Class 10th Science

Chapter - 12

Electricity

Textual Questions and Answers :

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Q.1. What does an electric circuit mean?

Ans :- A continuous and closed path of an electric current is called an electric circuit.

Q.2. Define the unit of current?

Ans :- The unit of current is ampere. Flow of one coulomb of charge in one second is called one ampere.

$$\text{i.e. 1 amp} = \frac{\text{1 coulomb}}{\text{1 second}}$$

Q.3. Calculate the number of electrons constituting one coulomb of charge.

Ans :- Charge on one electron (e) = $1.6 \times 10^{-19} C$

Total charge Q = 1C

$$\therefore \quad \text{Number of electrons, } n = \frac{Q}{\text{--------}}$$

C

$$= \frac{1C}{1.6\times10^{-19}C}$$

$$= 6.25\times10^{18}$$

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Q.1. Name a device that helps to maintain a potential duo difference across a conductor.

Ans :- Battery.

Q.2. What is meant by saying that the potential difference between two points is 1V?

Ans :- One volt is the potential difference between two points in a current carrying conductor when 1 Joule of work is done to move a change of 1 coulomb from one point to the other.

$$\text{Therefore 1 volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$

Q.3. How much energy is given to each coulomb of charge passing through a 6v battery?

Ans :- Required energy = Charge x potential difference

= 1c x 6v

= 6 Joule

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Q.1. On what factors does the resistance of a conductor depend?

Ans :- The resistance of a conductor depends upon the following factors :

(i) Length of the conductor.

(ii) Area of cross section of the conductor.

(iii) Nature of its material.

Q.2. Will current flow more easily through a thick wire or a thin wire the same material. When connected to the same source? Why?

Ans :- The current will flow more easily through a thick wire than a thin wire of the same material. Because resistance of the conductor is inversely proportional to the area of cross-section.

Q.3. Let the resistance of an electrical component remains constant while the potential difference across the two Isikn ends of the component decreases to half of its for men value. What change will occur in the current through it?

Ans :- When the potential difference across the two ends of the component decreases to half then the current through it also decreases to half of its initial value. Because V ∝ I.

Q.4. Why are coils of electric toasters and electric irons made of an alloy rather than a pure metal?

Ans :- The resistivity of an alloy is generally higher than that of its constituent metals. Alloys do not oxidise readily at high temperatures. For this reason they are commonly used in electrical toasters and electric iron.

Q.5. Use the date in Table 12.2 to answer the following-

(a) Which among iron and mercury is a better conductor?

(b) Which material is the best conductor?

Ans :- (a) Resistivity of iron = $10.0 \times 10^{-8} \Omega m$

Thus iron is a better conductor because it has lower resistivity than mercury.

(b) As silver has the lowest resistivity, so silver is the best conductor.

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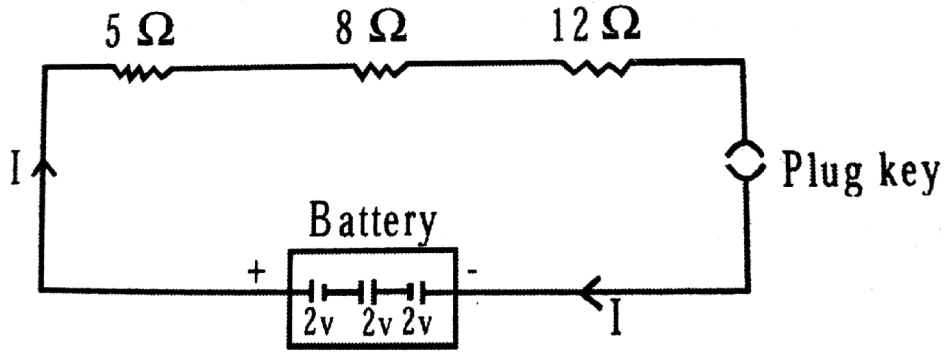
Q.1. Draw a schematic diagram of a circuit consisting of a battery of three cells of 2v each, a 5Ω resistor, and 8Ω

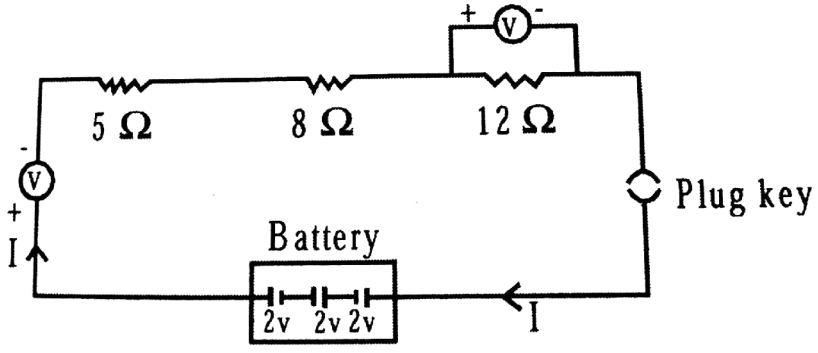
resistor, and a 12Ω resistor, and a plug key, all connected in series.

Ans :- The circuit diagram is given below :-



Q.2. Redraw the circuit of questions 1, putting in an ammeter to measure the current through the resistors and a voltmeter to measure the potential difference across the 12Ω resistor. What would be the readings in the ammeter and voltmeter? Ans. The circuit diagram is given below :

Ans :- The circuit diagram is given below :-



Total voltage, V = 3x2 = 6v

Total resistance, R = 5+8+12 = 25 Ω

$$\text{Reading of ammeter, } I = \frac{V}{R}$$

$$= \frac{6}{25} = 0.24A$$

Reading of voltmeter, V = I.R

$$= 0.24 \times 12$$

$$= 2.88V$$

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Q.1. Judge the equivalent resistance when the following are connected in parallel -

(a) 1Ω and $16^6\Omega$

(b) 1Ω and $10^3\Omega$ and $10^6\ \Omega$

Ans :- (a) Hare, $R_1 = 1\ \Omega$

$$R_2 = 10^6\ \Omega$$

$$\therefore \quad \frac{1}{\text{-------}} = \frac{1}{\text{-------}} + \frac{1}{\text{-------}}$$

R_p R_1 R_2

$$= \frac{1}{1} + \frac{1}{10^6}\ \Omega$$

$$= \frac{16^6 + 1}{16^6}\ \Omega$$

$$= \frac{1000000+1}{1000000}\ \Omega$$

$$= \frac{1000001}{1000000}\ \Omega$$

$$\therefore \quad R_p = \frac{1000000}{1000001}\ \Omega$$

$$= 0.999999\ \Omega$$

$$\therefore \quad R_p = 1\ \Omega \text{ (approx)}$$

(b) Hare $R_1 = 1\ \Omega$

$R_2 = 10^3\ \Omega$

$R_3 = 10^6\ \Omega$

$$\therefore \quad \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\ \Omega$$

$$= \frac{1}{1} + \frac{1}{10^3} + \frac{1}{10^6}\ \Omega$$

$$= \frac{10^6 + 10^3 + 1}{10^6}\ \Omega$$

$$= \frac{1000000 + 1000 + 1}{1000000}\ \Omega$$

$$= \frac{1001001}{1000000}\ \Omega$$

$$\therefore \quad R_p = \frac{1000000}{1001001}\ \Omega$$

1001001

= 0.99900001 Ω

∴ R_p = 1 Ω (approx)

Q.2. An electric lamp of 100 Ω, toaster of resistance 50 Ω and a water filter of resistance 500 Ω are connected in parallel to a 220V source. What is the resistance of the electric iron connected to the same source that takes as much current as all the three appliances and what is the current through it?

Ans :- Here R_1 = 100 Ω

R_2 = 50 Ω

R_3 = 500 Ω

$$\therefore \quad \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{1}{100} = \frac{1}{50} + \frac{1}{50}\ \Omega$$

5 + 10 + 1

$$= \frac{\quad}{500}\ \Omega$$

$$= \frac{16}{500}\ \Omega$$

$$\therefore \quad R_p = \frac{500}{16}\ \Omega$$

$$= 31.25\ \Omega$$

$\therefore$ Resistance of the electric iron = 31.25 Ω

2nd part :- Here V = 220 Volt

R = 31.25 Ω

I = ?

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

$$= \frac{220}{31.25}$$

$$= 7.04\ A$$

Q.3. What are the advantages of connecting electric devices in parallel with the battery instead of connecting them series?

Ans :- The advantages are as follows :-

(i) Each device gets the fall battery voltage.

(ii) The parallel circuit divides the current through the electrical devices. Each device gets proper current depending on its resistance.

(iii) If one device is switched OFF or ON, others are not affected.

Q.4. How can three resistors of resistances 2 Ω, 3 Ω and 6 Ω be connected to give a total resistance of

(a) 4 Ω

(b) 1 Ω ?

Ans :- (a) First 3 Ω and 6 Ω are connected in we have

$$\frac{1}{R_{p'}} = \frac{1}{3} + \frac{1}{6}$$

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

$$= \frac{3}{6}$$

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

$\therefore \quad R_{p'} = 2\ \Omega$

Now $R_{p'}$ is connected with the 3rd resistor of resistance 2 Ω in series.

$\therefore$ The total resistance = $R_{p'} + 2\ \Omega$

$= 2\ \Omega + 2\ \Omega$

$= 4\ \Omega$

(b) If we connected all three in parallel then

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

$$= \frac{1}{} + \frac{1}{} + \frac{1}{} \ \Omega$$

$$\frac{2}{} \quad \frac{3}{} \quad \frac{6}{}$$

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

$$= \frac{6}{6}\ \Omega$$

$$= 1\ \Omega$$

Q.5. What is the (a) highest; (b) lowest total resistance that can be secured by combination of four coils of resistances 4 Ω, 8 Ω, 12 Ω, 24 Ω ?

Ans :- (a) Resistance is maximum when connected is series.

∴ Total resistance = 4Ω + 8Ω +12Ω +24 Ω

= 48 Ω

(b) Resistance is minimum when connected in parallel.

$$\therefore \quad \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{Ry}$$

$$\frac{1}{} \quad \frac{1}{} \quad \frac{1}{} \quad \frac{1}{}$$

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

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

$$= \frac{12}{24}\ \Omega$$

$$= \frac{1}{2}\ \Omega$$

$\therefore \quad R_p = 2\ \Omega$

$\therefore$ Total resistance = 2

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Q.1. Why does the cord of an electric heater not glow while the heating element does?

Ans :- Both the cord and the heating element of an electric heater carry the same current. But the heating element becomes not due to its high resistance and begins to glow. The cord remains cold due to its low resistance and does not glow.

Q.2. Compute the heat generated while transferring 96,000 coulomb of charge in one hour through a potential difference of 50v.

Ans :- Here $Q = 96,000c$

$t = 1$ hour

$= 36$ sec

$V = 50$ V

Heat generated is $H = VQ$

$= 50 \times 96,000J$

$= 48,00000J$

Q.3. An electric iron of resistance 20 Ω tkes a current of 5A. Calculate the heat developed in 30 Sec.

Ans :- Here, $R = 20\ \Omega$

$I = 5A$

$t = 30$ sec

$\therefore$ Heat developed $= I^2Rt$

$= 5^2 x 20 x 30$ J

= 25x20x30 J

= 15000 J

= 15 KJ

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Q.1. What determines the rate at which the energy is delivered by a current?

Ans :- The rate at which the energy is delivered by a current is called power.

The power P is given by $P = VI$

or $P = I^2R$

$= v^2/R$

Q.2. An electric motor takes 5A from a 220v line. Determine the power of the motor and the energy consumed in 2h.

Ans :- Here $I = 5A$

$V = 220v$

$P = ?$

We have $P = VI$

$= 220 \times 5$

= 1100 w

Energy consumed = P x t

= 1100w x 2h

= 1100w x 2 x 60 x 60 sec

= 1100w x 7200 sec

= 7920000 J

EXERCISES

Q.1. A piece of wire of resistance R is cut into five equal parts. These the equivalent resistance of this combination is R^{I}, then the ratio R/R^{I} is

(a) $\frac{1}{25}$ (b) $\frac{1}{5}$ (c) 5 (d) 25

Ans :- Hare,

$$\frac{1}{R^{I}} = \frac{1}{R/5} + \frac{1}{R/5} + \frac{1}{R/5} + \frac{1}{R/5} + \frac{1}{R/5}$$

$$= \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R}$$

$$= \frac{25}{R}$$

$$\therefore \quad R^{I} = \frac{R}{25}$$

$$\text{Now } R/R^{I} = \frac{R}{R/25}$$

$$= \frac{25R}{R}$$

$$= 25$$

Hence answer is (d)

Q.2. Which of the following terms does not represent electrical power in the circuit?

(a) I^2R?

(b) IR^2

(c) VI

(d) v^2/R?

Ans :- (b) IR^2 is not power.

Q.3. An electrical bulb is rated 220v and 100w. When it is operated on 110v, the power consumed will be

(a) 100w

(b) 75w

(c) 50w

(d) 25w

Ans :- (d) 25w.

$$\text{Resistance} \quad R = \frac{v^2}{P}$$

$$= \frac{(220)^2}{100} = 484\ \Omega$$

When operated on 110v, the power consumed will be

$$P^{l} = \frac{v^{l2}}{R} = \frac{(110)^2}{484}$$

$$= 25\ w$$

Q.4. Two conducting wires of the same material and of equal lengths and equal diameters are first connected is vlivi series and then parallel in circuit across the same potential difference. The ratio of heat produced in series ai and parallel combinations would be

(a) 1:2

(b) 2:1

(c) 1:4

(d) 4:1

Ans :- Since the wires are of the same material and are equal in lengths and diameters therefore if R is resistance of each, resistance in series and parallel would be R_S and R_p respectively given by

$$R_S = R+R = 2R$$

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

$$\therefore \quad R_p = \frac{R}{2}$$

When connected to source v, then heat produced in series H_5 and when in parallel in H_p and is given by

$$H_s = \frac{v^2t}{R_2} \quad \text{and} \quad H_p = \frac{v^2t}{R_p}$$

$$\therefore \quad \frac{H_s}{H_p} = \frac{v^2t}{R_s} \times \frac{R_p}{v^2t}$$

$$= \frac{R_p}{R_s}$$

$$= \frac{R/2}{2R}$$

$$= \frac{R}{4R} = \frac{1}{4}$$

$$\Rightarrow H_s : H_p = 1:4$$

Hence (c) is correct.

Q.5. How is voltmeter connected in the circuit to measure the potential difference between two points?

Ans :- A voltmeter is connected in parallel to measure the potential difference between two points in a circuit.

Q.6. A copper wire has diameter 0.5 mm and resistivity 1.6×10^{8} Ω m. What will be the length of this wire to make its resistance 10 Ω? How much does the resistance charge if the diameter is doubled?

Ans :- Here $d = 0.5$ mm

$= 0.5 \times 10^{-3}$ m

$= 5 \times 10^{-4}$ Ω m

$p = 1.6 \times 10^{-8}$ Ω m

$l = ?$

$R = 100$ Ω

We have

$$R = \frac{pl}{A}$$

$$\Rightarrow R = \frac{pl}{\text{------------}}$$

$\pi d^2/4$

$$\Rightarrow \quad R = \frac{4\rho l}{\pi d^2}$$

$$\Rightarrow \quad R = \frac{R\pi d^2}{4\rho}$$

$$\Rightarrow l = \frac{10 \times \frac{22}{7} \times (5 \times 10^{-4})^2}{4 \times 1.6 \times 10^{-8}}$$

$$= \frac{10 \times 22 \times 25 \times 10^{-8}}{4 \times 7 \times 1.6 \times 10^{-8}}$$

$$= 122.77 \text{ m}$$

If the diameter is doubled, resistance will become 1/4 of the original.

$$\therefore \text{ Resistance will be } = \frac{10\Omega}{4}$$

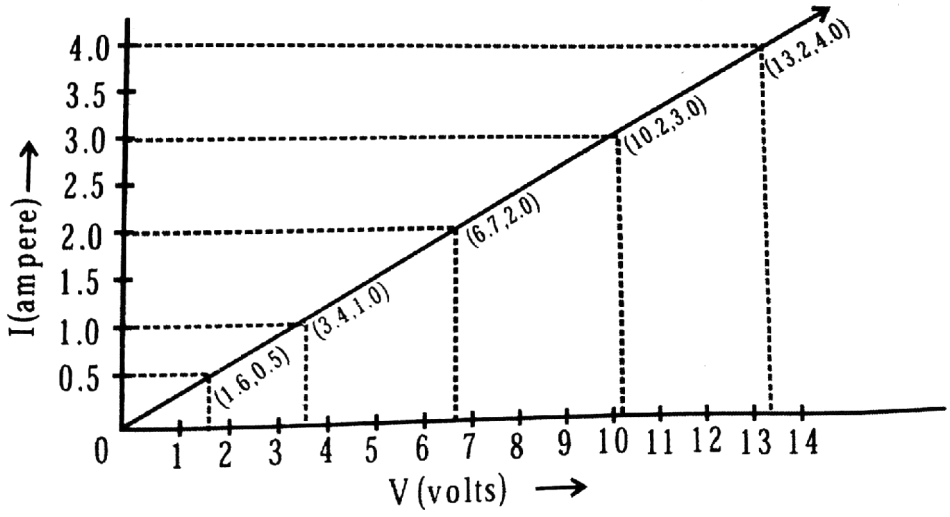
= 2.5 Ω

Q.7. The values of the current I flowing in a given resistor for corresponding values of potential differences V across the resistor are given below

I (amperes)	0.5	1.0	2.0	3.0	4.0
V (volts)	1.6	3.4	6.7	10.2	13.2

Plot a graph between V and I and calculate the resistance of the resistor.

Ans :- The graph between V and I for the given data is



Resistance of the resistor,

$$R = \frac{V_2 - V_1}{I_2 - I_1}$$

$$13.2 - 1.6$$

$$= \frac{}{4.0 - 0.5}$$

$$= \frac{11.6}{3.5}$$

$$= 3.214\ \Omega$$

Q.8. When a 12v battery is connected across an unknown resistor, there is a current of 2.5 mA in the circuit. Find the value of the resistance of the resistor.

Ans :- Hare $V = 12$ volt

$I = 2.5$ mA

$= 2.5 \times 10^{-3} A$

$R = ?$

We have ,

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

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

$$= 4800\ \Omega$$

Q.9. A battery of 9v is connected in series with resistors of 0.2 Ω, 0.4 Ω, 0.5 Ω and 12 Ω respectively. How much current would flow through the 12 Ω resistor?

Ans :- Here, $R = 0.2+0.3+0.4+0.5+12$

$= 13.4\ \Omega$

$v = 9$ volt

$I = ?$

We have $I = \dfrac{v}{R}$

$= \dfrac{9}{13.4}$ A

$= 0.67$A

∴ Current will low through 12 Ω resistor is 0.67A.

Q.10. How many 176 Ω resistors (in parallels) are required to carry 5A on a 220v line?

Ans :- Suppose n resistors are required.

$$\text{Now } \frac{1}{R} = \underbrace{\frac{1}{176} + \frac{1}{176} + \cdots + \frac{1}{176}}$$

$$= \frac{n}{176}$$

$$\therefore \quad R = \frac{176}{n}\ \Omega$$

Now, we have, $R = \frac{v}{I}$

$$\Rightarrow \quad \frac{176}{n} = \frac{220}{5}$$

$$\Rightarrow \quad n = \frac{176}{44} = 44$$

$$= 4$$

Q.11. Show how you would connect three resistors, each of resistance 6 Ω, so that the combination has a resistance of

(i) 9 Ω

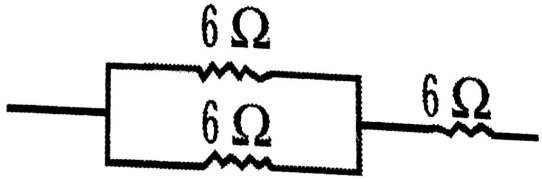
(ii) 4 Ω

Ans :- Here

$$R_1 = R_2 = R_3 = 6\ \Omega$$

(a) Combine R_2 and R_3 in parallel and connected R_1 in series.

$$\therefore \text{ Equivalent resistance } = R_1 + \frac{1}{\frac{1}{R_2} + \frac{1}{R_3}}$$



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

$$= 6 + \frac{6 - 6}{6 + 6}\ \Omega$$

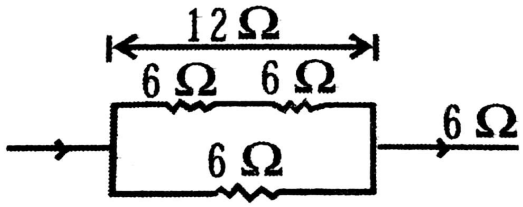
$$= 6 + \frac{36}{12}\ \Omega$$

$$= 6 + 3\ \Omega$$

$$= 9\ \Omega$$

(b) First R_1 and R_2 are connected in series and then connected R_3 in parallel.

$$\therefore \text{Equivalent resistance} = \frac{1}{\frac{1}{12} + \frac{1}{6}}$$



$$= \frac{1}{\frac{1+2}{12}}$$

$$= \frac{12}{3}$$

$$= 4\ \Omega$$

Q.12. Several electric bulbs designed to be used on a 220v electric supply line, are rated 10w. How many lamps can be connected in parallel with each other

across the two wires of 220v line if the maximum allowable current io t is 5A?

Ans :- Ut current through each bulb be I

$$P = vI$$

$$\Rightarrow \quad 10 = 220\, I$$

$$\Rightarrow \quad I = \frac{1}{22}\ A$$

Let n such bulbs be connected in series combined current through n bulbs = 5A

$$\Rightarrow \quad n \times I = 5$$

$$\Rightarrow \quad n \times \frac{1}{22} = 5$$

$$\Rightarrow \quad n = 5 \times 22$$

$$= 110$$

∴ 110 such bulbs can be lighted within allowable limit of 5A.

Q.13. A hot plate of an electric oven connected to a 220v line has two resistance coils A and B, each of 24 Ω

resistance, which may be used separately, in series, o in parallel. What are the current in the three cases?

Ans :- (i) When the two coils A and B are used separately,

Hare R = 24 Ω

v = 220v

I = ?

We have

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

$$= \frac{220}{24} A$$

$$= 9.167 A$$

(ii) When the two coils A and B are connected in series.

Hare R = 24 + 24 = 48 Ω

V = 220v

I = ?

We have,

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

$$= \frac{220}{48} \text{ A}$$

$$= 4.58 \text{ A}$$

(iii) When the two coils A and B are connected in parallel

Here

$$\frac{1}{R} = \frac{1}{24} + \frac{1}{24}$$

$$= \frac{1 + 1}{24}$$

$$= \frac{2}{24}$$

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

$$\therefore \quad R = 12 \ \Omega$$

v = 220v

I = ?

We have

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

$$= \frac{220}{12}$$

$$= 18.33 \text{ A}$$

Q.14. Compare the power used in the 2 Ω resistor in each of the following circuits :

(i) a 6v battery in series with 1Ω and 2 Ω resistors.

(ii) a 4v battery in parallel with 12 Ω and 2 Ω resistors.

Ans :- (i) 1 Ω and 2 Ω are connected in series .

$$\therefore \quad R = 1 + 2$$

$$= 3 \Omega$$

v = 6 volt

v

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

$$= \frac{6}{3}$$

$$= 2\ A$$

∴ The current passing through 2 Ω resistor is 2A

Power used in 2 Ω resistor $= I^2R$

$$= 2^2.2$$

$$= 8w$$

(ii) 12 Ω and 2 Ω are connected in parallel

$$\text{power used in 2 Ω resistor} = \frac{V^2}{R}$$

$$= \frac{4^2}{2}$$

$$= 8w$$

Q.15. Two lamps, one rated 100w at 220v, and the other 60w at 220v, are connected in parallel to electric mains

supply. What current is drawn from the line if the supply voltage is 220v?

Ans :- Total power consumed in the circuit

$= 100+60$

$= 160w$

$v = 220$ volt

We have, power $= vI$

$$\Rightarrow I = \frac{\text{Power}}{v}$$

$$= \frac{160}{220} A$$

$= 0.727$ A

Q.16. Which appliances uses more energy, a 250w TV set in or a 1200w toaster in 10 minutes?

Ans :- For TV set

Energy used $= 250w \times 1h$

$= 250wh$

For toaster

Energy used = 1200w x 10 minutes

= 1200w × 10 minutes

$$= 1200w \times \frac{10}{60} h$$

$$= 1200w \times \frac{1}{6} h$$

= 200wh

Thus, TV set uses more energy than the toaster.

Q.17. An electric heater of resistance 8 Ω draws 15A from service mains for 2 hours. Calculate the rate at which heat is developed in the heater.

Ans :- Here R = 8 Ω

I = 15 A

Power (P) = ?

We have,

$$P = I^2R$$

$$= 15^2.8$$

$$= 225 \times 8$$

$$= 1800w$$

Q.18. Explain the following :

(a) Why is the tungsten used almost exclusively for filament iqu of electric lamps?

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

(c) Why is series arrangement not used for domestic circuits?

(d) Why does the resistance of a wire vary with its area of cross section?

(e) Why are copper and aluminium usually employed for electricity transmission?

Ans :- (a) Tungsten has very high melting point. So tungsten can be heated to very high temperature.

(b) The resistivity of an alloy is generally higher than that of its constituent metals. Alloys do not oxidise readily at high temperatures. For this reason, they are

commonly used in electrical heating devices like as electric irons, toasters etc.

(c) Because the disadvantage of a series circuit is that when one component fails the circuit is broken and none of the components works. Also in a series circuit the current is constant throughout the electric circuit.

(d) Resistance of a conductor is inversely proportional to its area mo cross-section.

(e) Copper and aluminium have low resistivity and therefore there will be less loss of energy when a certain current flows through them.

Additional Questions and Answers :

Q.1. What is frictional electricity?

Ans :- The electricity developed by rubbing or friction is called frictional electricity.

Q.2. What is the fundamental law of electrostatics?

Ans :- Like charges repel and unlike charges attract each other.

Q.3. Define law of conservation of charge.

Ans :- Electric charges can neither be created nor destroyed they can only be transferred from one body to another.

Q.4. What do you mean by static and current electricities?

Ans :- Static electricity deals with the electric charges at rest while other current electricity deals with the electric charges in motion.

Q.5. Define conductor. Give examples.

Ans :- 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.

Q.6. What is insulator? Give examples.

Ans :- A substance that has infinitely high resistance does not allow electric current to flow through it. It is called an insulator.

For example - rubber, glass, plastic etc.

Q.7. Define electric current.

Ans :- The electric current is defined as the rate of flow of electric charge through any section of a conductor.

$$\text{Electric current} = \frac{\text{Charge}}{\text{time}}$$

$$\text{i.e. } I = \frac{Q}{t}$$

Electric current is a scalar quantity.

Q.8. What is electric field?

Ans :- Electric field is the region around a charged body within which its influence can be experienced.

Q.9. Define ohm's law.

Ans :- This law 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.

$\therefore$ i.e. $v \propto I$

Or $v = IR$

Where R is called resistance of the conductor.

Q.10. What do you mean by heating effect of current?

Ans :- When an electric current is passed through a conductor, heat is produced in it. This is known as heating effect of current.

Q.11. What is meant by resistance? What is SI unit of nonresistance?

Ans :- Resistance is the opposition to the flow of current in the conductor.

The SI unit of resistance is ohm (Ω)

Q.12. What is the potential difference between two points in the electric field? Name and define its SI unit.

Ans :- The potential difference between two points in the electric field is defined as the amount of work done in moving a unit positive charge from one point to the other against electrostatic force due to electric field.

SI unit of potential difference is volt.

Potential difference between two points is said to be 1 volt if 15 of the work is done in moving a charge of IC from one point to the other.

Q.13.Two resistors when connected in parallel, give resultant value of 2 Ω. When connected in series, the value becomes 9 Ω. Calculate the value of each resistance.

Ans :- at R_1 and R_2 be the two resistor.

Given that, R_p = 2 Ω

R_s = 9 Ω

Kow $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$\Rightarrow \frac{1}{2} = \frac{1}{R_1} + \frac{1}{R_2}$ --------- (i)

$R_s = R_1 + R_2$

$\Rightarrow 9 = R_1 + R_2$

$\Rightarrow R_1 = 9 - R_2$

---------- (ii)

Putting the value of R_1 in (i). We get

$\frac{1}{2} = \frac{1}{9 - R_2} + \frac{1}{R_2}$

$\Rightarrow \frac{1}{2} = \frac{R_2 + 9 - R_2}{(9 - R_2) R_2}$

$\Rightarrow \frac{1}{2} = \frac{9}{(9 - R_2) R_2}$

$$2 \qquad 9R_2 - R_2^2$$

$$\Rightarrow \qquad 9R_2 - R_2^2 = 18$$

$$\Rightarrow \qquad R_2^2 - 9R_2 + 18 = 0$$

$$\Rightarrow \qquad R_2^2 - 6R_2 - 3R_2 + 18 = 0$$

$$\Rightarrow \qquad R_2(R_2 - 6) - 3(R_2 - 6) = 0$$

$$\Rightarrow \qquad (R_2 - 6)(R_2 - 3) = 0$$

Either $R_2 - 6 = 0$ or $R_2 - 3 = 0$

$\Rightarrow R_2 = 6$ $\Rightarrow R_2 = 3$

if $R_2 = 6\ \Omega$, Then $R_1 = 9 - 6$

$= 3\ \Omega$

if $R_2 = 3\ \Omega$, Then $R_1 = 9 - 3$

$= 6\ \Omega$

$\therefore$ Two resistances are 6 Ω and 3 Ω.

Q.14. How is voltmeter connected in circuit ?

Ans :- Voltmeter is put in parallel to resistance across which difference is to be measured.

Q.15. What is material of wires used in household? Give reason.

Ans :- It is copper. Its resistance Is very small. Hence energy lost in transmission is very small.

Q.16. Name a low resistance device.

Ans :- An ammeter.

Q.17. What is electric energy? What is its practical unit?

Ans :- Electric energy is the total amount of energy consumed in an electric circuit in a given time.

The total energy consumed not only depends upon the power of the appliance but also upon the time for which the power is maintained.

If a power P is maintained for t second, the work done or the energy consumed

$$w = p \times t$$

$$W = p\left(\frac{J}{s}\right) \times t\ (s)$$

$$= Pt \text{ joule}$$

But $P = vI$

$$\therefore \quad w = vI\,t \text{ joul}$$

Practical unit of Electric energy :- Practical unit of electric energy called kwh is usually used.

This unit kwh is equal to the work done or energy consumed when a power of IKW is consumed for I hour.

$$\text{Energy (in kwh)} = \text{kw} \times 1 \text{ hour}$$

$$= \frac{\text{watt} \times \text{hour}}{1000}$$

$$\text{or Energy (in kwh)} = \frac{\text{volt} \times \text{ampere} \times \text{hour}}{1000}$$

Q.18. A 100w and 500w bulb are joined in parallel to the mains, which bulb will glow brighter?

Ans :- In parallel same voltage v is applied to both the bulbs. But 500 bulb has a smaller resistance. So it will produce more heat per second and will glow brighter than 100w bulb.

Q.19. An electric geyser has the ratings 2000w, 220v marked on it. What should be the minimum rating, in whole number of a fuse wire, that may be required for safe use with this geyser?

Ans :- Here, P = 2000w

V = 220v

I = ?

we have,

$$P = vI$$

$$\Rightarrow \quad I = \frac{P}{V}$$

$$= \frac{2000}{220} \text{ A}$$

$$= 9.1 \text{ A}$$

Hence, the minimum rating of fuse wire should be 10A for safe use with the geyser.

Q.20. The element of heater is very hot while the wires carrying current are cold. Why?

Ans :- Both heater element and conducting wire carry the same current. But the heater element becomes hot due to its high resistance and the conducting wires remain cold due to their low resistance.

Q.21. Out of 60w and 40w lamps, which one has a higher electrical resistance when in use?

Ans :- Resistance

$$R = \frac{v^2}{p}$$

$$= \text{i.e. } R \propto P$$

So, 40w lump has move resistance than a 60w lamp.

Q.22. Tap water conducts electricity whereas distilled water does not. Why?

Ans :- Tap water contains dissolved salts and minerals which ionise in water. Tap water conducts electricity due to the presence of these ions. Distilled water is a covalent compound containing very few ions and almost does not conduct electricity.

Q.23. Name a metal which offers higher resistance to the passage of electricity rather than copper.

Ans :- Aluminium.

Q.24. What is meant by the statement, "The potential difference between two points in an electric field is ivolt"?

Ans :- 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 brining a positive charge of one coulomb from one point to another.

Q.25. An electric fan is connected to 220v supply and draws a current of 0.5A. What is the power rating of the fan?

Ans :- Here V = 220 volt

I = 0.5 A

P = ?

We have, P = VI

= 220x0.5 w

= 110w

Q.26. Calculate the energy transferred by 5A current flowing through a resistor of 2 Ω for 30 minutes.

Ans :- Here I = 5A

R = 2 Ω

t = 30 minutes

= 60x30 sec.

= 1800 seconds

∴ Required energy transferred = I^2Rt

= $5^2x2x1800$

= 25x2x1800

= 90,000 J

Q.27. A radio set of 60w runs for 50 hours. Find the electrical energy consumed in terms of units of electricity.

Ans :- Here P = 60w

$$= \frac{6}{1000} \text{ kw}$$

$$= \frac{6}{100} \text{kw}$$

t = 50 hours

∴ Energy consume = p × t

$$= \frac{6}{100} \times 50 \text{ kwh}$$

= 3 kwh

= 3 units

Q.28. In an office , two 60w bulbs remain lighted for 5 hours and three 100w bulbs for 4 hours everyday. Find the electrical energy consumed in the month of April.

Ans :- For two 60w bulbs

$$P = 2 \times 60w$$

$$= 120W = \frac{120}{1000} kw$$

$$t = 5h$$

$\therefore$ Energy consumed $= p \times t$

for one day

$$= \frac{120}{1000} \times 5 \text{ kWh}$$

$$= \frac{60}{100} kwh$$

$$= \frac{6}{10} kwh$$

$$\therefore \text{Energy consumed for 30 day} = \frac{6}{10} \times 30 \text{ kwh}$$

$$= 18\text{kwh}$$

for 100w bulbs $p = 3\times100\text{w}$

$$= 300\text{w}$$

$$= \frac{300}{1000} \text{ kw}$$

$$= \frac{3}{10} \text{ kw}$$

$$t = 4\text{h}$$

$$\therefore \text{Energy consumed for 1 day} = p \times t$$

$$= \frac{3}{10} \times 4 \text{ kwh}$$

$$= \frac{12}{10} \text{ kwh}$$

12

∴ Energy consumed for 30 day = $\frac{}{10}$ × 30 kwh

= 36 kwh

∴ Total Energy consumed for 30 day

= (18 + 36) kwh

= 54 kwh

Q.29. A house hold uses the following electric appliances :-

(i) Refrigerator of rating 400w for two hours each day.

(ii) Two electric fans of rating 80w each for twelve hours each day.

(iii) Six electric tubes of rating 18w each for 6 hours each day.

Calculate the electricity bill of the household for the month of June if the cost per unit of electric energy Rs. 300.

Ans :- Energy consumed by refrigerator for

2h = p × t

= 400w x 2h

$$= \frac{400}{1000}\ \text{kwh} \times 2\text{h}$$

$$= 0.8\ \text{kwh}$$

Energy consumed by electric fans for

$$12\text{h} = p \times t$$

$$= 80\text{w} \times 2 \times 12\text{h}$$

$$= 160\text{w} \times 12\text{h}$$

$$= \frac{160}{1000}\ \text{kw} \times 12\text{h}$$

$$= 1.92\ \text{kwh}$$

Energy consumed by electric tubes for

$$6\text{h} = p \times t$$

$$= 6 \times 18\text{w} \times 6\text{h}$$

$$= 180\text{w} \times 6\text{h}$$

$$= \frac{180}{1000}\ \text{kw} \times 6\text{h}$$

100

= 0.648 kwh

Total Energy consumed in the month of june

= (0.8 + 1.92 + 0.648) kwh × 30

= 6.568 × 30 kwh

= 197.04 kwh

= 197.04 units

Electricity bill for the months of june

= 197.04 × Rs.3

= Rs. 591.12

= Rs. 591

Q.30. A torch bulb is rated 2.5v and 750mA. Calculate

(i) Its power.

(ii) Its resistance. and

(iii) The energy consumed its this bulb is lighted for four hours.

Ans :- Here V = 2.5 volt

$$I = 750\ mA$$

$$= 750 \times 10^{-3} A$$

(i) power $(P) = VI$

$$= 2.5 \times 750 \times 10^{-3}$$

$$= 1875 \times 10^{-3}$$

$$= 1.875w$$

(ii) Resistance $(R) = \frac{v}{I}$

$$= \frac{2.5}{759 \times 10^{-3}}\ \Omega$$

$$= 3.3\ \Omega$$

(iii) Energy consume of

$$E = p \times t$$

$$= 1.875w \times 4th$$

$$= 1.875\ J/s \times 4 \times 60 \times 60\ Sec$$

$$= 26000\ J$$

Q.31. How much current will an electric heater draw from a 220 volt line if the resistance of the heater (when hot) is 50 ohm?

Ans :- Here $v = 220$ volt

$R = 50\ \Omega$

$I = ?$

We have $I = \frac{v}{R}$

$= \frac{220}{50}$ A

$= 4.4$ A

Q.32. What is the resistance (hot) of an electric arc lamp if the lamp uses 20A when connected to a 220 volt line?

Ans :- Hare $I = 20A$

$V = 220$ volt

$R = ?$

We have, $R = \frac{v}{\quad}$

I

$$= \frac{220}{20}\ \Omega$$

$$= 11\ \Omega$$

Q.33. A resistance of 40 ohms has a current of IA following through it. Find the potential difference across its ends.

Ans :- Here, R = 40 Ω

I = 1A

v = ?

We have v = 1R

= 1 x 40 volt

= 40 volt

Q.34. One billion (10^9) electrons pass from a point P towards another point Q in 10^{-3} sec. What is the current in ampere? What is its direction?

Ans :-Here n = 10^9

e = 1.6×10^{-19}C

$t = 10^{-3}$ sec

$\therefore$ total charge $Q = ne$

$= 10^{9} \times 1.6 \times 10^{-19} C$

$= 1.6 \times 10^{-10} C$

$$\therefore \text{Current } I = \frac{Q}{t}$$

$$= \frac{1.6 \times 10^{-10}}{10^{-3}} A$$

$= 1.6 \times 10^{-7} A$

The direction of current is from Q to P.

Q.35. Calculate the current in a wire if a charge of 1500 coulomb flows through it in t minutes.

Ans :- Here $Q = 1500$ c

$t = 5$ min

$= 5 \times 60$ sec

$= 300$ sec

$I = ?$

We have,

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

$$= \frac{1500}{300} \text{ A}$$

$$= 5 \text{ A}$$

Q.36. Calculate the charge passing through a lamp in 2 minutes if the current is 300 milliampere.

Ans :- Here, $t = 2 \text{ min}$

$= 2 \times 60 \text{ sec}$

$= 120 \text{ sec}$

$I = 300 \text{ mA}$

$= 300 \times 10^{-3} \text{A}$

$Q = ?$

We have, $Q = I \times t$

$= 300 \times 10^{-3} \times 120 \text{ C}$

$= 36000 \times 10^{-3} \text{ C}$

= 36C

Q.37. A conductor carries a current of 0.4A. Find the amount of charge that will pass through the cross-section of the conductor in 1.5 minute. How many electrons will flow in this time interval. Given charge on an electron = 1.6×10^{-19}C

Ans :- Here I = 0.4A

Q = ?

t = 1.5 min.

= 1.5 x 60 sec

= 90 sec.

We have, Q = I × t

= 0.4 x 90 c

= 36 c

2nd part :-

n = ?

Q = 36 c

e = 1.6×10^{-19} c

We have,

$$n = \frac{Q}{e}$$

$$= \frac{36}{1.6 \times 10^{-19}}$$

$$= 22.5 \times 10^{19}$$

$$= 2.25 \times 10^{20} \text{ electrons}$$

Q.38. Two metallic wires A and B are connected in parallel wire A has length l and radius r, wire B has a length 2 l and radius 2r. Compute the ratio of the total resistance of parallel combination and the resistance of wire A.

Ans :- As $R_A = P \frac{l}{A} \quad p \frac{1}{\pi r^2}$

and $R_B = P = \frac{2\,l}{\pi(2r)^2}$

$$= p \frac{1}{2\pi r^2}$$

The resistance R_p of the parallel combination is given by

$$\frac{1}{R_p} = \frac{1}{R_A} + \frac{1}{R_B}$$

$$= \frac{\pi r^2}{pl} + \frac{2\pi r^2}{pl}$$

$$= \frac{3\pi r^2}{pl}$$

$$\therefore \quad R_p = \frac{pl}{3\pi r^2}$$

$$\therefore \quad \frac{R_p}{R_A} = \frac{pl}{3\pi r^2} \times \frac{\pi r^2}{pl}$$

$$= \frac{1}{3}$$

$$= 1:3$$

Q.39. If four resistance each of value 1 Ω are connected in parallel, what will be the combined resistance.

Ans :- Here $R_1 = R_2 = R_3 = R_4 = 1\ \Omega$

$$\text{Now,} \quad \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

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

$$= 1 + 1 + 1 + 1$$

$$= 4\ \Omega$$

$$\therefore \quad R_p = \frac{1}{4}\ \Omega$$

$$= 0.25\ \Omega$$

Q.40. A circuit consists of 1 Ω wire connected in series with a parallel arrangement of 6 Ω and 3 Ω wires. Calculate the total resistance of the circuit.

Ans :- Here $R_1 = 1\ \Omega$

$R_2 = 6\ \Omega$

$R_3 = 3\ \Omega$

$$\frac{1}{} \quad \frac{1}{} \quad \frac{1}{}$$

Now, $\frac{1}{R_p} = \frac{1}{R_2} + \frac{1}{R_3}$

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

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

$$= \frac{3}{6}$$

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

$\therefore \quad R_p = 2\ \Omega$

Now Total resistance $= R_1 + R_p$

$= 1 + 2$

$= 3\ \Omega$

Multiple choice questions

Q.1. The unit of charge is

(a) Ampere.

(b) Coulomb.

(c) Farad.

(d) Volt.

Ans :- (b) Coulomb.

Q.2. The SI unit of electric current is

(a) Ohm.

(b) Volt.

(c) Ampere.

(d) Coulomb.

Ans :- (c) Ampere.

Q.3. Volt is the SI unit of

(a) Potential difference.

(b) Current.

(c) Resistance.

(d) Charge.

Ans :- (a) Potential difference.

Q.4. Number of electron is IC charge is

(a) 1.6×10^{-19}

(b) 6.023×10^{23}

(c) 6.25×10^{18}

(d) 6×10^{24}

Ans :- (c) 6.25×10^{18}

Q.5. Filament of electric bulb is made of

(a) Copper.

(b) Silver.

(c) Tin.

(d) Tungsten.

Ans :- (d) Tungsten.

Q.6. Power p in terms of potential difference v and resistance R is :-

(a) v^2/R

(b) v/R

(c) v/R^2

(d) v^2/R

Ans :- (a) v^2/R

Q.7. The resistances R_1 and R_2 are connected in parallel. The equivalent resistance of the combination is

(a) $R_1 + R_2$

(b) $R_1 - R_2$

(c) $\dfrac{R_1 R_2}{R_1 + R_2}$

(d) $\dfrac{R_1 + R_2}{R_1 R_2}$

Ans :- (c) $\dfrac{R_1 R_2}{R_1 + R_2}$

Q.8. The device used for measuring current is

(a) Galvanometer.

(b) Ammeter.

(c) Voltmeter.

(d) Potentiometer.

Ans :- (b) Ammeter.

Q.9. Walt is the unit of

(a) Electric current.

(b) Electric energy.

(c) Electric power.

(d) Potential difference.

Ans :- (c) Electric power.

Q.10. Household electric appliances are connected in

(a) Series.

(b) Parallel.

(c) Neither parallel nor series.

(d) Both.

Ans :- (b) Parallel.

Q.11. Electric power is given by

$$(a)\ p = \frac{V}{I}$$

$$(b)\ p = \frac{I}{V}$$

$$(c)\ p = \frac{I}{VI}$$

(d) p = VI

Ans :- (d) p = VI

Q.12. Kilowatt hour is the unit of

(a) Electric power.

(b) Electric resistance.

(c) Electric potential.

(d) Electric energy.

Ans :- (d) Electric energy.

Q. Fill in the blanks :-

(i) SI unit of resistivity is ----------.

(ii) Charge passing per unit time is called ----------.

(iii) Resistance is measured in ----------.

(iv) SI unit of conductivity is ----------.

Ans :- (i) Ohm.m.

(ii) Current.

(iii) Ohm.

(iv) Chemical, electric.

(v) $Ohm^{-1}\ m^{-1}$