Electricity

94. Define electric current. Give mathematical relation between electric current, electric charge and time
The filament of an electric lamp, which draws a current of 0.2 A, is used for 5 hours. Calculate the amount of charge flowing through the circuit.
2015/2016 [5 Marks]

Electric current is expressed by the amount of charge flowing through a particular area in unit time

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

Current, $I = 0.2$ A

Time, $t = 5$ hours $= 18000$ sec.

Charge, $Q = ?$

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

Putting the values of I and *t*, we get

$$\Rightarrow 0.2 \text{ A} = \frac{Q}{18000 \text{ sec.}}$$

$$\Rightarrow Q = 3600 \text{ C}$$

---

95. What is meant by electric circuit? What is done in order to have continuous flow of electric charge from a point A to another point B in an electric circuit? Write the relation between coulomb and ampere.
2015/2016 [5 Marks]

⇒ A continuous and closed path of an electric current is called an electric circuit.

⇒ In order to have continuous flow of electric charge from a point A to B, the electric circuit should be closed. If the circuit is broken anywhere the current stops flowing.

⇒ Relation: $1 \text{ Ampere} = \frac{1 \text{ Coulomb}}{1 \text{ sec.}}$

⇒ Current = 1 Ampere

Charge on an electron $= 1.6 \times 10^{-19}$ C

$$\text{Number of electrons} = \frac{\text{Total current}}{\text{Charge on an electron}} = \frac{1 \text{ A}}{1.6 \times 10^{-19} \text{ C}}$$

$$= 6.25 \times 10^{18} \text{ electrons}$$

---

96. Define 1 volt. Express it in terms of SI unit of work and charge. Calculate the amount of energy consumed in carrying a charge of 1 coulomb through a battery of 3 volts.
2014/2015 [3 Marks]

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

$$= \frac{\text{Word done}}{\text{Charge}}$$

$$= \frac{1 \text{ Joule}}{1 \text{ Coulomb}} = 1 \text{ JC}^{-1}$$

The amount of energy consumed in carrying a charge of 1 coulomb through a battery of 3 volts:

$$\text{Energy} = \text{Charge} \times \text{Potential difference}$$
$$= 1 \text{ coulomb} \times 3 \text{ volt}$$
$$= 3 \text{ Joule}$$

---

98. A bulb cannot be used in place of a resistor to verify Ohm's Law. Justify this statement.

2013/2014/2015/2016 [1 Mark]

It is because Ohm's law holds good at constant temperature only.

---

99. What is meant by electric resistance of a conductor?

2010/2011/2012/2014 [1Mark]

Resistance is the property of a conductor to resist the flow of charge through it.

100.(a) Name and state the law that gives relationship between the potential difference (V) across the two ends of a conductor and the current (I) flowing through it.
(b) Represent it (Ohm's Law) mathematically.
(c) Draw the circuit diagram for the verification of Ohm's law.
(d) Draw the V-I graph for this (Ohm's) law.

2010/2011/2012 [5 Marks]

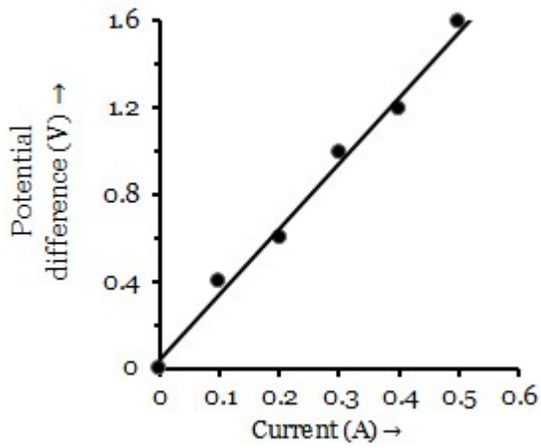
(a) Ohm's law establishes a relation between potential difference (V) and current (I). It states that, at same physical condition, (*i.e.,* constant temperature and pressure), the current flowing through a conductor is directly proportional to the potential difference across it.

ılly,

$$V = IR$$

(b) Mathematica

(c)



V-I graph for verification of Ohm's law

101.Mention any two factors on which the resistance of a cylindrical conductor depends.

2010/2011/2012/2016 [1 Mark]

Resistance of a conductor depends upon the following factors:
(a) Length of the conductor
(b) Area of cross-section of the conductor
(c) Material of the conductor

102.Define 1 ohm resistance.
A student has a resistance wire of 1 ohm. If the length of this wire is 50 cm, to what length he should stretch it uniformly so as to obtain a wire of 4 Ω resistance? Justify your answer.

2015/2016 [3 Marks]

(a) Original resistance, R = 1Ω

Original length of wire, l = 50 cm

New length of wire, l' = ?

New resistance, R' = 4Ω

So,

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

$$\Rightarrow 1 = \frac{\rho \times 50}{A}$$

$$\Rightarrow \frac{\rho}{A} = \frac{1}{50}$$

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

$$\Rightarrow 4 = \frac{\rho \times l'}{A}$$

$$\Rightarrow 4 = \frac{\rho}{A} \times l'$$

$$\Rightarrow 4 = \frac{1}{50} \times l'$$

$$\Rightarrow l' = 200 \text{ cm}$$

Length should be stretched by 200 cm.

103.The resistance per metre length of a wire is 10 Ω. If the resistivity of the material of the wire is 50 x 10^{-8} Ω m, find the area of cross-section of the wire.

2014/2015/2016 [3 Marks]

Resistance, R = 10 Ω
Resistivity, ρ = 50 × 10^{-8} Ω m
Area of cross-section of the wire = ?
l = 1 m
A = ?

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

$$A = \frac{\rho l}{R} = \frac{50 \times 10^{-8} \times 1}{10} = 50 \times 10^{-9} \text{ m}^2$$

A (cross-section of the wire) = 5 × 10^{-8} m²

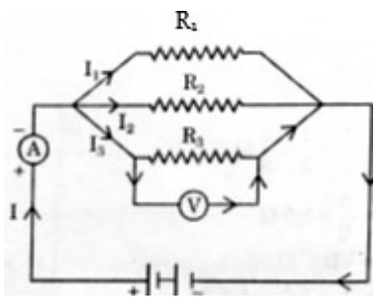
---

104. Three resistors of resistances R_1, R_2, and R_3 are connected in parallel to a source of potential difference V. Draw the schematic circuit diagram. Find the equivalent resistance of the circuit.

Or

Derive the expression for the equivalent resistance of three resistors R_1, R_2, and R_3 connected in parallel.

2010/2012 [3 Marks]



In parallel arrangement, the total current I is equal to the sum of the separate currents through each branch of the combination.

$$I = I_1 + I_2 + I_3$$

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

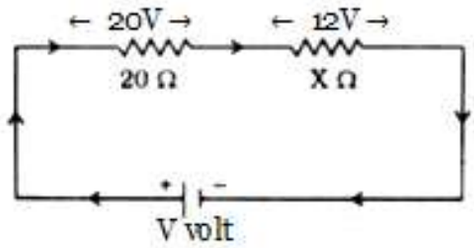
or, $$\frac{I}{V} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Let R_p be the equivalent resistance of the parallel combination of resistors.

$$\frac{I}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \qquad \left[\therefore R_p = \frac{V}{I}\right]$$

105.(a) With the help of a circuit diagram, deduce the equivalent resistance of two resistances connected in series.

(b) Two resistances are connected in series as shown in the diagram.



Calculate:

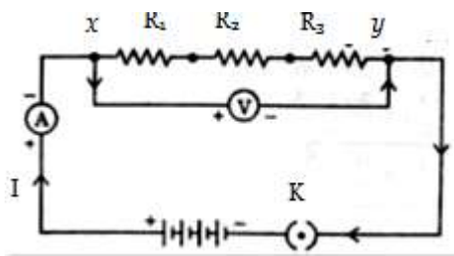
(i) The current through the 20 Ω resistance.

(ii) Current through X.

(iii) Resistance in X.

2015/2016 [5 Marks]

(a)



Let the potential difference across the resistors R_1, R_2, and R_3 are V_1, V_2, and V_3 respectively. In the electric circuit shown above, let I be the current through the circuit. In this case, the current through each resistor is also I and the potential difference V across a combination of resistors is equal to the sum of potential differences across the individual resistors. That is

$$V = V_1 + V_2 + V_3 \quad ...(1)$$

If the resistors R_1, R_2, and R_3 are replaced by an equivalent single resistor R, such that the potential difference V across it, and current I through the circuit remain the same, then, applying the Ohm's law to the entire circuit and three resistors separately, we have:

$$V = IR$$

$$V_1 = IR_1$$

$$V_2 = IR_2$$

$$V_3 = IR_3$$

From eqn. (1), $IR = IR_1 + IR_2 + IR_3$

or $R = R_1 + R_2 + R_3$

(b) (i) $R = 20\ \Omega$

$V = 20\ V$

Total current, I = ?

$V = IR$

$20 = I \times 20$

$I = 1\ A$

(ii) Current is same in series combination is *i.e.*, 1A.

(iii) $V = 12\ V$

$R = 'X'\ \Omega$

$I = 1\ A$

So, $V = 1\ R$

$12 = 1 \times X$

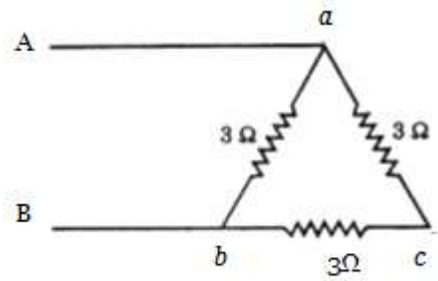
$X = 12\ \Omega$

---

106. For the parallel combination of resistors, establish the relation:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

where the symbols have their usual meanings.
Find the resistance between A and B in the following network.



2014/2016 [5 Marks]

Parallel combination: Resistance R_1 and R_2 are in series

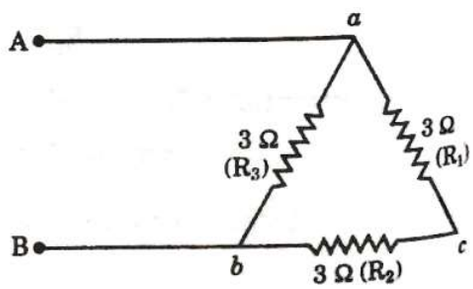
∴ $R_s = R_1 + R_2 = 3 + 3 = 6\ \Omega$

Now, R_3 is parallel to R_s

∴ $\frac{1}{R_p} = \frac{1}{R_s} + \frac{1}{R_3}$

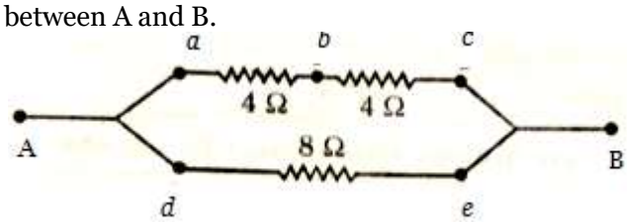
$= \frac{1}{6} + \frac{1}{3} = \frac{3}{6} = \frac{1}{2}\Omega$

$R_p = 2\ \Omega$



---

107. Three resistors are connected in an electrical circuit as shown. Calculate the resistance between A and B.



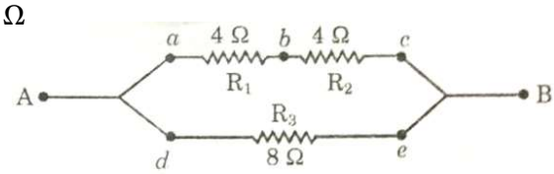
2015/2016 [5 Marks]

Relationship of three resistors connected in parallel:

The resistance between *a* to *e* i.e., R_1 and R_2 are in series.

$\therefore \quad R_s = R_1 + R_2$

$= 4 + 4 = 8\ \Omega$



R_3 is in parallel to Rs i.e., $R_1 + R_2$

$\therefore \quad \frac{1}{R_p} = \frac{1}{R_s} + \frac{1}{R_3}$

$= \frac{1}{8} + \frac{1}{8} = \frac{2}{8}\ \Omega = \frac{1}{4}$

$R_p = 4\ \Omega$

---

108. A current of 5 amperes is passed through a conductor of 12 ohms for 2 minutes. Calculate the amount of heat produced.

2014/2015/2016 [3 Marks]

$H = I^2Rt$ Joule

$I = 5$ A

$R = 12\ \Omega$

$t = 2$ minutes $= 2 \times 60 = 120$ sec.

$H = (5)^2 \times 12 \times 120$

$= 25 \times 12 \times 120 = 36000$

$= 3.6 \times 10^4$ Joule

---

109. Why do we use copper and aluminum wires for transmission of electric current?

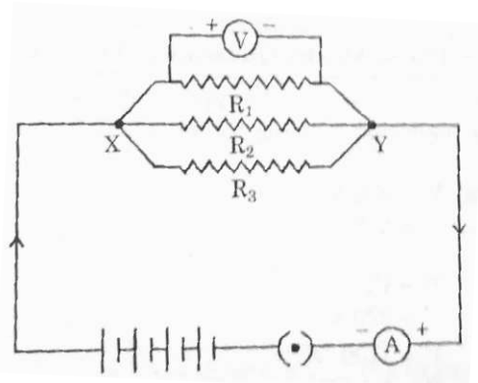
2010/2012/2013 [5 Marks]

(a) (i) Tungsten is used in making the filament of an electric bulb because:

- Tungsten has high melting point.
- Tungsten has high resistivity to retain much heat.

(ii) Copper and aluminum have low resistivity and they are good conductors of electricity. So, they are used for transmission of electric current.

(b) A parallel combination XY of three resistors having resistances R_1, R_2 and R_3 respectively is made. It is connected with a battery, a plug key and an ammeter as shown in the figure. Then a voltmeter is connected with resistor R_1 in parallel and the potential difference is noted down.



The key is switched off, and similarly potential difference across resistors R_2 and R_3 are also noted down.

It is observed that the potential difference across all the three resistors are the same.
