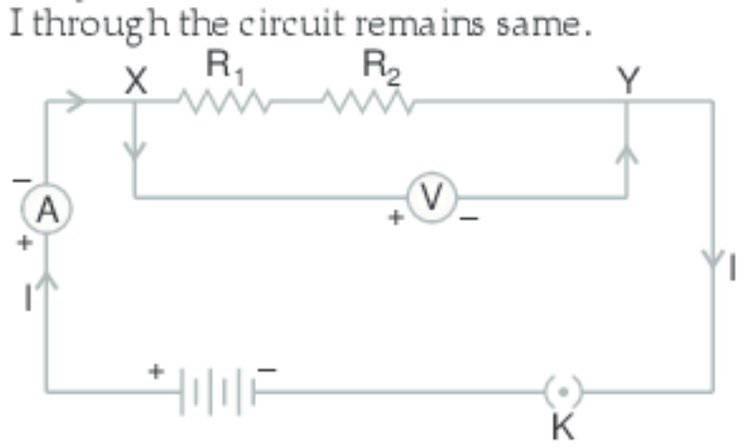
No, we cannot run.

Current needed is more than 5 A

U **Q. 15. Derive an expression for the combination of two resistances connected in series.**

[Board Term I, Set-WDCXXOV, 2016]

Ans. Two resistors of resistance R_1 and R_2 are connected in series. Let I be the current flowing through the circuit. The current through each resistor is also I. The two resistors joined in series is replaced by an equivalent single resistor of resistance R such that the potential difference V across it, and the current I through the circuit remains same. **1**



1

(Resistors in series)

As, $V = IR,\ V_1 = IR_1, V_2 = IR_2$

$$IR = IR_1 + IR_2$$

$$IR = I(R_1 + R_2) \Rightarrow R - R_1 + R_2. \mathbf{1}$$

A **Q. 16. Three resistors of 10 Ω, 15 Ω and 20 Ω are connected in series in a circuit. If the potential drop across the 15 Ω resistor is 3 V, find the current in the circuit and potential drop across the 10 Ω resistor.**

[Board Term I, Set-WDCXXOV, 2016]

Ans. In series circuit same current flows through all the resistors current through 15 Ω resistor

$$I = \frac{V}{R} = \frac{3V}{15\Omega} = \frac{1}{5}$$

$$= 0.2\ A$$

∴ Current in the circuit = 0.2 A

∴ Potential drop across 10 Ω resistor is

$$I = \frac{V}{R}$$

$$V = IR$$

$$= 0.2\ A \times 10\Omega$$

$$= 2V \qquad 1½ + 1½$$

[CBSE Marking Scheme, 2016]

A **Q. 17. A circuit has a line of 5 A. How many lamps of rating 40W, 200V can simultaneously run on this line safely ?**

[Board Term I, Set-L7ZSVLH, 2016]

Ans. Given, $V = 200\ V, P = 40\ W, I = 5A, n = ?$

$$nP = VI$$

$$n = \frac{VI}{P} = \frac{200 \times 5}{40}$$

$$= \frac{100}{4} = 25$$

25 Lamps. **[CBSE Marking Scheme, 2016] 3**

A **Q. 18. Calculate the resistance of a 1 Km long copper wire of area of cross section 2×10^{-2} cm^2. The resistivity of copper is 1.623×10^{-8} ohm-meter.**

[Board Term I, Set-OQKPLGV, 2016]

Ans. $R = \rho\frac{l}{A}$

$= \frac{1.623\times10^{-8}\times1000}{2\times10^{-2}\times10^{-4}\ m^2}$

$= 0.81 \times 10\Omega = 8.1\Omega$ 3

[CBSE Marking Scheme, 2016]

U **Q. 19. Two devices of rating 44W; 200V and 11W; 220V are connected in series. The combination is connected across a 440V mains. The fuse of which of the two devices is likely to burn when switch is on ? Justify your answer.**

[Board Term I, Set-28, 2012]

Ans. The fuse of device of rating 11W; 220V will burn.

$R = \frac{V^2}{W}$, ∴ Resistance of 11W device will be four times than that of the device of 44W.

∴ Voltage across 11W = 352V

∴ Voltage across 44W = 88V

352V across the device of 11W; 220V rating is sufficient to burn the fuse of the device. 3

U **Q. 20. Semi-conductors are certain type of metals which allow only partial current to pass through them in one direction only. In a solar cell, the pieces (wafers) of semi-conductor materials containing impurities are so arranged that potential difference develops between two regions of the semi-conductors when light falls on it. A lead storage battery is connected in the circuit which gets charged and can be used as and when desired.**

(i) How does conductivity of semi-conductors increases ?

(ii) Name any four materials which act as a semi-conductor.

Ans. (i) Conductivity of semi-conductors increases when light falls on them and certain impurities are added to them. 1

(ii) Materials like Silicon, Selenium, Cadmium sulphide and Copper sulphide acts as semi-conductors. 2

A **Q. 21. A bulb is rated at 200V – 40W. What is its resistance ? 5 such bulbs are lighted for 5 hours. Calculate the electrical energy consumed ? Find the cost if the rate is 5.10 per KWh.**

[Board Term I, Set-1ZHNPNO, 2016]

Ans. $V = 200\ V, P = 40W$

$P = VI$

$I = \frac{P}{V} = \frac{40}{200} = \frac{1}{5}\ A$

$R = \frac{V}{I} = \frac{200}{\frac{1}{5}}$

$= 200 \times 5 = 1000\Omega$

Total Power $= 40\ W \times 5 = 200w$

Time $= 5$ hrs

Electrical energy $= 200\ W \times 5$ hrs.

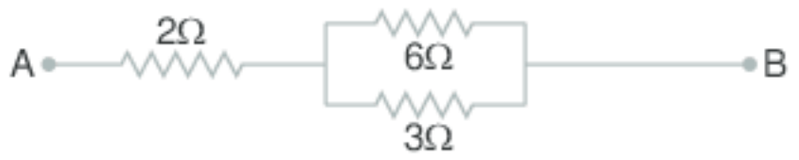
$= 1000$ Wh

$= 1$ KWh.

Cost of 1 Kwh $= 5.10$ Rs. 3

[CBSE Marking Scheme, 2016]

A **Q. 22**



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

[Board Term I, Set-IN14KGB, 2014]

Ans. Resistance $R_1 = 2\ \Omega$, $R_2 = 6\ \Omega$, and $R_3 = 3\ \Omega$,

$= R_2$ and R_3 are in parallel combination

$\frac{1}{R_4} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{6} + \frac{1}{3}$

$= \frac{1+2}{6} = \frac{3}{6} = \frac{1}{2}\Omega$

$R_4 = 2\ \Omega.$

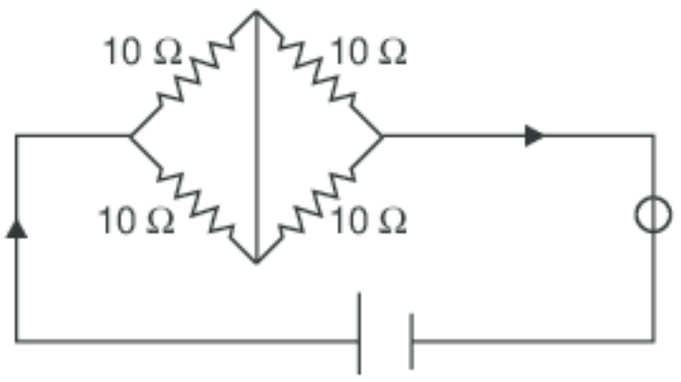
Resistance R_1 and R_4 are in series combination

$R_{eq} = R_1 + R_4$

$= 2 + 2 = 4\ \Omega$ 3

[CBSE Marking Scheme, 2014]

A **Q. 23. Find the current drawn from the battery by the network of four resistors shown in the figure.**



[Board Term I, Set-WH1SGOB, 2014]

Ans. Two combinations of two parallel resistors of 10Ω each connected in series.

$\frac{1}{R_5} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{10} + \frac{1}{10} = \frac{1+1}{10} = \frac{2}{10}$

$\frac{2}{10} = \frac{1}{5}$

$R_5 = 5\Omega$

$\frac{1}{R_6} = \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{10} + \frac{1}{10} = \frac{1+1}{10} = \frac{2}{10}$

$R_6 = 5\Omega$

$Req = R_5 + R_6 = 5\Omega + 5\Omega = 10\Omega$

Potential $V = 3V$

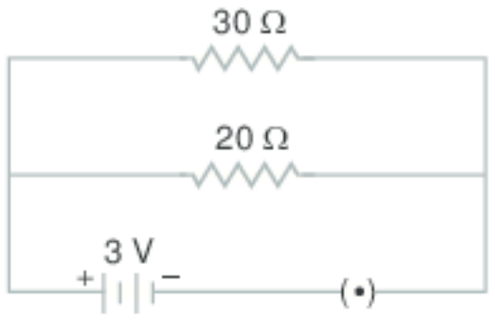
$I = \frac{V}{R} = \frac{3}{10} = 0.3$ Amp.

1 + 1 + 1

[CBSE Marking Scheme, 2014]

A **Q. 24. Study the following electric circuit and calculate the energy drawn from the battery in 10 s.**

[DDE-2015]



Ans. From ohm's law, V = IR

$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}=\frac{1}{30}+\frac{1}{20}=\frac{20+30}{600}\Rightarrow\frac{50}{600}=\frac{1}{12}\Omega$$

$\therefore$ $R = 12\Omega$

As $V = IR \Rightarrow 3 = I \times 12$

$$I = \frac{3}{12}=\frac{1}{4}\text{ A}$$

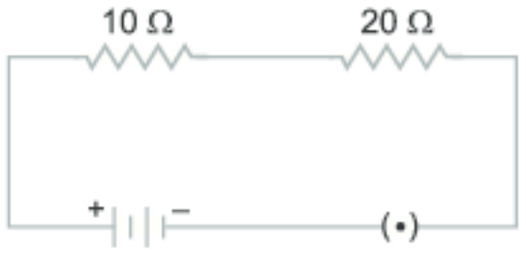
Electrical energy $W = VIt$

$$= 3 \times \frac{1}{4} \times 10$$

$$= \frac{30}{4}=\frac{15}{2} = 7.5\text{ J.}$$ 3

A **Q. 25. Study the following electric circuit (i) the current flowing in the circuit and (ii) the potential difference across 10Ω resistor**

[DDE-2015]



Ans. $R = R_1 + R_2 = 10 + 20 = 30\ \Omega$

$V = 3\text{ V}$

(i) From ohm's law $V = IR$ 1

$$3 = I \times 30 \Rightarrow I = \frac{3}{30}=\frac{1}{10}\text{ Ampere or 0.1 A}$$ 1

(ii) Potential difference across 10Ω resistor

$V = IR$

$$= \frac{1\times10}{10} = 1\text{ volt.}$$ 1

A **Q. 26. Calculate the amount of heat generated while transferring 90000 coulombs of charge between the two terminals of a battery of 40V in one hour. Also determine the power expended in the process.**

[DDE-2015]

Ans. $Q = 90000,\ t = 1h = 3600\text{s},\ V = 40\text{V}$

$$I = \frac{Q}{t}=\frac{90,000}{3,600} = 25\text{A}$$

$$R = \frac{V}{I}=\frac{40}{25} = 1.6\Omega$$

$H = I^2Rt = 25 \times 25 \times 1.6 \times 3600$

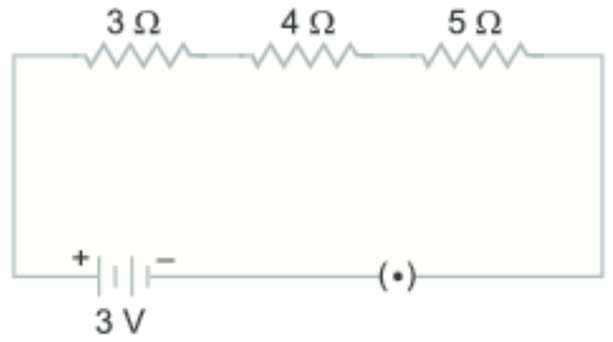
$= 36 \times 10^5\text{ J or 3600 kJ}$

$P = I^2R = 25 \times 25 \times 1.6$

$= 1000\text{ W} = 1\text{ KW.}$ 3

A **Q. 27. Study the following electric circuit and calculate the potential difference across 5 Ω resistor 3.**

[Board Term-I, Set-2ZGOVV, 2015]



Ans. $V = IR$

$R = 3 + 4 + 5 = 12\ \Omega$

$3 = I \times 12$

$$I = \frac{3}{12}=\frac{1}{4}\text{ Ampere}$$

Potential difference across 5 Ω resistor.

$\mathbf{V} = IR$

$$\mathbf{V} = \frac{1}{4}\times5$$

$$= \frac{5}{4}\text{ V or 1.25 V}$$ 1½+1½

A **Q. 28. An electric heater is used on 220 V supply and takes a current of 5A. What is its power ? Calculate the per hour cost of using the heater if 1 unit costs Rs 6.0.**

Ans. Power = VI

$= 220 \times 5 = 1100\text{ Watt}$

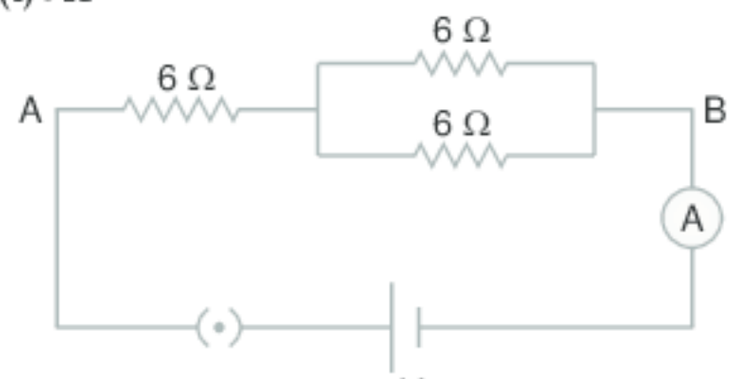
$= 1.1\text{ kW}$

Cost per hour $= 1.1 \times 6$

₹ = 6.6 1½+1½

A **Q. 29. Show how would you connect three resistors each of resistance 6Ω, so that the combination has a resistance of (i) 9Ω and (ii) 4Ω.[NCT-2014]**

Ans. (i) 9Ω



V

$$\frac{1}{R_4}=\frac{1}{R_1}+\frac{1}{R_2}=\frac{1}{6}+\frac{1}{6}=\frac{2}{6}$$

$R_4 = 3\Omega$

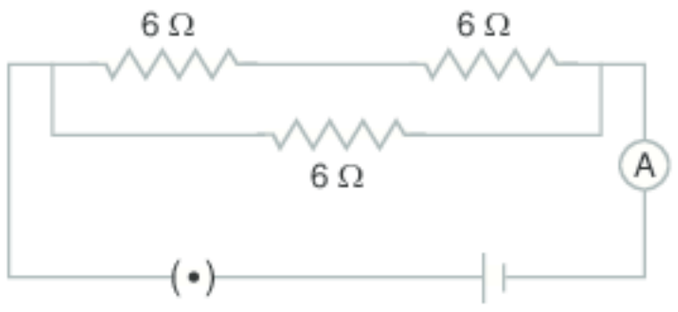
$R_5 = R_3 + R_4$

$= 6 + 3$

$= 9\Omega$

In this circuit, equivalent resistance will be 9Ω.

(ii) 4Ω

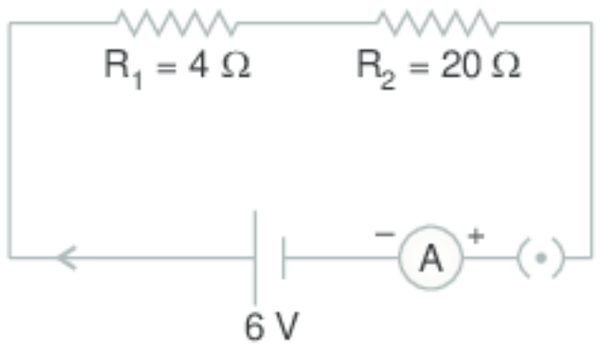


$$R_4 = R_1 + R_2$$
$$= 6\,\Omega + 6\,\Omega = 12\,\Omega$$
$$\frac{1}{R_5} = \frac{1}{R_3} + \frac{1}{R_4}$$
$$= \frac{1}{6} + \frac{1}{12} = \frac{2+1}{12} = \frac{3}{12}$$
$$R_5 = \frac{12}{3} = 4\Omega.$$

In this circuit, equivalent resistance will be 4Ω

1½ + 1½

A **Q. 30.**



In the given circuit, calculate :

(i) the total resistance of the circuit

(ii) the current through the circuit, and

(ii) the potential difference across R_1 and R_2

[DDE – 2014]

Ans. Given, The resistance of conductor $R_1 = 4\Omega$

The resistance of conductor $R_2 = 20\Omega$

(i) The total resistance of the circuit

$R = R_1 + R_2$ (series combination)

$R = 4 + 20 = 24\Omega$

Now by ohm's Law,

(ii) The current through the circuit,

$$V = IR, \quad I = \frac{V}{R} = \frac{6}{24} = \frac{1}{4} = 0.25\,\text{Amp.}$$

(iii) The potential difference across the two terminals of the battery = 6V.

$V_1 = I \times R_1$

$= 0.25 \times 4 = 1V$ (Potential difference across the conductor R_1)

$V_2 = I \times R_2$

$= 0.25 \times 20 = 5V$ (Potential difference across the conductor R_2) 1 + 1 + 1

A **Q. 31. A hot plate connected to a 220 V line has two resistance coils A and B, each of 22 Ω resistance. Calculate the amount of electric current flowing when these coil are :**

(i) used individually.

(ii) connected in series.

(iii) connected in parallel. **[NCERT]**

[Board Term I, Set-3R6WRQL, 2013]

Ans. (i) $I = \frac{V}{R} = \frac{220}{22} = 10$ Ampere. 1

(ii) $R = R_1 + R_2 = 22 + 22 = 44\Omega$

$I = \frac{220}{44} = 5$ Ampere. 1

(iii) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{22} + \frac{1}{22} = \frac{2}{22}$

$\therefore \quad R = \frac{22}{2} = 11\,\Omega$

$I = \frac{220}{11} = 20$ Ampere. 1

[CBSE Marking Scheme, 2013]

A **Q. 32. A torch bulb is rated 5 V and 500 mA. Calculate its (i) power, (ii) resistance, (iii) energy consumed when it is lighted for 4 hours.**

[Board Term I, Set-WJ7QPA9, 2013]

Ans. (i) $P = VI = 5 \times 0{\cdot}5 = 2{\cdot}5$ Watt 1

(ii) $R = \frac{V}{I} = \frac{5}{0.5} = 10\Omega$ 1

(iii) $W = P \times t = 2{\cdot}5 \times 4 \times 3600$

$= 36000 = 3{\cdot}6 \times 10^4 J$ 1

[CBSE Marking Scheme, 2013]

A **Q. 33. Amongst iron, silver, nichrome, tungsten, copper, which metal / alloy should be used to make the**

(i) Heating element of electric geysers

(ii) Filament of incandescent bulbs.

An electric iron has rating of 750W, 220V. Calculate :

(i) Current required and

(ii) Its resistance when it is in use.

[Board Term I, Set-42, 2012]

Ans. (i) Heating element – Nichrome ½

(ii) Filament of bulb – Tungsten ½

$P = 750$ W $\quad V = 220$ V

(i) $P = VI \quad \therefore I = \frac{P}{V} = \frac{750}{220} = 3.4$ A 1

(ii) $R = V/I = \frac{220\,V}{3.4\,A} = 64.5\,\Omega$ 1

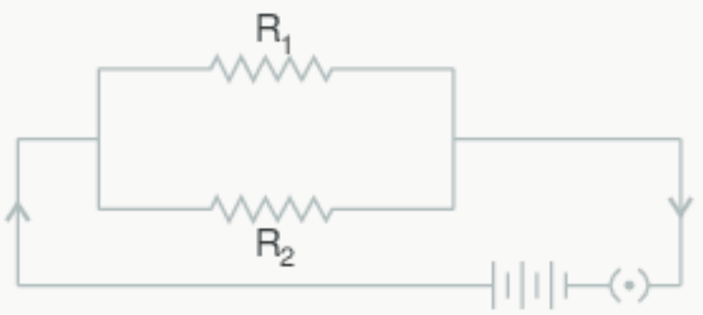
[CBSE Marking Scheme, 2012]

A **Q. 34. (i) Draw a diagram to show how two resistors R_1 and R_2 are connected in parallel.**

(ii) In a circuit if two resistors of 4 Ω and 8 Ω are connected in parallel, find out the ratio of current passing through the two resistors.

[Board Term I, Set-40, 2012]

Ans. (i)



1

(ii) $R_1 = 4\,\Omega$

$R_2 = 8\,\Omega$

Potential difference = V

$$I_1 = \frac{V_1}{R_1} = \frac{V}{4\,\Omega}$$

$$I_2 = \frac{V}{R_2} = \frac{V}{8\,\Omega} \qquad ½$$

$$\frac{I_1}{I_2} = \frac{V/4\,\Omega}{V/8\,\Omega} \qquad ½$$

$$\Rightarrow \quad \frac{I_1}{I_2} = \frac{8}{4}$$

$$\Rightarrow \quad \frac{I_1}{I_2} = \frac{2}{1}$$

$$\therefore \quad I_1 : I_2 = 2 : 1 \qquad 1$$

[CBSE Marking Scheme, 2012]

A Q. 35. A lamp rated 60W and an electric iron rated 800W are used for 6 hours everyday. Calculate the total energy consumed in 30 days.

[Board Term I, Set-40, 2012]

Ans. $P_1 = 60$ W $\quad P_2 = 800$ W

$E_1 = 60 \times 6$ $\quad E_2 = 800 \times 6$

$= 360$ watt-hr. $\quad = 4800$ watt-hr.

Total energy consumed $E = E_1 + E_2$

$= 360 + 4800$

$= 5160$ watt-hour

Energy consumed in 30 days $= 5160 \times 30$

$= 154800$ watt-hour

$= 154.8$ kWh. 3

[CBSE Marking Scheme, 2012]

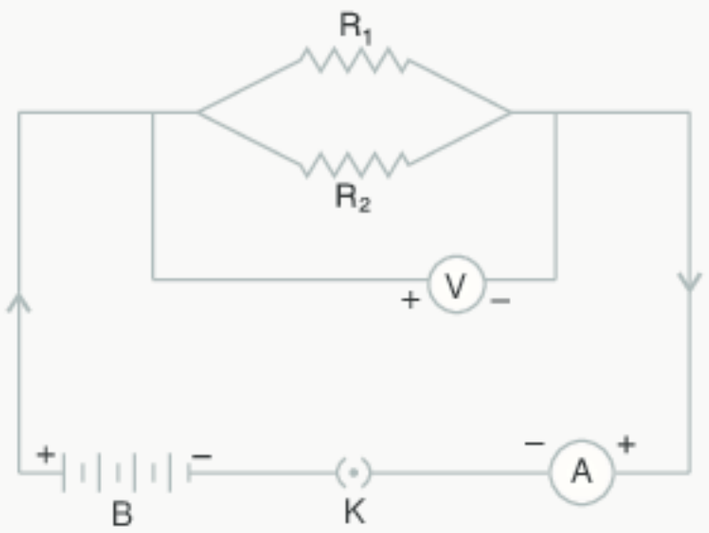
A Q. 36. A wire of resistance R is cut into five equal parts. These parts are then connected in parallel. If the equivalent resistance of this combination is R′. Calculate the ratio R/R′. Draw a circuit diagram to show two resistors R_1 and R_2 connected in parallel along with a battery, key, ammeter and voltmeter. [Board Term I, Set-43, 2012]

Ans. Resistance of each part = R/5 ½

When connected in parallel :

$$\frac{1}{R'} = \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R} = \frac{25}{R} \qquad ½$$

$$\therefore \quad \frac{R}{R'} = 25 \qquad 1$$

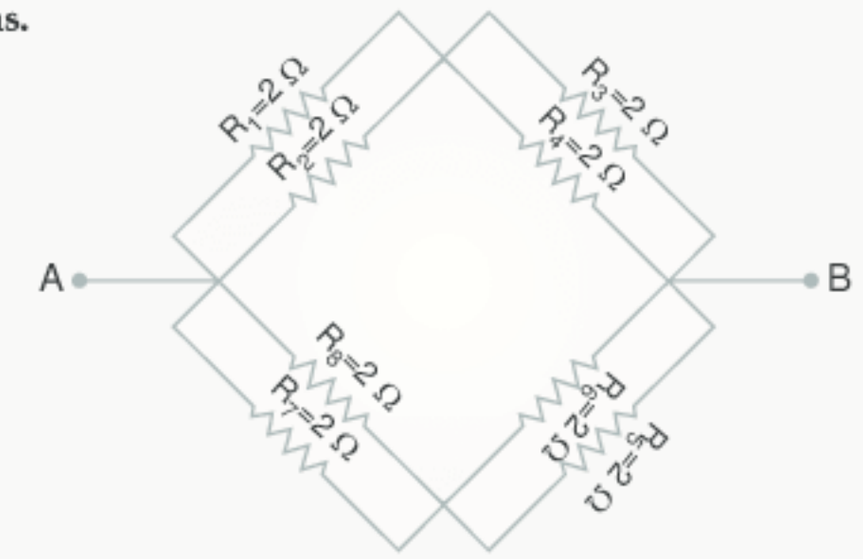


[CBSE Marking Scheme, 2012] 1

A Q. 37. Find the equivalent resistance across the two ends A and B of this circuit.

[Board Term I, Set-46, 2012]

Ans.



$$\frac{1}{R_{1,2}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2} = 1\Omega \qquad ½$$

Similarly $R_{3,4} = 1\Omega$

$R_{5,6} = 1\Omega$

$R_{7,8} = 1\Omega$ ½

Now $R_{1,2}$ and $R_{3,4}$ are connected in series ½

$R_{1,2,3,4} = R_{1,2} + R_{3,4} = 1 + 1 = 2\Omega$

Also, $R_{5,6}$ and $R_{7,8}$ are connected in series

$R_{5,6,7,8} = R_{5,6} + R_{7,8} = 1 + 1 = 2\Omega$ ½

Now, equivalent resistance

$$\frac{1}{R} = \frac{1}{R_{1,2,3,4}} + \frac{1}{R_{5,6,7,8}} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2} = 1\Omega \qquad ½$$

$R = 1\Omega$ ½

[CBSE Marking Scheme, 2012]

A Q. 38. Calculate the amount of heat generated when 7200 coulombs of charge is transferred in one hour through a potential difference of 50 V.

[Board Term I, Set-54, 2012]

Ans. $Q = 7200$C, $t = 1$h $= 60 \times 60 = 3600$s, $V = 50$V

$$I = \frac{Q}{t} = \frac{7200}{3600} = 2\text{A}. \qquad 1$$

$$R = \frac{V}{I} = \frac{50\text{V}}{2\text{A}} = 25\Omega \qquad 1$$

$H = I^2Rt$

$= 2 \times 2 \times 25 \times 60 \times 60$

$= 36 \times 10^4$ J or 360 kJ. 1

[CBSE Marking Scheme, 2012]

A Q. 39. An electric iron consumes energy at a rate of 840W when heating is at the maximum and 360W, when the heating is at the minimum. The voltage at which it is running is 220V. What are the current and resistance values in each case ?

[Board Term I, Set-38, 2012]

Ans. $P_1 = 840$ W, $V = 220$ V,

$$\text{Current drawn } I_1 = \frac{P_1}{V}$$

$$= \frac{840}{220} = \frac{42}{11} = 3.8 \text{ A} \qquad 1$$

$$P_2 = 360\ W,\quad V = 220\ V,$$

$$\text{Current drawn } I_2 = \frac{P_2}{V} = \frac{360}{220} = 1.6\ A$$

By Ohms law,

$$V = I_1 R_1$$

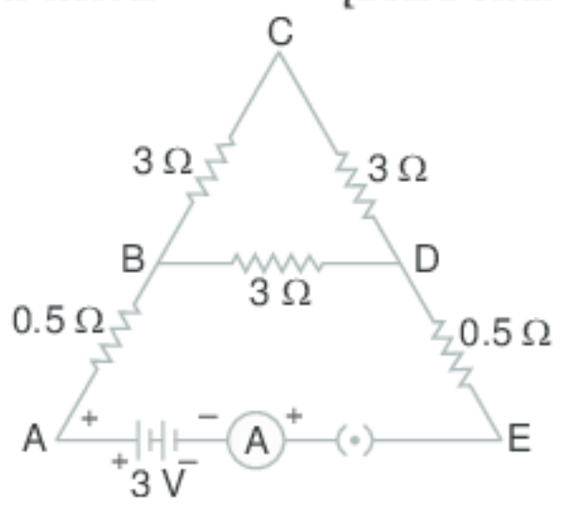
$$R_1 = \frac{V}{I_1} = \frac{220}{\frac{42}{11}} = \frac{220 \times 11}{42} = \frac{1210}{21}\Omega = 57.5\ \Omega \quad \mathbf{1}$$

$$V = I_2 R_2$$

$$R_2 = \frac{V}{I_2} = \frac{220}{\frac{18}{11}} = 220 \times \frac{11}{18} = 134.4\ \Omega \quad \mathbf{1}$$

[CBSE Marking Scheme, 2012]

A **Q. 40. Five resistors are connected in a circuit as shown. Find the ammeter reading when circuit is closed.** **[Board Term I, Set-29, 2011]**



Ans. The resistance between the points B and D is x

$$x = \frac{3\Omega \times 6\Omega}{3\Omega + 6\Omega} = 2\Omega$$

Now the resistance of the whole combination is

$$R = 0.5\ \Omega + x + 0.5\ \Omega$$
$$= 0.5\ \Omega + 2.0\ \Omega + 0.5\ \Omega$$
$$= 3.0\ \Omega$$

$$\therefore \text{ Ammeter reading} = \frac{3\ V}{3\Omega} = 1.0 \text{ ampere.} \quad \mathbf{3}$$

A **Q. 41. Study the circuit shown in which three identical bulbs B_1, B_2 and B_3 are connected in parallel with a battery of 4.5V.**

(i) What will happen to the glow of other two bulbs if the bulb B_3 gets fused ?

(ii) If the wattage of each bulb is 1.5 W, how much reading will the ammeter A show when all the three bulbs glow simultaneously.

(iii) Find the total resistance of the circuit.

[Board Term I, Set-29, 2011]

Ans. (i) Other bulbs will glow with same brightness. **1**

(ii) When the bulbs are in parallel, wattage will be added (4.5 W) and the ammeter reading would be

$$\because\ I = \frac{P}{V} = \frac{4.5\ W}{4.5\ V} = 1.0 \text{ Ampere} \quad \mathbf{1}$$

(iii) Since ammeter reading is 1.0 ampere, resistance of the combination is $\frac{4.5\ V}{1.0\ A} = 4.5\ \Omega$. **1**

A **Q. 42. How many resistors of 88 Ω are connected in parallel to carry 10 A current on a 220 V line ?** **[Board Term I, Set-36, 2011]**

Ans. Let n number of resistance are connected in parallel.

$$\text{Equivalent resistance, } \frac{1}{R_P} = \frac{n}{88}$$

$$R_P = \frac{88}{n}$$

$$V = IR \text{ or } R = \frac{88}{n} = \frac{220}{10}$$

$$n = \frac{88}{22} = 4 \text{ resistors.} \quad \mathbf{3}$$

A **Q. 43. (i) What is the total resistance of n resistors each of resistance 'R' connected in :**

(a) Series, **(b)** Parallel.

(ii) Calculate the resultant resistance of 3 resistors 3 Ω, 4 Ω and 12 Ω connected in parallel. **[Board Term I, Set-37, 2011]**

Ans. (i)

$$R_S = (R + R + \ldots\ldots R) = nR$$

$$\frac{1}{R_P} = n\left(\frac{1}{R} + \frac{1}{R} + \ldots\ldots + \frac{1}{R}\right)$$

$$\therefore \quad R_P = \frac{R}{n} \quad \mathbf{1}$$

(ii)

$$\frac{1}{R} = \frac{1}{3} + \frac{1}{4} + \frac{1}{12} = \frac{8}{12}$$

$$R = \frac{12}{8} = 1.5\ \Omega \quad \mathbf{2}$$

A **Q. 44. A 400 W refrigerator operates for 16 h per day. Calculate the cost to operate if for 30 days at ₹ 3.40 kWh.** **[Board Term I, Set-25, 2011]**

Ans. $$\text{Energy consumed} = \frac{\text{Watt} \times \text{hours} \times \text{No. of days}}{1000}$$

$$= \frac{400 \times 16 \times 30}{1000} = 192 \text{ kWh (unit)}$$

$$\text{Cost of energy consumed} = \text{Rate} \times \text{kWh}$$
$$= 3.40 \times 192$$
$$= ₹\ 652.80. \quad \mathbf{3}$$

A **Q. 45. The resistance offered by a wire of unit length and unit cross-sectional area is called resistivity. For a material irrespective of length and area, the resistivity is a constant. It is also called specific resistance of the material. Metals and alloys have low resistivity while**

insulators have high resistivity. Resistivity of two elements A and B are 1.62×10^{-8} Ωm and 520×10^{-8} Ωm respectively. Out of these two, name the element that can be used to make :

(i) filament of electric bulb.

(ii) wires for electrical transmission lines.

Ans. (i) Element B ½

∴ It has more resistivity (520×10^{-8} Ωm) ½

(ii) Element A ½

∴ It has less resistivity and hence less heating effect. ½

Dissipation of energy during transmission of power. **1**

Long Answer Type Questions

(5 marks each)

R **Q. 1. What is meant by electric current ? Name and define S.I. unit. In a conductor electrons are flowing from B to A. What is the direction of conventional current ? Give justification for your answer.**

A steady current of 1 Ampere flows through a conductor. Calculate the number of electrons that flow through any 5 section of conductor in 1 second. (Charge on electron = 1.6×10^{-19} C)

[DDE-2014] [Board Term-I, Set-A85V2IL, 2015]

Ans. Definition of Electric current : Refer quick Review

S.I. Unit of Current-ampere

Definition of 1 Ampere : Refer Quick Review

Direction of Current from A to B - Justification

Justification : Refer to Quick Review

$$I = \frac{ne}{t} \qquad \Rightarrow n = \frac{I \times t}{e}$$

$$= \frac{1A \times 1s}{1.6 \times 10^{-19} C} = 6.25 \times 10^{18}$$

[CBSE Marking Scheme, 2015] 5

R **Q. 2. (i) What is meant by potential difference ? State its SI unit.**

(ii) Name a device that helps to maintain a potential difference across a conductor.

(iii) Calculate : (a) the highest, (b) the lowest resistance that can be obtained by the combination of four coils of resistances 4Ω, 8Ω, 12Ω and 24Ω ?

[Board Term I, Set-41, 2012]

Ans. (i) Potential difference : Potential difference between two points in an electric circuit carrying same current is the work done to move a unit charge from one point to another. Volt. **1½**

(ii) A battery.

(iii) (a) Highest resistance $R_S = R_1 + R_2 + R_3 + R_4$ **1**

$= (4 + 8 + 12 + 24)\Omega$

$= 48\ \Omega$ **1**

(b) Lowest resistance R parallel

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} \quad ½$$

$$\frac{1}{R_P} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24}$$

$$= \frac{6+3+2+1}{24} = \frac{12}{24}$$

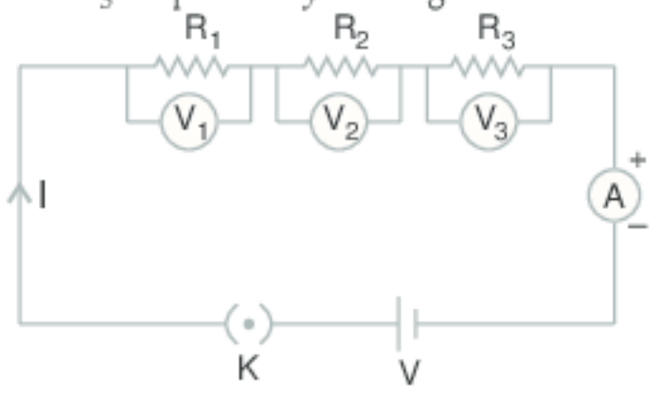
$$R_P = \frac{24}{12} = 2\Omega. \quad 1$$

[CBSE Marking Scheme, 2012]

U **Q. 3. Establish a relationship to determine the equivalent resistance R of a combination of three resistors having resistances R_1, R_2 and R_3 connected in series. Calculate the equivalent resistance of the combination of three resistors of 2Ω, 3Ω and 6Ω joined in parallel.**

[Board Term I, Set-L7ZSVLH, 2016, WH1SGOB, 2015]

Ans. An applied potential V produces current I in the resistors R_1, R_2 and R_3, causing a potential drop V_1, V_2 and V_3 respectively through each resistor.



Total Potential, $V = V_1 + V_2 + V_3$

By Ohm's Law, $V_1 = IR_1$

$V_2 = IR_2$

$V_3 = IR_3$

Thus, $V = IR_1 + IR_2 + IR_3$

$= I(R_1 + R_2 + R_3)$

If R is the equivalent resistance, $V = IR$

Hence, $IR = I(R_1 + R_2 + R_3)$

$R = R_1 + R_2 + R_3$

This proves that overall resistance increases when resistors are connected in series.

Three resistors 2Ω, 3Ω and 6Ω, are joined in parallel combination.

Equivalent resistance,

$$\frac{1}{R_P} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$$

$$= \frac{3+2+1}{6} = \frac{6}{6}$$

$R_P = 1\ \Omega$ **4 + 1**

U **Q. 4. (i) Derive an expression for Joule's law of heating.**

(ii) Give two examples for applications of heating effect of electric current.

(iii) 100 J of heat is produced each second in a 4Ω resistor. Find the potential difference across the resistor.

[DDE-2014] [Board Term I, Set-WJ7QPA9, 2013]

Ans. (i) $P = VI$

$H = P \times t = VIt$

But $V = IR$ (Ohm's law)

$\therefore H = I^2Rt$ 2

(ii) (a) Electric fuse

(b) Electric water heater ½ + ½

(iii) $H = 100\ J,\ R = 4\ \Omega,\ t = 1\ sec.$

$H = I^2Rt$

$I^2 = \frac{H}{Rt}$

$I = \sqrt{\frac{H}{Rt}} = \sqrt{\frac{100}{4 \times 1}} = \sqrt{\frac{100}{4}} = \sqrt{25} = 5$ Ampere.

Now, $V = IR$

$V = 5 \times 4$

$V = 20\ V.$ 2

[CBSE Marking Scheme, 2014]

U **Q. 5. (i) A wire of resistivity ρ is stretched to double it's length which is it's new resistivity. Give reason for your answer.**

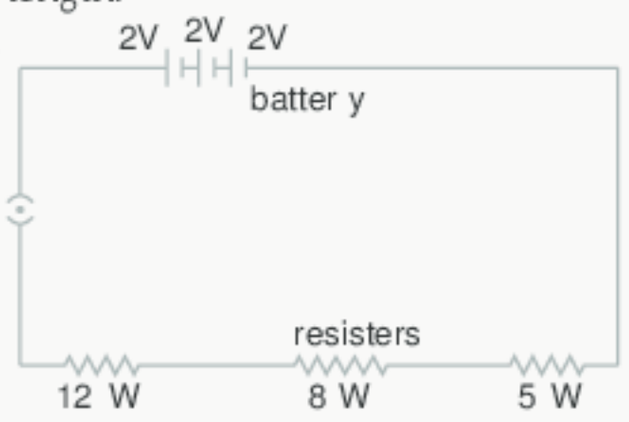
(ii) Draw a schematic diagram of a circuit consisting of a battery of three cells of 2V each, a 5Ω resistor, 8Ω resistor and 12Ω resistor and a plug key all connected in series.

(iii) Two wires, one of copper and other of manganese have equal lengths and equal resistances : Which is thicker. (Given that resistivity of manganese is lower than that of copper.) [DDE 2014]

[Board Term I, Set-WJ7QPA9, 2013]

Ans. (i) Resistivity remains unchanged because resistivity depends on nature of material not on length. 1

(ii)



2

(iii) $R_{copper} = \rho_c \frac{l_c}{A_c}$

$R_m = \rho_m \frac{l_m}{A_m}$

Now, $R_c = R_m$ (given)

$l_c = l_m$ (given)

$\therefore \frac{\rho_m}{A_c} = \frac{\rho_m}{A_m}$

or $\frac{\rho_c}{\rho_m} = \frac{A_c}{A_m}$

Since, $\rho_m < \rho_c$

$\therefore A_m < A_c$

Copper wire will be thicker. 2

[CBSE Marking Scheme, 2014]

U **Q. 6. (i) Derive an expression for the equivalent resistance of three resistors R_1, R_2 and R_3 connected in series.**

(ii) Fuse of 3A, 5A and 10A are available. Calculate and select the fuse for operating electric iron of 1 kW power at 220 V line. [Board Term I, Set-36, 2012]

Ans. (i) Total potential difference across a combination of resistors in series is equal to the sum of potential difference across the individual resistors. 1

$V = V_1 + V_2 + V_3$

Let I be the current in the circuit. The current through each resistor is also I.

It is possible to replace the three resistors joined in series by an equivalent resistor of resistance R.

Applying Ohm's law,

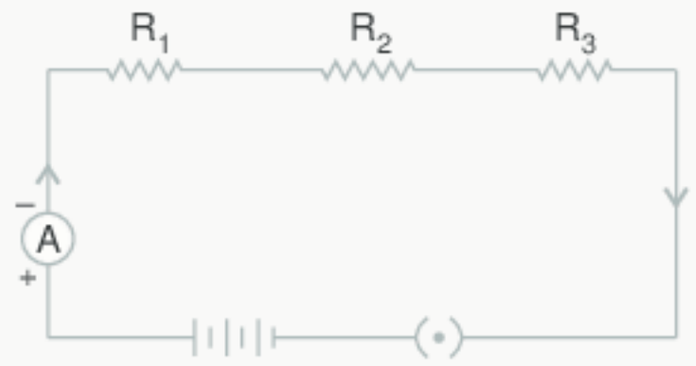
$V = IR$

On applying Ohm's law to the three resistors respectively we further have

$V_1 = IR_1$

$V_2 = IR_2$

$V_3 = IR_3$



But $V = V_1 + V_2 + V_3$ 2

$IR = IR_1 + IR_2 + IR_3$

$R = R_1 + R_2 + R_3$

(ii) Power rating of electric iron = 1 kW = 1000 W

$V = 220\ V$

$P = VI$

$I = \frac{P}{V} = \frac{1000}{220}$ 2

$= 4.55\ A$

Hence, a fuse of rating 5A can be used because it can bear the current.

[CBSE Marking Scheme, 2012]

U **Q. 7. (i) What is meant by the statement that the resistance of a wire is 1 Ω?**

(ii) Two identical resistors each of resistance 12 Ω are connected (i) in series (ii) in parallel, in turn to a battery of 6 V.

Calculate the ratio of power consumed in the combination of resistors in the two cases.

(iii) What combination is used for connecting the circuit to measure the potential difference across two points ? [Board Term I, Set-36, 2012]

Ans. (i) When 1 ampere current flows through a conductor whose potential difference is 1 volt, then resistance is 1 ohm. **1**

(ii) $R_1 = R_2 = 12\Omega$

$V = 6V$

$R_S = R_1 + R_2$

$= (12 + 12)\Omega = 24\ \Omega$ ½

$$\frac{1}{R_P} = \frac{1}{12} + \frac{1}{12}$$

$$\Rightarrow \quad \frac{1}{R_P} = \frac{2}{12}$$

$\therefore \quad R_P = 6\ \Omega$ ½

Power consumed by series combination

$= P_s$

$$= \frac{V^2}{R_s} = \frac{6 \times 6}{24}$$

$= 1.5$ W **1**

Power consumed by parallel combination

$$= P_P = \frac{V^2}{R_p} = \frac{6 \times 6}{6}$$

$= 6$ W **1**

$$\text{Ratio} = \frac{P_s}{P_p} = \frac{1.5}{6} = \frac{1}{4} = 1:4$$

$\therefore$

(iii) Voltmeter is connected in parallel across the two points in the circuit. **1**

[CBSE Marking Scheme, 2012]

U **Q. 8. (i) Explain the term : Heating effect of electric current.**

(ii) Derive an expression for the heat produced by electric current and state Joule's Law.

(iii) Explain why an inert gas like argon is filled in bulbs. **[Board Term I Set (40) 2012]**

Ans. (i) Heating effect of electric current : When an electric current is passed through a high resistance wire like nichrome, the resistance wire becomes very hot and produces heat. This is called heating effect of electric current. **1**

(ii) $P = V \times \frac{Q}{T}$

$P = VI$

$E = P \times t$

$= VI \times t = VIt$

$E = IRIt$ [$V = IR$; Ohm's law]

$= I^2 Rt$. **2**

Joule's Law : When current of I ampere flows in a wire of resistance R Ω for t seconds, the heat energy dissipated by it is given by $\boxed{H = I^2Rt}$ **1**

(iii) The bulbs are usually filled with chemically inactive nitrogen and argon gas so that filament does not burn out and the life of filament is prolonged. **1**

[CBSE Marking Scheme, 2012]

R **Q. 9. (i) State Ohm's law. Give mathematical relation between potential difference (V), Current (I) and resistance (R) of a conductor. Draw an electric circuit for studying ohm's law.**

(ii) When a 12 V battery is connected across an unknown resistor, 2.5 mA current flows in the circuit. Find the resistance of the resistor.

[Board Term I, Set-2ZGOVVV, 2015]

Ans.

(i) Refer to Topic II SAQ-II-Q.N.5

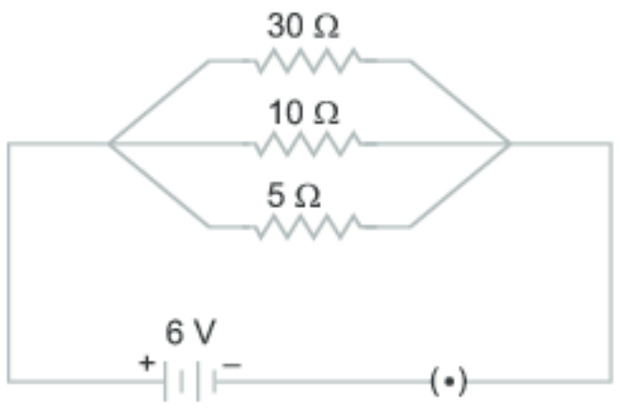
(ii) $V = IR$

$V = 12$ V, $I = 2.5$ mA $\Rightarrow 2.5 \times 10^{-3}$ A

$12 = 2.5 \times 10^{-3} \times R$

$$R = \frac{12}{2.5 \times 10^{-3}} = \frac{12 \times 10^3}{2.5} = 4.8\ \text{k}\Omega$$ **3+2**

Q. 10. Two wires X and Y are of equal length and have equal resistances. If the resistivity of X is more than that of Y, which wire is thicker and why ? For the electric circuit given below calculate : **[DDE-2015]**



(i) Current in each resistor

(ii) Total current drawn from the battery and

(iii) Equivalent resistance of circuit

Ans. $V = IR$. Wire A is thicker

(i) for 30 Ω, $I = \frac{6}{30} = \frac{1}{5} = 0.2$ A

for 10 Ω, $I = \frac{6}{10} = 0.6$ Ampere

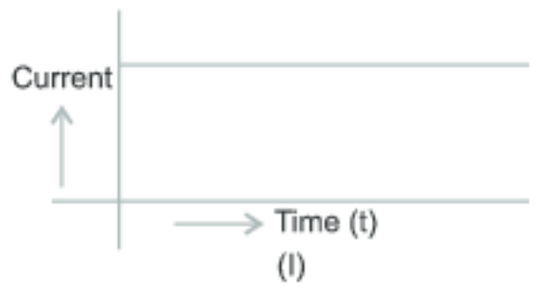
for 5 Ω, $I = \frac{6}{5} = 1.2$ Ampere

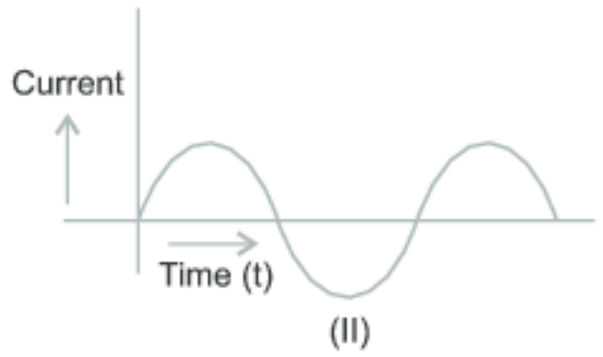
(ii) $\frac{1}{R} = \frac{1}{30} + \frac{1}{10} + \frac{1}{5} = \frac{1}{3} \Rightarrow R = 3\ \Omega$

$V = IR \Rightarrow I = \frac{V}{R} = \frac{6}{3} = 2$ Ampere

(iii) Equivalent Resistance = 3 Ω **2 + 2 + 1**

U **Q. 11. Study the following current time graphs from two different sources.**





(i) Use above graphs to list word differences between the current in the two cases.

(ii) Name the type of current in two cases

(iii) Identify one source each for these currents.

(iv) What is meant by the statement that "the frequency of current in India is 50 Hz ?"

[Board Term-I, Set-JYNE6XG, 2015]

Ans.

(i) (a) In (I) current is constant while in (II) current is variable.

(b) In (I) current is in positive state while in (II) current is in both state.

(ii) I — Direct current

II — Alternating current

(iii) I — From Battery

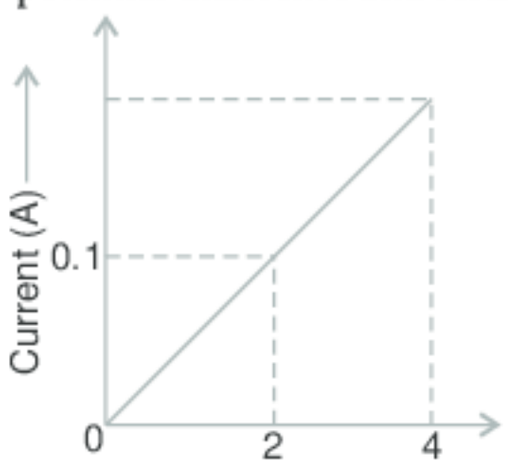
II — From power supply in our houses

(iv) Because current type is alternating current that's why frequency varies form 0 to 50 Hz. **2 + 1 + 1 + 1**

U **Q. 12. (i) Calculate the resistance of the wire using the graph.**

(ii) How many 176Ω resistors in parallel are required to carry 5A on a 220 V line ?

(iii) Define electric power. Derive relation between power, potential difference and resistance.



[DDE-2014] [Board Term I, Set-15, 2012]

Ans. (i) $R = \frac{V}{I}, R = \frac{2}{0.1} = 20\Omega$ ½+½

(ii) $R = \frac{V}{I} = \frac{220}{5} = 44\Omega$ **1**

Number of resistors is $= \frac{176}{44} = 4$ **1**

(iii) The rate at which electric energy is dissipated or consumed in an electric circuit is called electric power $P = \frac{V^2}{R}$. **2**

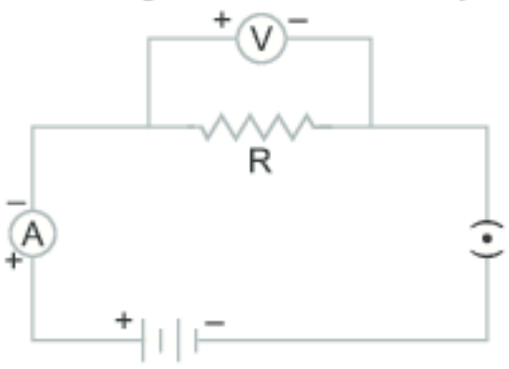
[CBSE Marking Scheme, 2014]

A **Q. 13. Draw a labelled circuit diagram to study the relationship between the current (I) flowing through a conductor and the potential difference (V) applied across its two ends. State the formula co-relating the I in a conductor and the V across it. Also show their relationship by drawing a diagram.**

What would be the resistance of a resistor if the current flowing through it is 0.15 A when the potential difference across it is 1.05 V ?

[Board Term I, Set-JYNE6XG, 2015]

Ans.



The formula states that the current passing through a conductor is directly proportional to the potential difference across its ends, provided the physical conditions like temperature, density, etc. remain unchanged. This is Ohm's law.

$$I \propto V \text{ or } I = \frac{V}{R}$$

$$V = \pm IR.$$

R is called resistance of the conductor.

As $V = 1.05\ V$

$I = 0.15\ A$

$V = IR$

$1.05 = 0.15 \times R$

$R = \frac{1.05}{0.15} = 7\Omega$ **1 + 2 + 2**

A **Q. 14. Find out the following in the electric circuit given in the figure.**

[Board Term I, Set-37, 2012]

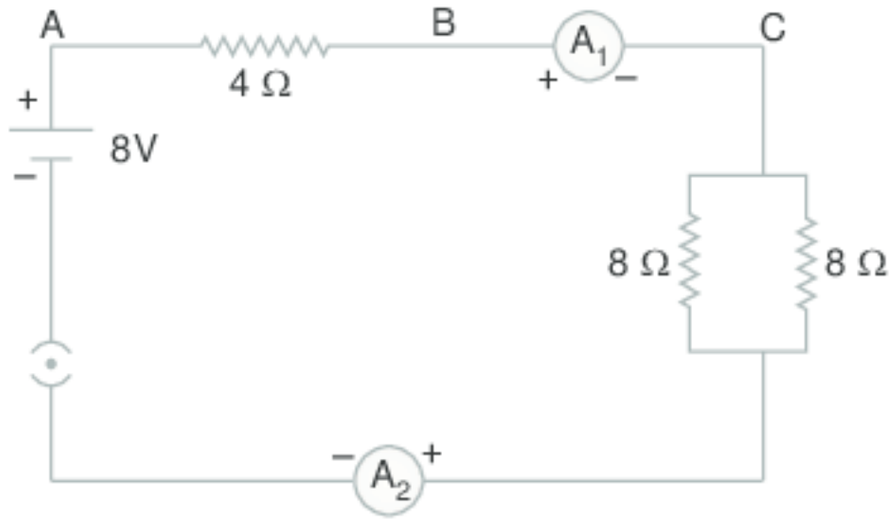
(i) Effective resistance of two 8Ω resistors in the combination

(ii) Current flowing through 4Ω resistor

(iii) Potential difference across 4Ω resistor

(iv) Power dissipated in 4Ω resistor

(v) Difference in reading of ammeter A_1 and A_2 (if any).



Ans. (i) Effective resistance of two 8Ω resistors

$$\frac{1}{R} = \frac{1}{8} + \frac{1}{8} = \frac{2}{8}$$

$$R = 4\Omega \quad \textbf{1}$$

(ii) Current flowing through the circuit = current flowing through 4Ω

Equivalent resistance of the circuit = 4Ω + 4Ω

= 8Ω

Current flowing in the circuit = $\frac{V}{R} = \frac{8V}{8\Omega} = 1A$ **1**

(iii) Potential difference across $4\Omega = V_1 = IR_1$

$= 1A \times 4\Omega = 4V$ **1**

(iv) Power dissipated in $4\Omega = P = VI = 4V \times 1A$

$= 4$ watt **1**

(v) Both A_1 and A_2 show same reading because current remains same in series combination. **1**

[CBSE Marking Scheme, 2012]

A **Q. 15. Two conductors A and B of resistances 5 Ω and 10 Ω respectively are first joined in parallel and then in series. In each case the voltage applied is 20 V.**

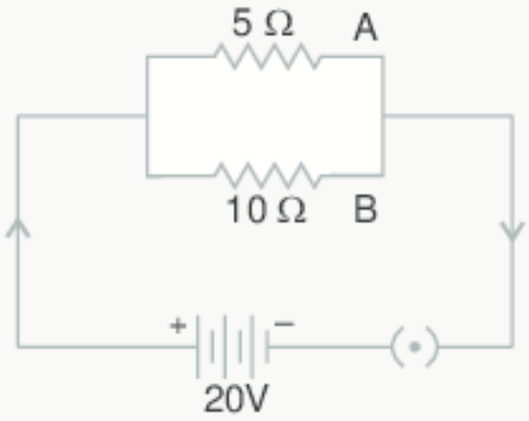
(i) Draw the circuit diagram to show the combination of these conductors in each case.

(ii) In which combination will the voltage across the conductors A and B be the same ?

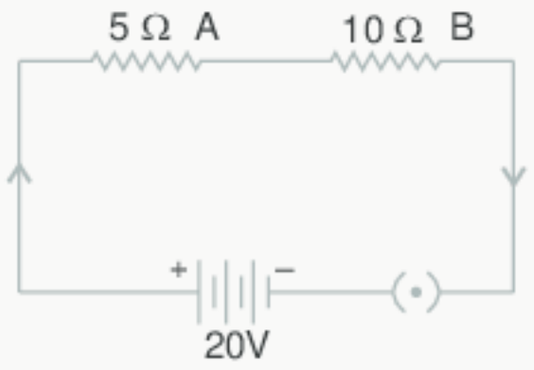
(iii) In which arrangement will the current through A and B be the same ?

(iv) Calculate the equivalent resistance for each arrangement. [Board Term I, Set-45, 2012]

Ans. (i) Parallel arrangement



Series arrangement



2

(ii) Voltage across A and B will be same in parallel arrangement. ½

(iii) Current in A and B will be same in series arrangement. ½

(iv) Equivalent resistance in

(a) Parallel combination R_P

$$= \frac{R_1 R_2}{R_1 + R_2} = \frac{5 \times 10}{5 + 10} = \frac{10}{3}$$

$= 3{\cdot}33$ W **1**

(b) Series combination $R_s = R_1 + R_2$

$= 5 + 10$

$= 15$ W **1**

[CBSE Marking Scheme, 2012]

High Order Thinking Skills (HOTS) Questions

Q. 1. How does the resistance of a wire depend upon its radius ? 3

Ans. As $R \propto l/A$,

$R \propto l/r \propto \pi r^2$, *i.e.* $R \propto l/r^2$. 3

Q. 2. Though same current flows through the electric line wires and the bulb filament, yet only the filament of bulb glows. Give the reason behind it. 3

Ans. The resistance of electric line wires is very, very less than that of the filament of the bulb. Therefore, the current through high resistance filament produces more heat which makes it glow. 3

Q. 3. The heating elements of electric toasters and electric irons are made of an alloy rather than a pure metal. Why ? 3

Ans. The heating elements of electric toasters and electric irons are made of an alloy rather than a pure metal due to the following reasons :

(i) Alloys do not oxidise readily at high temperature.

(ii) Alloys have higher resistivity than their constituent elements. 3

Q. 4. For domestic purposes, we connect the electrical devices in parallel instead of connecting them in series. What are the advantages of connecting electrical devices in parallel ? 3

Ans. By connecting the electrical devices in parallel :

(i) Each device gets the full or same voltage.

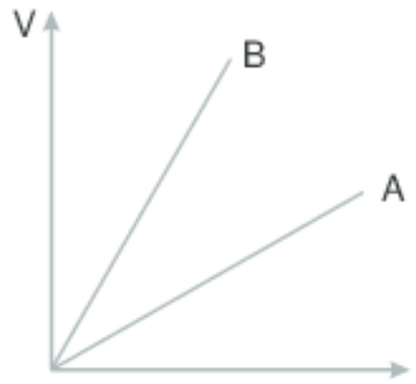
(ii) Each device gets proper current depending on its resistance.

(iii) If one device is switched off / on, other electrical appliances remain unaffected.

That is why for domestic purposes we connect the electrical devices in parallel instead of connecting them in series. 3

Q. 5. (a) A large number of free electrons are present in metals. Why is there no current in the absence of electric field across it ?

(b) V-I graphs for parallel and series combination of two metallic resistors are shown in figure. Which graph represents parallel combination ? Justify your answer. 3



Ans. (a) In the absence of an electric field, the motion of the electrons in a metal is random. There is no net flow of charge across any section of the conductor. So no current flows in the metal.

(b) As $R = \frac{V}{I}$, clearly, slope of V-I graph gives resistance R. As graph B has a greater slope than A, so graph B represent series combination (higher resistance) and graph A represents parallel combination (lower resistance). **1½ + 1½**

Q. 6. A number of bulbs are to be connected to a single source. Will they provide more illumination when connected in parallel or in series ? Give reasons to justify your answer and also list two advantages of this type of arrangement.

[Board Term I, Set-43, 2012] 3

Ans. The bulbs will provide more illumination when connected in parallel as each bulb will get the required voltage/current and their illuminations will be added. In case the bulbs are connected in series, they will not get the required voltage and may even not glow. **1**

The bulbs should be connected in parallel because each bulb will show its maximum power or total resistance decrease hence greater current may be drawn from the cell. **1**

Advantages of parallel arrangement :

(i) Voltage across each device is same and it can take current as per its resistance.

(ii) If one device is damaged, then others continue to work properly. **½ + ½**

[CBSE Marking Scheme, 2012]

Q. 7. Explain the following ;

(i) Why is tungsten used exclusively for filament of electric lamps ?

(ii) Why are the conductors of electric heating devices, such as bread toasters and electric iron made of an alloy rather than a pure metal ?

(iii) Why is series arrangements not used for domestic circuit ?

(iv) How does the resistance of a wire vary with its area of cross section ?

(v) How many joules are there in one kilo watt hour ?

[NCERT, NCT-2014] 5

Ans. (i) Tungsten has a high melting point (3380°C). It does not melt at high temperatures. It retains as much of heat generated, so that it becomes very hot and emits light.

(ii) Conductors of electric heating devices are made up of alloys because alloys do not oxidise readily at high temperatures, unlike metals. Also alloys have a greater resistivity as compared to their constituent pure metals.

(iii) Because if one component fails, the circuit is broken and none of the other components will work. Also components need currents of widely different values to operate properly. But in a series circuit, the current is constant throughout the electric device.

(iv) Resistance is inversely proportional to the area of cross-section of the wire. Thus, if the wire is thick, then resistance is less. If the wire is thin, then resistance is large.

(v) The commercial unit of electrical energy is kilo-watt hour.

$$1 \text{ kilowatt hour} = 1 \text{ kW} \times 1\text{h}$$
$$= 10^3 \text{ W} \times 3600\text{s}$$
$$= 3.6 \times 10^6 \text{ Ws}.$$

or $1 \text{ KWh} = 3.6 \times 10^6 \text{ J}$ **1× 5 = 5**

Value Based Questions

Q. 1. We generally use a device in an electrical circuit, which is essential for safety of appliance as well as life.

(i) What is that safety device called ?

(ii) How it works and helps us to live happily ?

(iii) Do you think it is necessary for every place where electricity is used ? 3

Ans. (i) Fuse

(ii) Yes, Fuse protects circuit and appliances by stopping the flow of any unduly high electric current. **1**

(iii) Yes **1**

Associated Value : The learners will be able to understand and appreciate the importance of electric fuse in the domestic circuit. **1**

Q. 2. One day Sohan went to his friend's house. He was surprised to see that most of the electrical appliances at his house were functional. For example, tube light and fan in all rooms two TV's, computer, light of toilet & kitchen were switched on. Sohan told his friend that this is not the way to use electricity. Now the question arises whether this habit of consuming electrical energy is acceptable or not. Will it effect the economic condition of the family, as well as the nation how ? 3

Ans. No.

Yes, it will affect the economic condition of family as well as the nation because both renewable and

mostly non-renewable sources of energy is used to generate large amount of electricity. We should conserve the energy. 2

Associated Value : The learners will be encouraged to adopt eco-friendly attitude which is also a need of the hour. 1

Q. 3. Decorative lights are made using many bulbs of low power and are all connected in series and parallel combinations. If we want to connect two bulbs to the same battery than an obvious way to connect them is in series. At home, all your appliances are connected in parallel with each other. This means they all get the full mains voltage and you can turn on your tv without turning your microwave. Each appliance has its own connection between live and neutral. Even though all the appliances in our home are connected across the same voltage, they all draw different currents.

(i) What problem you face when you connect two bulbs in a series ?

(ii) List two advantages of connecting the bulbs in parallel.

(iii) As a student what initiative you take to suggest the statement "Power Consumption." 3

Ans. (i) When bulbs are connected in series, even if one bulb fuses or is removed, the others do not glow. **1**

(ii) Advantages of connecting bulbs into parallel :

(a) They get full battery voltage, so they all glow brightly.

(b) They remain only at their conducting loop without affecting others. **1**

(iii) Suggestions :

(a) Less electrical appliances should be connected in parallel.

(b) To use compact fluorescent appliances. **1**

Q. 4. Kritika observed that the tube lights in the corridor of her school were always switched on the whole day. She brought the matter to the notice of her class teacher who talked to the principal about it. The principal took immediate action.

(i) Kritika helped in a way to reduce air pollution. Explain how ?

(ii) Kritika was appreciated by the teachers and the principal for portraying which values ?

(iii) How can the consumption of electricity be reduced in the school ? 3

[Board Term I, Set A85V2IL 2015, DDE 2015;]

Ans. (i) Power/Electricity production involves burning of fossil fuel. Electricity save is fuel saved, less fuel burnt means less air pollution.

(ii) Courage, appreciation and protection of environment.

(iii) Students should turn off the lights while going out of their class, they should not waste water as it also involves the use of electricity many times. **1+1+1**

[CBSE Marking Scheme, 2015]

Practical Based Questions

Experiment 1 : **(1)** To study the dependence of potential difference (V) across a resistor on the current (I) passing through it and determine its resistance. Also plot a graph between V and I.

(2) To determine the equivalent resistance of two resistors when connected in series.

(3) To determine the equivalent resistance of two resistors when connected in parallel.

Q. 1. Explain how we connect an ammeter and a voltmeter in a circuit while performing experiment for studying the dependence of current (I) on potential difference (V) across a resistor ?

[Board Term I, Set-L7ZSVLH, 2016]

Ans. Ammeter - in series

Voltmeter - in parallel

1+1

[CBSE Marking Scheme, 2016]

Q. 2. A ammeter has a range of 0 – 3 ampere and these are 30 divisions on its scale. Calculate the least count of the ammeter.

[Board Term I, Set-1ZHNPNO, 2016]

Ans. Range of ammeter $A_R = 3$ ampere.

No. of divisions in ammeter = 30.

$$\therefore \text{Least count of ammeter} = \frac{\text{Range}}{\text{Total Division}} = \frac{3}{30}$$

$$= 0.1 \text{ A.} \quad \textbf{2}$$

[CBSE Marking Scheme, 2016]

Q. 3. In a voltmeter there are 20 divisions between the 0 mark and 0.5 V mark. Calculate the least count of the voltmeter. [Board term I, Set-OQKPLGV, 2016]

Ans. Range of voltmeter = 0.5 V

No. of divisions = 20

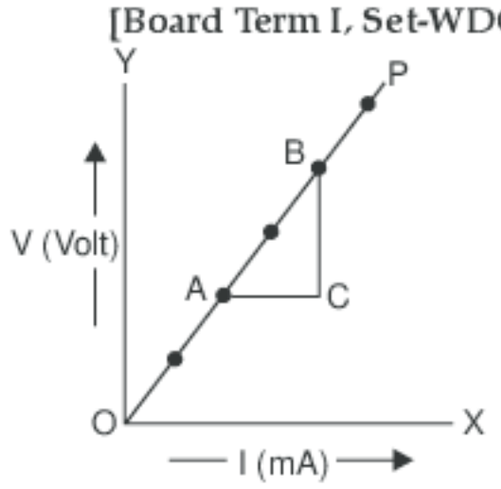
$$\therefore \text{Least count of voltmeter} = \frac{\text{Range}}{\text{Total Division}}$$

$$= \frac{0.5}{20} = .025 \text{ V.} \quad \textbf{2}$$

[CBSE Marking Scheme, 2016]

Q. 4. To verify ohm's law a student drew graph between electric current (I) and potential difference (V) across a resistor.

[Board Term I, Set-WDCXXOV, 2016]



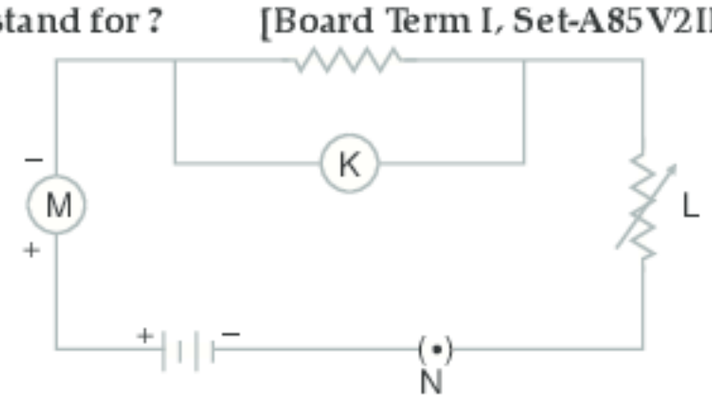
Fill in the blanks :

(i) From graph we calculate current by side ..... and potential difference by side ..... .

(ii) From graph we calculate resistance by ..... .

Ans. (i) Side AC
Side BC
(ii) Slope **[CBSE Marking Scheme, 2016] 1+1**

Q. 5. To verify Ohm's law a circuit diagram was drawn by a student as shown below. What do K, L, M, N stand for ? [Board Term I, Set-A85V2IL, 2015]



Ans. K = Voltmeter, L = Rheostat, M = Ammeter, N = Key ½+½+½+½

[CBSE Marking Scheme,2015]

Q. 6. The current flowing through a conductor and the potential difference across its ends are as per the readings of ammeter and voltmeter shown below. The resistance of the conductor would be _____

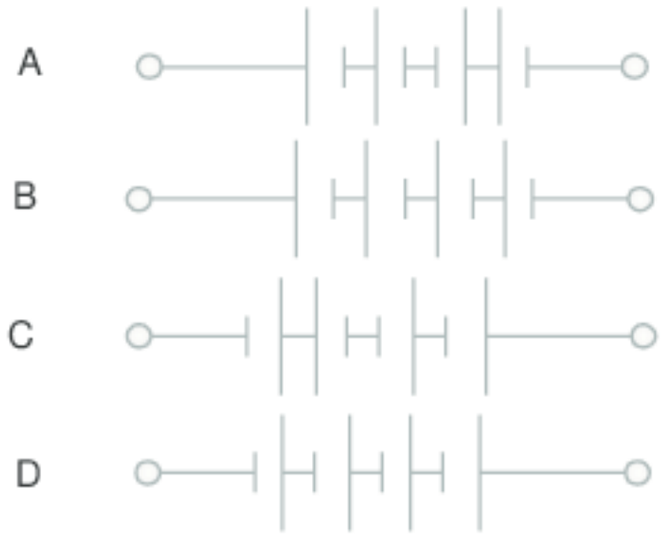
290 mA

5.8 V

Ans. Resistance (R) $= \frac{V}{I} = \frac{5.8\,V}{290\times10^{-3}}A = \frac{58\times1000}{290\times10}$

$\Rightarrow$ $R = 20\ \Omega$ 2

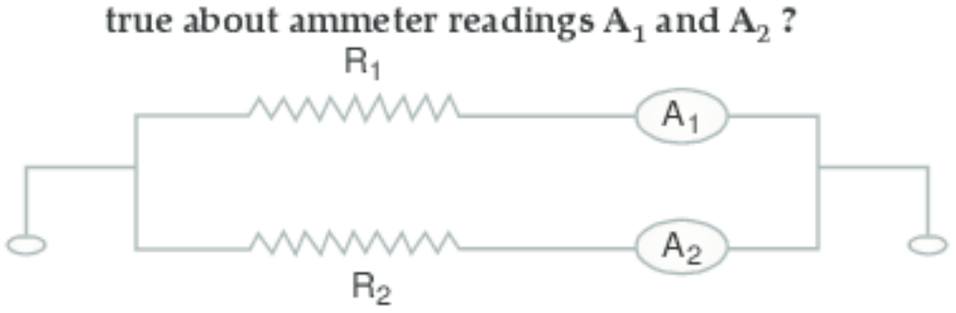
Q. 7. Four students connect 4 cells of 1.5V each to get a battery of voltage 6V. Connections of which student is incorrect ?



Ans. A, B and C are incorrect. D is correct.

Reason : Negative terminal of each cell should connect to the positive terminal of the next cell or positive terminal of each cell should connect to the negative terminal of the next cell. **1 + 1**

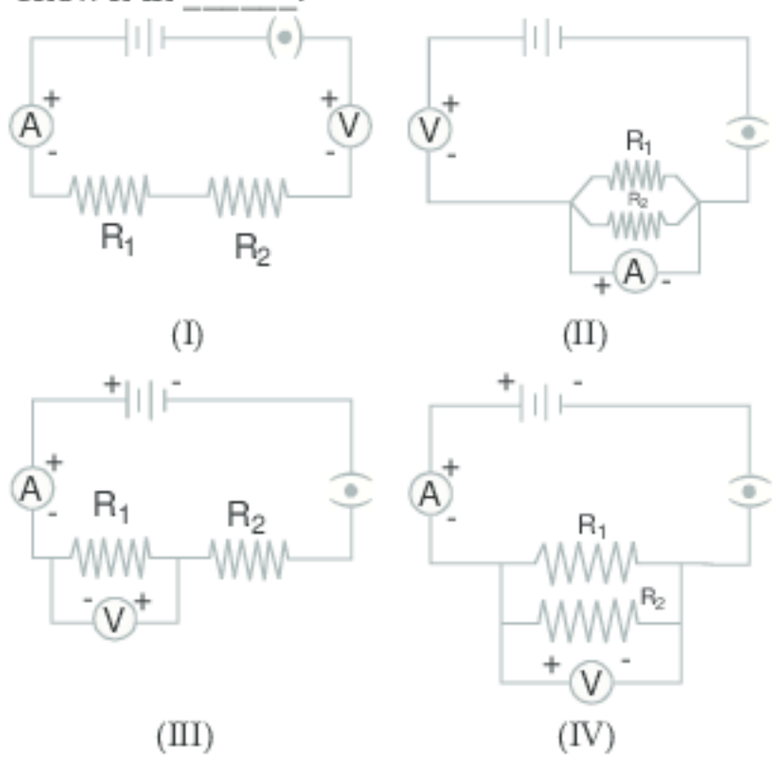
Q. 8. If the applied voltage (V) across both the resistors R_1 and R_2 is same but $R_1 > R_2$, then what would be true about ammeter readings A_1 and A_2 ?



Ans. $A_1 < A_2$.

Reason : In parallel combination, current depends on resistance, $I \propto 1/R$ *i.e.*, more will be the resistance, less is the current. **1 + 1**

Q. 9. The correct voltmeter and ammeter connections, in an experiment to find the equivalent resistance when two resistors are connected in parallel is shown in _____.



Ans. Diagram IV is correct.

Reason : In a circuit, voltmeter should be connected in parallel and ammeter should be connected in series. **1 + 1**

Q. 10. If two resistors of value R are connected in series and then in parallel, what is the difference in equivalent resistance in both cases ?

Ans. (a) $\frac{3R}{2}$

Equivalent resistance in series $(R_s) = R + R = 2R$

Equivalent resistance in parallel, (R_p),

$$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R}$$

$$\frac{1}{R_p} = \frac{2}{R}$$

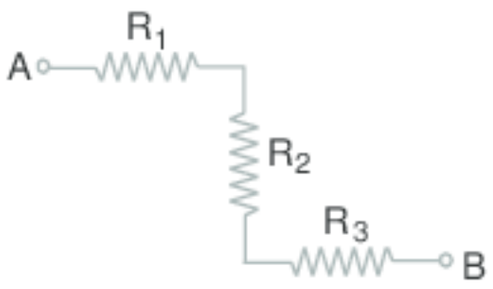
$$\therefore \quad R_p = \frac{R}{2}$$

$$\therefore \quad R_s - R_p = 2R - \frac{R}{2}$$

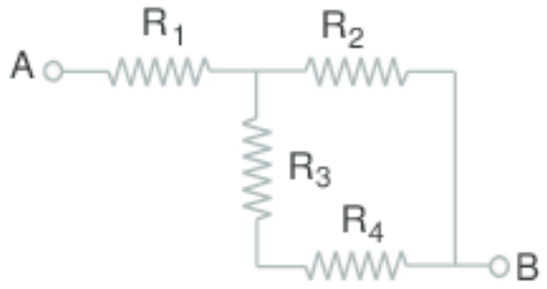
$$= \frac{4R - R}{2} = \frac{3R}{2} \qquad \textbf{1 + 1}$$

Q. 11. Identify the series combination in the following circuit.

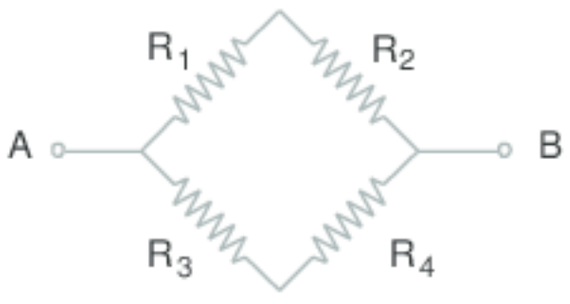
(I)



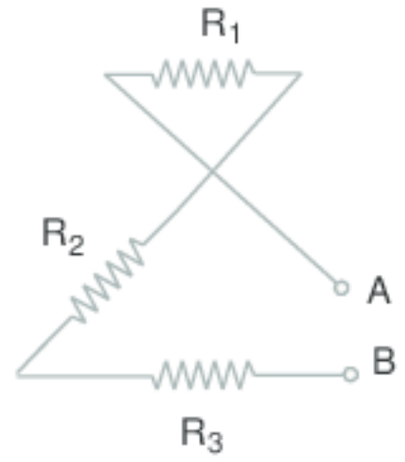
(II)



(III)

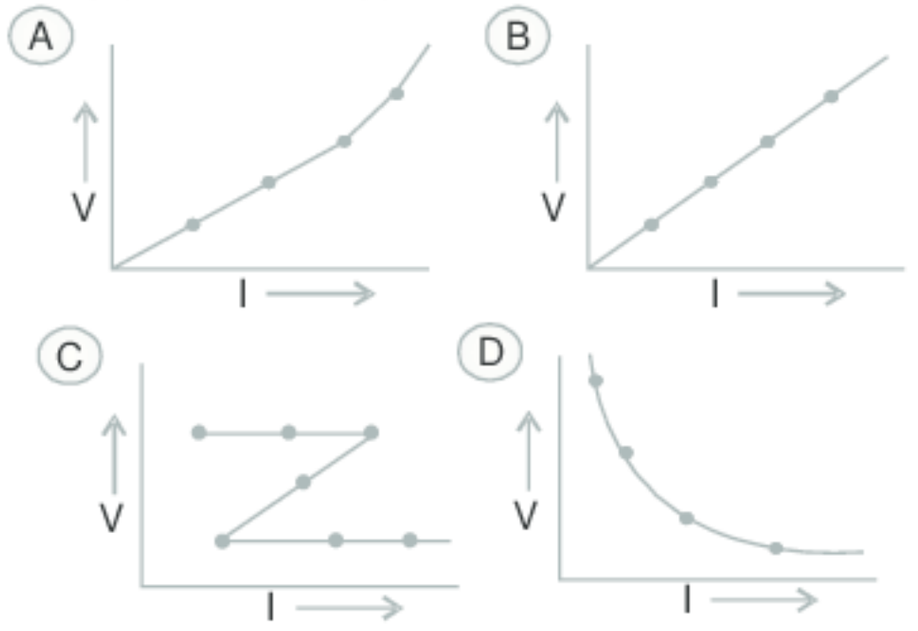


(IV)



Ans. Figure I and IV have series combinations only. Resistance are placed between terminal A and B only. **1 + 1**

Q. 12. Which of these represent relation between voltage (V) and current (I) ?



Ans. Figure B. It verifies Ohm's Law. **1 + 1**

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