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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 on daily life; Heating effect of Electric current, electric Power, Interrelation between P, V, and R.

**Formulae Handbook for Class 10 Maths and Science**

**Page 200**

What does an electric circuit mean?
Electric circuit is a continuous and closed path made of conducting wires, through which the electric current flows. It comprises a cell, ammeter, voltmeter, plug key, etc.

**Define the unit of current.**
SI unit of electric current is ampere (A).
Ampere is the flow of electric charges through an area at the rate of one coulomb per second, i.e. if 1 coulomb of electric charge flows through a cross-section of wire for 1 second, then it would be equal to 1 ampere.

So, \(1 \text{ ampere} = \frac{1 \text{ Coulomb}}{1 \text{ Second}}, \text{i.e.}\ 1 \text{ A} = 1 \text{ C s}^{-1}\)

**Calculate the number of electrons constituting one coulomb of charge.**
Given \(q = 1 \text{ C}, e = 1.6 \times 10^{-19} \text{ C}, n = ?, q = ne\)
\[1 \text{ C} = n \times 1.6 \times 10^{-19} \text{ C}\]
\[n = \frac{1}{(1.6 \times 10^{-19})} = 6.25 \times 10^{18} \text{ electrons}\]

**Page 202**

**Question 1:**
Name a device that helps to maintain a potential difference across a conductor.
**Answer:**
Cell or battery eliminator.

**Question 2:**
What is meant by saying that the potential difference between two points is 1 V?

**Answer:**
As we know that \( V = \frac{W}{q} \)
Thus, the potential difference between two points is one volt when one joule of work is done to carry a charge of one coulomb between the two points in the electric field.

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**Question 3:**
How much energy is given to one coulomb of charge passing through a 6 V battery?

**Answer:**
\[
q = 1 \text{ C}; \quad V = 6 \text{ V},
\]
\[
V = \frac{W}{q}
\]
\[
\Rightarrow \quad W = q \times V
\]

So, Work done = \( 1 \text{ C} \times 6 \text{ V} = 6 \text{ J} \)

As, Energy = Work done
\[
\Rightarrow \quad \text{Energy} = 6 \text{ J}
\]

**Page 209**

**Question 1:**
On what factors does the resistance of a conductor depend?

**Answer:**
Resistance of a conductor depends upon:
(i) Resistivity of the material.
(ii) Length of the conductor.
(iii) Cross-sectional area of the conductor.

**Question 2:**
Will current flow more easily through a thick wire or thin wire of the same material when connected to the same source? Why?
Answer:
The current flows more easily through a thick wire than through a thin wire because the resistance of thick wire is less than that of a thin wire as $R \propto \frac{1}{A}$.

Question 3:
Let the resistance of an electrical component remains constant while the potential difference across the two ends of the component decreases to half of its former value. What change will occur in the current through it?
Answer:
As we know that

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

if

$$V' = \frac{V}{2}$$

$$\Rightarrow I' = \frac{V'}{R} = \frac{V}{2R} = \frac{I}{2}$$

Hence, the current through an electrical component also becomes half of its previous value.

Question 4:
Why are the coils of electric toasters and electric irons made of an alloy rather than a pure metal?
Answer:
The coils of electric toaster and electric iron are made of an alloy rather than a pure metal because of the following reasons;
(i) The resistivity of an alloy is higher than that of a pure metal.
(ii) It has high melting point and does not oxidise.

Question 5:
Use the data in Table 12.2 of NCERT book to answer the following:
(a) Which among iron and mercury is a better conductor?
(b) Which material is the best conductor?

Answer:
(a) Iron because its resistivity is less than mercury.
(b) Silver is the best conductor as it has least resistivity.

Page 213

Question 1:
Draw a schematic diagram of a circuit consisting of a battery of three cells of $2\text{ V}$ each, a $5\ \Omega$ resistor, a $8\ \Omega$ resistor and a $12\ \Omega$ resistor and a plug key, all connected in series.
Question 2:
Redraw the circuit of the above question, putting in an ammeter to measure the current through the resistors and a voltmeter to measure the voltage across the $12 \, \Omega$ resistor. What would be the reading in the ammeter and the voltmeter?

Answer:

Total resistance of the circuit $R$
Since all the three resistors are connected in series, so, the equivalent resistance $R$ is equal to the sum of all resistance.
$R = 5 \, \Omega + 8 \, \Omega + 12 \, \Omega = 25 \, \Omega$

$V = 2 \, V + 2 \, V + 2 \, V = 6 \, V$

$V = IR$

$\Rightarrow I = \frac{V}{R} = \frac{6}{25} = 0.24 \, A$

The reading of voltmeter across $R' = 12 \, \Omega$ is

$V' = IR'$

$= 0.24 \times 12 = 2.88 \, V$

Page 216

Question 1:
Judge the equivalent resistance when the following are connected in parallel.
(a) $1 \, \Omega$ and $10^6 \, \Omega$
(b) $1 \, \Omega$, $10^3 \, \Omega$ and $10^6 \, \Omega$

Answer:
Equivalent resistance in parallel combination of resistors is always less than the least resistance of any resistor in the circuit. Hence, in both the given cases, the equivalent resistance is less than 1 Ω.

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

**Answer:**
\[ R_1 = 100 \, \text{Ω}, \, R_2 = 50 \, \text{Ω}, \, R_3 = 500 \, \text{Ω} \]

All the appliances are connected in parallel, so
\[
\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \\
\frac{1}{R} = \frac{1}{100} + \frac{1}{50} + \frac{1}{500} = \frac{5 + 10 + 1}{500} = \frac{16}{500} \\
R = \frac{500}{16} = \frac{125}{4} \, \text{Ω} \\
\]

Current through all the appliances
\[
I = \frac{V}{R} = \frac{220}{\frac{125}{4}} = \frac{220 \times 4}{125} = 7.04 \, \text{A} \\
\]

Now if only electric iron is connected to the same source such that it takes as much current as all three appliances, i.e. \( I = 7.04 \, \text{A} \), its resistance should be equal to \( \frac{125}{4} \, \text{Ω} \), i.e. 31.25 Ω.

**Question 3:**
What are the advantages of connecting electrical devices in parallel with the battery instead of connecting them in series?

**Answer:**
Advantages of connecting electrical devices in parallel:
(i) When the appliances are connected in parallel with the battery, each appliance gets the same potential difference as that-of battery which is not possible in series connection.
(ii) Each appliance has different resistances and requires different currents to operate properly. This is possible only in parallel connection, as in series connection, same current flows through all devices, irrespective of their resistances.
(iii) If one appliance fails to work, other will continue to work properly.

**Question 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?

**Answer:**
(a) In order to get 4 Ω, resistance 2 Ω should be connected in series with the parallel
Question 5:
What is (a) the highest (b) the lowest total resistance that can be secured by combination of four coils of resistances 4 \( \Omega \), 8 \( \Omega \), 12 \( \Omega \), 24 \( \Omega \)?

Answer:
(a) The highest resistance is secured by combining all four coils of resistance in series.
\[
R_s = 4 \, \Omega + 8 \, \Omega + 12 \, \Omega + 24 \, \Omega = 48 \, \Omega
\]
(b) The lowest resistance is secured by combining all four coils of resistance in parallel.
\[
\frac{1}{R_p} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24} = \frac{6 + 3 + 2 + 1}{24} = \frac{12}{24}
\]
\[
R_p = 2 \, \Omega
\]
The cord of an electric heater is made up of metallic wire such as copper or aluminum which has low resistance while the heating element is made up of an alloy which has more resistance than its constituent metals. Also, heat produced H is

\[ H = I^2Rt \]

Thus, for the same current H \( \propto \) R, so for more resistance, more heat is produced by heating element and it glows.

**Question 2:**
Compute the heat generated while transferring 96000 C of charge in one hour through a potential difference of 50 V.

**Answer:**
Given \( q = 96000 \, \text{C}, \, V = 50 \, \text{V}, \, t = 1 \, \text{h} \)

\[ H = I^2Rt = VI \]

\[ = \frac{Vq}{t} \]

\[ = 50 \times 96000 = 48 \times 10^5 \, \text{J} \]

**Question 3:**
An electric iron of resistance 20 \( \Omega \) takes a current of 5 A. Calculate the heat developed in 30 s.

**Answer:**
Given \( R = 20 \, \Omega, \, I = 5 \, \text{A}, \, t = 30 \, \text{s} \)

\[ H = I^2Rt = (5)^2 \times 20 \times 30 = 15000 \, \text{J} = 1.5 \times 10^4 \, \text{J} \]

**Page 220**

**Question 1:**
What determines the rate at which energy is delivered by a current?

**Answer:**
Electric power determines the rate at which energy is delivered by a current.

**Question 2:**
An electric motor takes 5 A from a 220 V line. Determine the power of the motor and the energy consumed in 2 h.

**Answer:**
Given \( I = 5 \, \text{A}, \, V = 220 \, \text{V}, \, t = 2 \, \text{h} \)

\[ p = VI = 220 \times 5 = 1100 \, \text{W} \]

\[ \text{Energy consumed} = VIt = Pt \]

\[ = 1100 \times 2 = 2200 \, \text{Wh} \]

**TEXTBOOK QUESTIONS**

**Question 1:**
A piece of 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’, then the ratio R/R’ is
Answer:

(d) On cutting, there will be 5 equal resistors of \( \frac{R}{5} \) Ω each. When they are connected in parallel the equivalent value will be

\[
\frac{1}{R'} = \frac{1}{R/5} + \frac{1}{R/5} + \frac{1}{R/5} + \frac{1}{R/5} + \frac{1}{R/5} = \frac{25}{R}
\]

i.e., \( R' = \frac{R}{25} \) Ω.

\[ \Rightarrow \frac{R}{R'} = \frac{R}{R/25} = 25. \]

Question 2:
Which of the following terms does not represent electrical power in a circuit?
(a) \( I^2R \)
(b) \( IR^2 \)
(c) \( VI \)
(d) \( V^2/R \)

Answer:
(b) \( P = V^2/R = I^2R = VI \) Option (b) does not represent electrical power.

Question 3:
An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, the power consumed will be
(a) 100 W
(b) 75 W
(c) 50 W
(d) 25 W

Answer:

(d) \( R \) of bulb = \( \frac{V^2}{P} = \frac{220^2}{100} \).

\[ \therefore \text{Power consumed at 110 V} = \frac{110^2}{R} = \frac{110^2}{220^2} \times 100 = 25 \text{ W}. \]

Question 4:
Two conducting wires of same material and of equal lengths and diameters are first connected in series and then parallel in a circuit across the same potential difference. The ratio of heat produced in series and parallel combinations would be
(a) 1:2
(b) 2:1
(c) 1:4
(d) 4:1
Answer:

(e) Resistors are equal. So, power in series \( (P_s) = \frac{V^2}{2R} \)

\[
\text{Power in parallel (} P_p \text{)} = \frac{V^2}{(R/2)} = \frac{2V^2}{R} \text{. So, } P_s : P_p = \frac{1}{2} : 2 = 1 : 4.
\]

Question 5:
How is a voltmeter connected in the circuit to measure the potential difference between two points?
Answer:
A voltmeter is connected in parallel across any two points in a circuit to measure the potential difference between them with its +ve terminal to the point at higher potential and -ve terminal to the point at lower potential of the source.

Question 6:
A copper wire has a diameter 0.5 mm and resistivity of \( 1.6 \times 10^{-8} \) Ωm. What will be the length of this wire to make its resistance 10 Ω? How much does the resistance change if the diameter is doubled?
Answer:
\[ d = 0.5 \text{ mm}, \quad r = \frac{0.5}{2} \times 10^{-3} \text{ m}, \]

\[ \rho = 1.6 \times 10^{-8} \Omega \text{ m}, \quad R = 10 \Omega \]

Using \[ R = \frac{\rho l}{A}, \]

we get

\[
\begin{align*}
    l &= \frac{R\pi r^2}{\rho} \\
    &= \frac{10 \times 3.14 \times (0.5 \times 10^{-3})^2}{1.6 \times 10^{-8}} \\
    &= 122.6 \text{ m} \approx 123 \text{ m.}
\end{align*}
\]

If the diameter is doubled, radius of copper wire is also doubled.

\[
\therefore \quad \frac{A_1}{A_2} = \frac{\pi r^2}{\pi (2r)^2} = \frac{1}{4}
\]

So,

\[
\frac{A_1}{A_1} = 4A_1
\]

For the same length and same material wire, \( R \propto \frac{1}{A} \)

we get,

\[
\begin{align*}
    \frac{R_2}{R_1} &= \frac{A_1}{A_2} \\
    &= \frac{A_1}{4A_1} = \frac{1}{4}
\end{align*}
\]

\[
\therefore \quad R_2 = \frac{1}{4} R_1
\]

Hence, the resistance becomes one-fourth of the original one.

**Question 7:**

The values of the current \( I \) flowing in a given resistor for the corresponding values of potential difference \( V \) across the resistor are given below:

<table>
<thead>
<tr>
<th>( I ) (amperes)</th>
<th>0.5</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V ) (volts)</td>
<td>1.6</td>
<td>3.4</td>
<td>6.7</td>
<td>10.2</td>
<td>13.2</td>
</tr>
</tbody>
</table>

Plot a graph between \( V \) and \( I \) and calculate the resistance of that resistor.
Answer:

The slope of $V$-$I$ graph is resistance.

So, resistance, \[ R = \frac{\text{Change in } V}{\text{Change in } I} = \frac{\Delta V}{\Delta I} = \frac{BC}{AC} \]

\[ = \frac{13.2 - 1.6}{4 - 0.5} = \frac{11.6}{3.5} = 3.314 \Omega. \]

**Question 8:**
When a 12 V 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.

**Answer:**

\[ V = IR \Rightarrow R = \frac{V}{I} \]

\[ \Rightarrow R = \frac{12}{0.25 \times 10^{-3}} = 4800 \Omega = 4.8 \text{ k}\Omega. \]

**Question 9:**
A battery of 9 V is connected in series with resistors of 0.2 Ω, 0.3 Ω, 0.4 Ω, 0.5 Ω and 12 Ω, respectively. How much current would flow through the 12 Ω resistor?

**Answer:**

Since all the resistors are in series, the same current, 0.67 A flows through the 12 Ω resistor.

\[ R_s = 0.2 + 0.3 + 0.4 + 0.5 + 12 = 13.4 \Omega, \quad V = 9 \text{ V}, \]

Current drawn, \[ I = \frac{V}{R} = \frac{9}{13.4} = 0.67 \text{ A}. \]

**Question 10:**
How many 176 Ω resistors (in parallel) are required to carry 5 A on a 220 V line?
Answer:

When $N$ resistors each $R \, \Omega$ are connected in parallel, then

$$R_p = \frac{R}{N}.$$  

Current drawn from cell, $I = \frac{V}{R_p} = \frac{VN}{R}$

$$\therefore \quad N = \frac{IR}{V} = \frac{5 \times 176}{220} = 4.$$  

**Question 11:**

Show how you would connect three resistors, each of resistance $6 \, \Omega$, so that the combination has a resistance of (i) $9 \, \Omega$, (it) $4 \, \Omega$.

**Answer:**

(i) When two $6 \, \Omega$ resistances are in parallel and the third is in combination to this, the equivalent resistance will be $9 \, \Omega$.

(ii) When two $6 \, \Omega$ resistances are in series and the third is in parallel to them, then it will be $4 \, \Omega$.

**Question 12:**

Several electric bulbs designed to be used on a $220 \, \text{V}$ electric supply line, are rated 10 W. How many lamps can be connected in parallel with each other across the two wires of $220 \, \text{V}$ line if the maximum allowable current is 5 A?

**Answer:**

Since, $N$ bulbs of power $P$ each connected in parallel will make the total power of $NP$,

Current drawn, $I = \frac{NP}{V}$

$$\therefore \quad I = 5 = \frac{N \times 10}{220}$$

$$\therefore \quad N = \frac{5 \times 220}{10} = 110$$

**Question 13:**

A hot plate of an electric oven connected to $220 \, \text{V}$ line has two resistance coils A and B, each of $24 \, \Omega$ resistance, which may be used separately, in series, or in parallel. What are the currents in the three cases?
Answer:
When used individually,
\[ I = \frac{220}{24} = 9.16 \, \text{A in both of them}. \]

When used in series, \( R_s = 24 + 24 = 48 \, \Omega \),
\[ \Rightarrow \quad I_s = \frac{220}{48} \, \text{A} = 4.58 \, \text{A} \]

When used in parallel,
\[ R_p = \frac{24 \times 24}{48} = 12 \, \Omega \]
\[ \Rightarrow \quad I_p = \frac{220}{12} \, \text{A} = 18.3 \, \text{A}. \]

Question 14:
Compare the power used in the 2 \( \Omega \) resistor in each of the following circuits.
(i) a 6 V battery in series with 1 \( \Omega \) and 2 \( \Omega \) resistors, and
(ii) a 4 V battery in parallel with 12 \( \Omega \) and 2 \( \Omega \) resistors.
Answer:
(i) \( I = \frac{6}{1+2} = 2 \, \text{A}. \)
Since current flowing is same in both resistors, power used in 2 \( \Omega \) resistor
\[ (P_1) = I^2R = (2)^2 \times 2 = 8 \, \text{W}. \]

(ii) Since both 12 \( \Omega \) and 2 \( \Omega \) are in parallel to the 4 V source, voltage across each resistor remain same.
\[ \therefore \text{Power used in 2 \( \Omega \) resistor} \]
\[ (P_2) = \frac{V^2}{R} = \frac{4^2}{2} = \frac{16}{2} = 8 \, \text{W}. \]
Comparing between the power used in both cases \( \frac{P_1}{P_2} = \frac{8 \, \text{W}}{8 \, \text{W}} = 1. \)

Question 15:
Two lamps, one rated 100 W at 220 V, and the other 60 W at 220 V, are connected in parallel to electric mains supply. What current is drawn from the line if the supply voltage is 220 V?
Answer:

\[ R_{100} = \frac{220^2}{100}, \quad R_{60} = \frac{220^2}{60}. \]

Current drawn by 100 W bulb = \[ \frac{220}{R_{100}} = \frac{100}{220} \text{ A} = 0.45 \text{ A}. \]

Current drawn by 60 W bulb = \[ \frac{220}{R_{60}} = \frac{60}{220} \text{ A} = 0.27 \text{ A}. \]

Total current drawn from the line = 0.45 A + 0.27 A = 0.72 A.

**Question 16:**
Which uses more energy, a 250 W TV set in 1 hr, or a 1200 W toaster in 10 minutes?

**Answer:**
Energy consumed by 250 W TV set in 1 h = 250 x 1 = 250 Wh.
Energy consumed by 1200 W toaster in 10 min = 1200 x 1/6 = 200 Wh.
\[ \therefore \text{Energy consumed by TV set is more than the energy consumed by toaster in the given timings.} \]

**Question 17:**
An electric heater of resistance 8 \( \Omega \) draws 15 A from the service mains 2 hours. Calculate the rate at which heat is developed in the heater.

**Answer:**
\[ R = 8 \Omega, \quad I = 15 \text{ A}, \quad t = 2h \]

Rate of heat developed = \[ \frac{H}{t} = \frac{I^2Rt}{t} \]
\[ = 15^2 \times 8 = 225 \times 8 = 1800 \text{ Js}^{-1}. \]

**Question 18:**
Explain the following.
(a) Why is the tungsten used almost exclusively for filament 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 a pure metal?
(c) Why is the series arrangement not used for domestic circuits?
(d) How does the resistance of a wire vary with its area of cross-section?
(e) Why are copper and aluminum wires usually employed for electricity transmission?

**Answer:**
(a) It has high melting point and emits light at a high temperature.
(b) It has more resistivity and less temperature coefficient of resistance.
(c) (i) All appliances do not get same potential in series arrangement.
(ii) All appliances cannot be individually operated.
(d) \( R \propto \frac{1}{\text{Area of cross-section}} \).
(e) They are very good conductors of electricity.

**Short Answer Type Questions**
Question 1:
Three 2 Ω resistors, A, B and C are connected as shown in figure. Each of them dissipates energy and can withstand a maximum power of 18 W without melting. Find the maximum current that can flow through the three resistors.

Answer:

Here, \( P = 18 \text{ W} \)

Since \( A \) is in series with the parallel combination of \( B \) and \( C \). So, it carries maximum current.

Using \( P = I^2R \), we get

\[ I^2 = \frac{P}{R} = \frac{18}{2} = 9 \]

\[ I = 3 \text{ A.} \]

Let \( I_B \) and \( I_C \) be the current flowing through \( B \) and \( C \) respectively. As they are in parallel, potential difference across them will be same, so

\[ I_B R_B = I_C R_C \]

or

\[ \frac{I_B}{I_C} = \frac{R_C}{R_B} = \frac{2}{2} = 1 \]

\[ I_B = I_C \]

But

\[ I_B + I_C = I = 3 \text{ A} \]

\[ 2I_B = 3 \]

or

\[ I_B = \frac{3}{2} = 1.5 \text{ A} \]

And

\[ I_C = I_B = 1.5 \text{ A}. \]

Question 2:
Should the resistance of an ammeter be low or high? Give reason.

Answer:
The resistance of an ammeter should be low so that it will not disturb the magnitude of current flowing through the circuit when connected in series in a circuit.

Question 3:
How does use of a fuse wire protect electrical appliances?

Answer:
The fuse wire is always connected in series with the live wire or electrical devices. If the flow of current exceeds the specified preset value due to some reason, the heat produced melts it and disconnects the circuit or the device from the mains. In this way, fuse wire protects the electrical appliances.

Question 4:
What is electrical resistivity? In a series electrical circuit comprising a resistor made up of a
metallic wire, the ammeter reads 5 A. The reading of the ammeter decreases to half when the length of the wire is doubled. Why?

**Answer:**
The resistance offered by a metallic wire of unit length and unit cross-sectional area is called electrical resistivity.

We know that

\[ R = \rho \frac{l}{A} \quad \text{and} \quad V = IR \]

So,

\[ R \propto l \quad \text{and} \quad I \propto \frac{1}{R}, \quad (V \text{ is constant}) \]

Hence, when the length of wire is doubled, the resistance becomes double and current decreases to half.

**Question 5:**
A current of 1 ampere flows in a series circuit containing an electric lamp and a conductor of 5 Ω when connected to a 10 V battery. Calculate the resistance of the electric lamp.

Now if a resistance of 10 Ω is connected in parallel with this series combination, what change (if any) in current flowing through 5 Ω conductor and potential difference across the lamp will take place? Give reason.

**Answer:**
Given: In series circuit containing lamp and resistor, 
\[ I = 1 \text{ A}, \quad R_L = ? \quad R_C = 5 \text{ } \Omega, \quad V = 10 \text{ V}. \]

Using Ohm’s law
\[ V = IR \]
\[ V = I(R_L + R_C) \]
\[ \Rightarrow \]
\[ 10 = I(R_L + 5) \]
\[ \Rightarrow \]
\[ R_L = 5 \text{ } \Omega \]

So, resistance of an electrical lamp is 5 \text{ } \Omega.

According to the given condition, circuit can be redrawn as shown.

\[
\begin{align*}
\frac{1}{R_p} &= \frac{1}{R_2} + \frac{1}{R_3} \\
&= \frac{1}{R_2} + \frac{1}{R_L + R_C} \\
&= \frac{1}{10} + \frac{1}{5} = \frac{1}{10} + \frac{1}{5} = \frac{1}{5}
\end{align*}
\]

\[ R_p = 5 \text{ } \Omega \]

Current drawn from the battery
\[ I = \frac{V}{R} = \frac{10}{5} = 2 \text{ A} \]

As in parallel combination, potential difference across them remains same. So
\[ I_1R_{AB} = I_2R_{CD} \]
\[ \Rightarrow \]
\[ \frac{I_1}{I_2} = \frac{R_{CD}}{R_{AB}} = \frac{10}{10} = 1 \]
\[ \Rightarrow \]
\[ I_1 = I_2 \]

i.e., current is divided in both the arms equally. So,
\[ I_1 = I_2 = 1 \text{ A} \]

Hence, there will be no change in the current through 5 \text{ } \Omega conductor.

Also there will be no change in the potential difference across the lamp as in both cases, current through the lamp remains same i.e. 1 A.

**Question 6:**
Why is parallel arrangement used in domestic wiring?
Answer:
Parallel arrangement is used in domestic wiring because
(i) Each appliance gets the same voltage as that of the mains supply.
(ii) If one component is switched off, others can work properly.
(iii) Fault in any branch of the circuit can be easily identified.

Question 7:
B₁, B₂ and B₃ are three identical bulbs connected as shown in figure. When all the three bulbs
glow, a current of 3A is recorded by the ammeter A.

(i) What happens to the glow of the other two bulbs when the bulb B₁ gets fused?
(ii) What happens to the reading of A₁, A₂, A₃ and A when the bulb B₂ gets fused?
(iii) How much power is dissipated in the circuit when all the three bulbs glow together?

Answer:
(i) Since B₁, B₂ and B₃ are in parallel, the potential difference across each of them will remain same. So when the bulb B₁ gets fused, B₂ and B₃ have the same potential and continues with the same energy dissipated per second, i.e. they will glow continuously as they were glowing before.
Long Answer Type Questions

Question 8:

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.

(ii) Resistance of the parallel combination when all the three bulbs are glowing

\[
\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R}
\]

\[R_p = \frac{R}{3}\]

Ammeter 'A' reads 3 A current

So,

\[V = IR_p\]

\[4.5 = 3 \times \frac{R}{3}\]

\[R = 4.5 \, \Omega\]

So, resistance of each bulb = 4.5 Ω.

Now when bulb \(B_2\) gets fused, the equivalent resistance of parallel combination of \(B_1\) and \(B_3\) is

As \[\frac{1}{R_{p'}} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R}\] (Bulbs are identical)

\[R_{p'} = \frac{R}{2}\]

\[\therefore\] Ammeter 'A' reads now, \[I' = \frac{V}{R'}\]

\[I' = \frac{4.5}{R/2}\]

\[= \frac{4.5 \times 2}{4.5} = 2 \, \text{A.}\]

Since resistance of each arm is same and p.d. is also same, current divides them equally. So 1 A current will pass through each bulb \(B_1\) and \(B_3\).

Therefore, ammeter \(A_1\) and \(A_3\) reads 1 A current while \(A_2\) will read zero and ammeter \(A\) read 2 A current.

(iii) In parallel, total power consumed

\[P_{eq} = P_1 + P_2 + P_3\]

So, when all the three bulbs glow together

\[P_{eq} = P + P + P\] (As \(P_1 = P_2 = P_3 = P\))

\[= 3P = 3 \times V \times I\]

\[= 3 \times 4.5 \times 1 = 13.5 \, \text{W. (Current through each bulb = 1 A)}\]
(a) Will the bulb in the two circuits glow with the same brightness? Justify your answer.
(b) Now let one bulb in both the circuits get fused. Will the rest of the bulbs continue to glow in each circuit? Give reason.

**Answer:**

For three identical bulbs,

In series, \( R_S = 3R \)

In parallel, \( R_p = \frac{R}{3} \).

(a) The bulbs in the two circuits will not glow equally bright as the current through them is not the same.

In series, \( I_S = \frac{V}{R_S} = \frac{V}{3R} \)

In parallel, \( I_p = \frac{V}{R_p} = \frac{3V}{R} \)

So, \( I_p > I_S \).

(b) As one bulb fuses, the other bulbs in the series circuit will not glow because the circuit becomes an open circuit. While the rest of bulbs in parallel circuit will continue to glow without getting disturbed because in parallel combination, current gets additional paths to flow.

**Question 9:**
Find out the following in the electric circuit given in figure:

![Electric Circuit Diagram]

**Answer:**

(a) Effective resistance, the two 8 \( \Omega \) resistors in parallel,

\[
R_p = \frac{8 \times 8}{8 + 8} = 4 \ \Omega
\]

(b) \( R_{eq} = 4 + R_p = 8 \ \Omega \)

So current through 4 \( \Omega \) = \( I = \frac{V}{R} = \frac{8}{8} = 1 \ \Lambda \)

(c) Potential difference across resistance 4 \( \Omega \) = \( V_1 = IR = 1 \times 4 = 4 \ \text{V} \)

(d) Power dissipated = \( I^2R = 1^2 \times 4 = 4 \ \text{W} \)

(e) No difference, since the ammeters are connected in series and same current will pass through them, so reading of both ammeters will be same.

**Multiple Choice Questions (MCQs) [1 Mark each]**

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**NCERT Solutions for Class 10 Science**
Question 1.
To determine the equivalent resistance of two resistors when connected in series, a student arranged the circuit components as shown in the diagram. But he did not succeed to achieve the objective. [CCE 2010]

![Circuit Diagram]

Which of the following mistakes has been committed by him in setting up the circuit?
(a) Position of ammeter is incorrect
(b) Position of voltmeter is incorrect
(c) Terminals of ammeter are wrongly connected
(d) Terminals of voltmeter are wrongly connected

Answer:
(c) Because positive terminal of ammeter must be connected with positive terminal of cell and negative terminal of an ammeter must be connected to negative terminal of a cell.

Question 2.
For the given circuit, name the components which are connected in parallel. [CCE 2011]

![Circuit Diagram]

(a) R_1 and R_2
(b) R_1, R_2 and V
(c) R_2 and V
(d) R_1 and V

Answer:
(b) The components R_1, R_2 and V are connected in parallel combination. Because terminals of the resistance and voltmeter are connected together.

Question 3.
A student arranges the following circuit to get equivalent resistance of a series combination of two resistors R_1 and R_2.

![Circuit Diagram]
Which one of the following statements will be true for this circuit? [CCE 2007]
(a) It gives incorrect reading for current I as well as potential difference V
(b) It gives correct reading for current I but incorrect reading for potential difference V
(c) It gives correct reading for potential difference V but incorrect reading for current I
(d) It gives correct reading for both I and V
Answer:
(b) The voltmeter should be connected across the components of and R₂ to give correct reading for potential difference.

Question 4.
An ammeter has 20 divisions between 0 mark and 2A mark on its scale. The least count of ammeter is
(a) 0.01A
(b) 0.2A
(c) 0.1A
(d) 1A
Answer:
(c) Number of divisions = 20
Maximum reading of ammeter = 2 A
Least count of ammeter = 2/20 = 1/10 = 0.1 A

Question 5.
A student finds that there are 20 divisions between zero mark and 1V mark of a voltmeter. The least count of voltmeter is
(a) 0.1 V
(b) 0.01 V
(c) 0.05 V
(d) 1.0 V
Answer:
(c) Number of divisions = 20
Maximum reading of the voltmeter = 1 V
Least count of voltmeter = 1/20 = 0.05 V

Question 6.
The current flowing through a resistor connected in an electric circuit and the potential difference applied across its ends are shown in figure alongside.

The value of the resistance of the resistor is [CCE2013]
(a) 1 Ω
(b) 5 Ω
(c) 8 Ω
(d) 10 Ω
Question 7.
Which of the following is the correct method to connect the ammeter and voltmeter with resistance in the circuit to verify Ohm's law? [CCE 2012]
(a) Ammeter and voltmeter in series
(b) Ammeter in series and voltmeter in parallel
(c) Ammeter in parallel and voltmeter in series
(d) Ammeter and voltmeter in parallel
Answer:
(b) In a circuit, ammeter should be connected in series, while voltmeter in parallel.

Question 8.
In an experiment on studying the dependence of the current I flowing through a given resistor on the potential difference V applied across it, a student has to change the value of the current. For doing this, he should change the
(a) number of cells used
(b) resistor itself
(c) ammeter used in the circuit
(d) Voltmeter used in the circuit
Answer:
(a) If we change the number of cells in electric circuit, the potential difference will change and as a result current flowing in the circuit changes.

Question 9.
A milliammeter had graduations marked 0, 100, 200, 300, 400 and 500. The space between 0 mark and 100 mark is divided into 20 divisions. If the pointer of the milliammeter is indicating the seventh graduation after 300 mark, the current flowing in the circuit is
(a) 335 mA
(b) 330 mA
(c) 331 mA
(d) 340 mA
Answer:
(a) Number of divisions = 20
Least count of milliammeter = (100-0) / 20 = 5 mA
Milliammeter reading = 300 + 7 x 5 = 335 mA

Question 10.
If a student while studying the dependence of current on the potential difference keeps the circuit closed for a long time to measure the current and potential difference, then
(a) ammeter's zero error will change
(b) ammeter will give more reading
(c) voltmeter will show constantly higher readings
(d) resistor will get heated up and its value will change
Answer:
(d) If the circuit is closed for a long time, then current flows in it for a long time which results that the resistor is heated.
Question 11.
To determine the equivalent resistance of two resistors connected in series, a student prepared two electric circuits, correct reading of ammeter in the circuits is [CCE 2015]

![Circuit Diagram](image)

(a) In circuit I, 1.0 A and in II, 0.1 A  
(b) In both circuits I and II, 1.0 A  
(c) In circuit I, 0.1 A and in II, 1.0 A  
(d) In both circuits I and II, 0.1 A

**Answer:**  
(b) Equivalent resistance of two resistors 3.5Ω and 1Ω in both the circuits I and II is \( R = 3.5 + 1 = 4.5 \, \Omega \)  
As, \( I = \frac{V}{R} = \frac{4.5}{4.5} = 1 \, A \)  
Therefore, current in both the circuits I and II is 1.0 A.

Question 12.
When parallel resistors are of three different values, the potential difference across its terminals is [CCE 2015]

(a) greatest across smallest resistance  
(b) greatest across largest resistance  
(c) equal across each resistance  
(d) least across the smallest resistance

**Answer:**  
(c) Potential difference across each resistor is same in parallel combination of resistors.

Hope given NCERT Solutions for Class 10 Science Chapter 12 helpful to you.

If you have any doubts, please comment below. We try to provide online math tutoring for you.