Electricity

Multiple Choice Questions

Question 1.
A cell, a resistor, a key and ammeter are arranged as shown in the circuit diagrams of Figure12.1. The current recorded in the ammeter will be

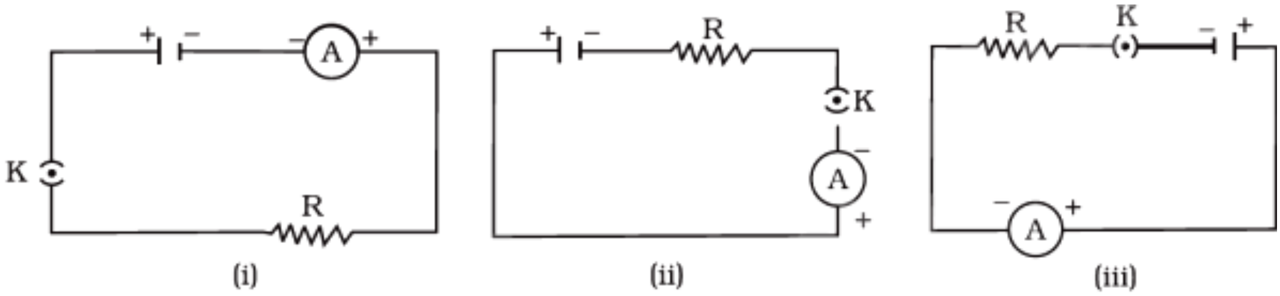


Fig. 12.1

A. maximum in (i)

B. maximum in (ii)

C. maximum in (iii)

D. the same in all the cases

Answer:
The Current will be given by: I = V/R

R is the total resistance of the circuits

Since V and R are equal in all the three circuits. So, Current will be same in all the three circuits and in series circuit current is same and only potential difference varies.

The current recorded in the ammeter will be same in all the three circuits.

Question 2.
In the following circuits (Figure 12.2), heat produced in the resistor or combination of resistors connected to a 12 V battery will be

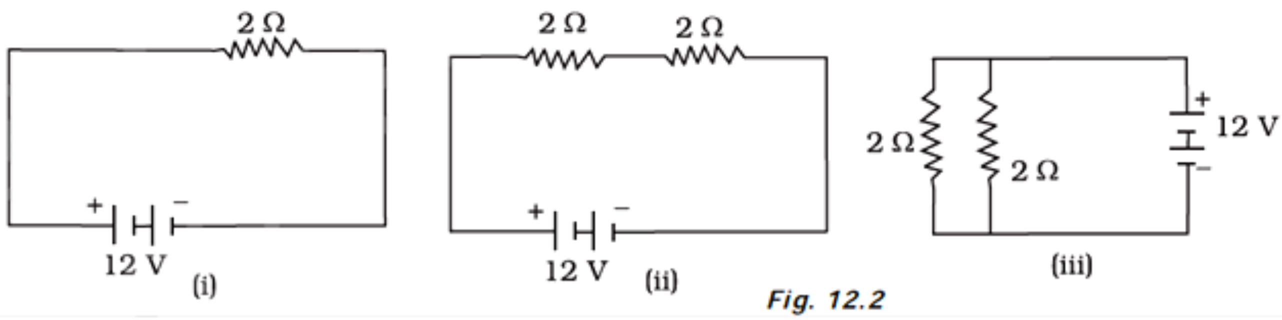


Fig. 12.2

A. same in all the cases

B. minimum in case (i)

C. maximum in case (ii)

D. maximum in case (iii)

Answer:
In figure (i), the value of net resistance R=2 Ω

In figure (ii), the value of net resistance R= 4 Ω

In figure (iii), the value of net resistance R = 1Ω

Heat is given by the formula: H = (V2× Time) /R

Since net resistance is minimum in figure (iii) and heat dissipated is inversely proportional to the resistance, so Heat dissipated will be maximum in case (iii)

Question 3.
Electrical resistivity of a given metallic wire depends upon
A. its length

B. its thickness

C. its shape

D. nature of the material

Answer:
Electrical Resistivity is given by the relation:

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

ρ is inversely proportional to the number density of free of electrons i.e. nature of the material.

Question 4.
A current of 1 A is drawn by a filament of an electric bulb. Number of electrons passing through a cross section of the filament in 16 seconds would be roughly
A. 1020

B. 1016

C. 1018

D. 1023

Answer:
Current, I= 1 A

Time, t = 16 seconds

No. of electrons, N = I×T/e

$$= \frac{1 \times 15}{1.6 \times 10^{-19}}$$

= 1020 electrons

Question 5.
Identify the circuit (Figure 12.3) in which the electrical components have been properly connected.

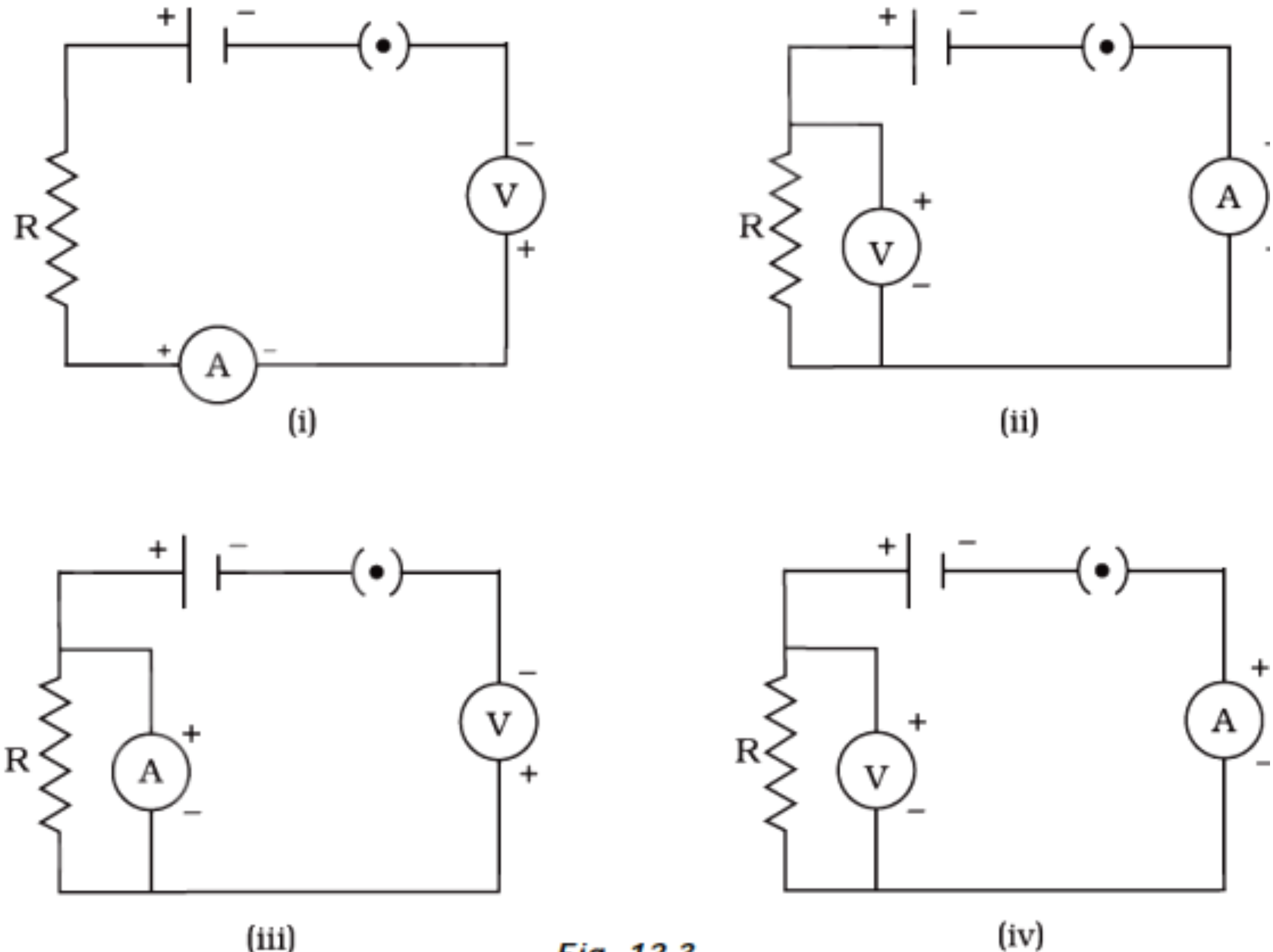


Fig. 12.3

A. (i)

B. (ii)

C. (iii)

D. (iv)

Answer:
Circuit shown in figure (ii) is properly connected. In other figures, the connections are not correct. For example: in figure (i), voltmeter is connected in series and not in parallel. Similarly in figure (iii), ammeter is in parallel which should be in series. In figure (iv), the negative terminal of battery has been connected to positive terminal of ammeter whereas it should be connected to negative terminal and not positive terminal of ammeter.

Question 6.

What is the maximum resistance which can be made using five resistors each of 1/5 Ω?
A. 1/5 Ω

B. 10 Ω

C. 5 Ω

D. 1 Ω

Answer:
When each resistor is of 1/5 Ω and when all the five resistors are connected in series, then the net resistor will be:

$R= R1+R2+R3+R4+R5$

$R = 1/5 +1/5+1/5+1/5+1/5$

$R= 1\ \Omega$

Question 7.
What is the minimum resistance which can be made using five resistors each of 1/5 Ω?
A. 1/5 Ω

B. 1/25 Ω

C. 1/10 Ω

D. 25 Ω

Answer:
When each resistor of 1/5 Ω is connected in parallel:

$1/R= 1/R1+1/R2+1/R3+1/R4+1/R5$

$1/R = 5+5+5+5+5$

1/R = 25 Ω

R = 1/25 Ω

Question 8.
The proper representation of series combination of cells (Figure 12.4) obtaining maximum potential is

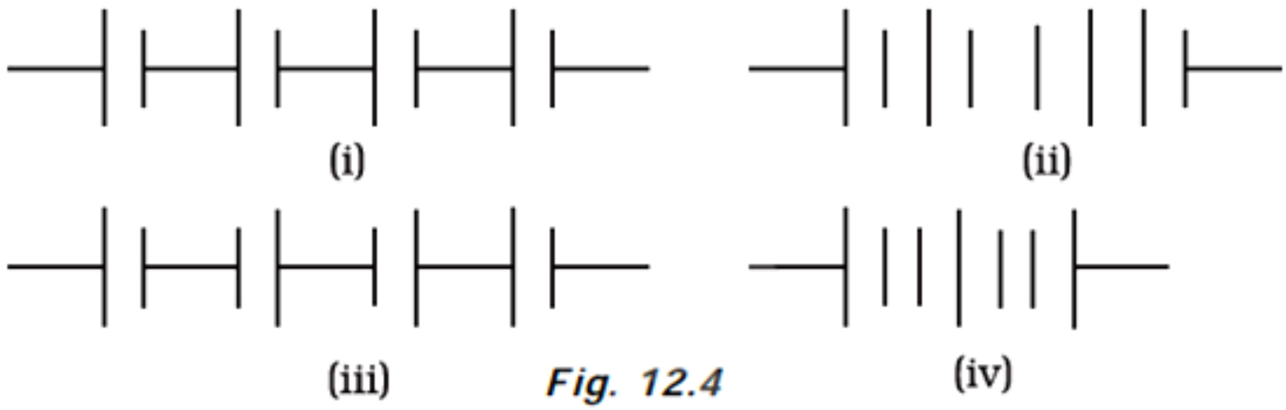


Fig. 12.4

A. (i)

B. (ii)

C. (iii)

D. (iv)

Answer:
The maximum potential in above connection will be when all are connected in series circuit. The negative terminal of cell should be connected to positive terminal and it should be continued which is correct in figure (i)

Question 9.
Which of the following represents voltage?

A. $\frac{\text{Work done}}{\text{Current} \times \text{Time}}$

B. Work done × Charge

C. Work done × Time/Current

D. Work done × Charge × Time

Answer:
Work done is given by the relation :

W= charge × potential difference

W= Q × V

As we know that Q= I × t

Therefore putting in above equation

W= I × t × V

V= Work done/ Current × time

Question 10.
A cylindrical conductor of length l and uniform area of cross section A has resistance R. Another conductor of length 2l and resistance R of the same material has area of cross section
A. A/2

B. 3A/2

C. 2A

D. 3A

Answer:
Case 1: when length is l and Area of cross section is A

Resistivity will be $\rho = \frac{RA}{l}$

Case 2: when length is 2l and resistance is R and let area is A'

Resistivity will be $\rho = \frac{RA'}{2l}$

As given in the question both conductors are of same material and has same area of cross-section, therefore, resistivity will be equal

$$\frac{RA}{l} = \frac{RA'}{2l}$$

And therefore, A'= 2A

Question 11.
A student carries out an experiment and plots the V-I graph of three samples of nichrome wire with resistances R1, R2 and R3 respectively (Figure.12.5). Which of the following is true?

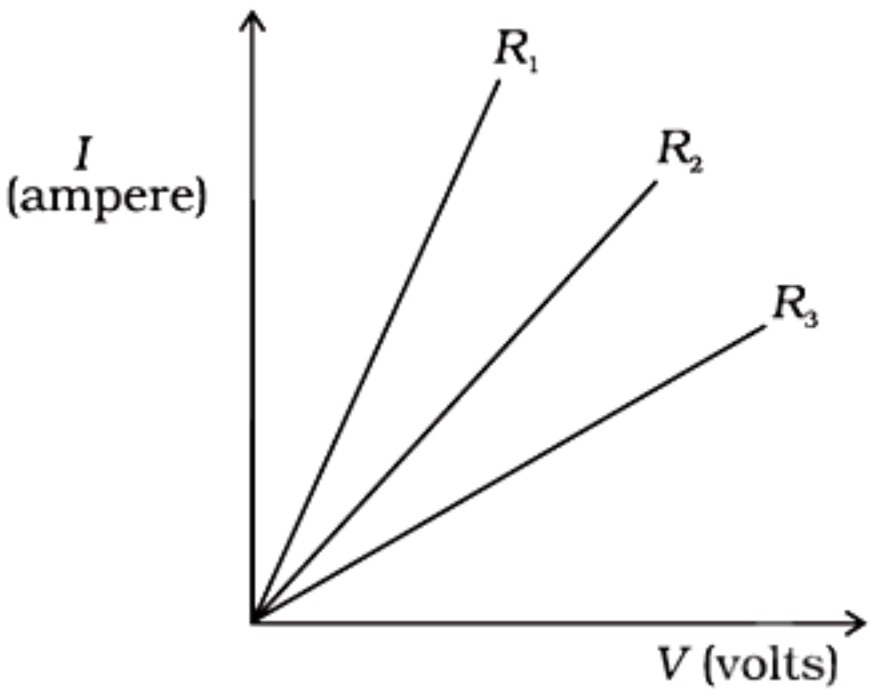


Fig. 12.5

A. R1 = R2 = R3

B. R1 > R2 > R3

C. R3 > R2 > R1

D. R2 > R3 > R1

Answer:
Since the slope of the above graph is inversely proportional to the resistance. As in the graph, slope of R1 is maximum, so resistance will be minimum. Similarly Slope of R3 is minimum, so it will have maximum resistance. So, the correct order is:

R3 > R2 > R1

Question 12.
If the current I through a resistor is increased by 100% (assume that temperature remains unchanged), the increase in power dissipated will be
A. 100 %

B. 200 %

C. 300 %

D. 400 %

Answer:
Case 1: power is given by

P1= I2R

Case 2: when current is increased by 100%

It means that current becomes doubled i.e. 2I

Power will be P2 = (2I)2R

i.e. Power = 4 I2R

Change in dissipated power = 4 I2R- I2R =3 I2R

Increase in percent of power dissipated = 3P1/P1 ×100% = 300%

Question 13.
The resistivity does not change if
A. the material is changed

B. the temperature is changed

C. the shape of the resistor is changed

D. both material and temperature are changed

Answer:
The resistivity depends on the nature of the material and temperature. It doesn't vary with the shape of the resistor.

Question 14.
In an electrical circuit three incandescent bulbs A, B and C of rating 40 W, 60 W and 100 W respectively are connected in parallel to an electric source. Which of the following is likely to happen regarding their brightness?
A. Brightness of all the bulbs will be the same

B. Brightness of bulb A will be the maximum

C. Brightness of bulb B will be more than that of A

D. Brightness of bulb C will be less than that of B

Answer:
Since bulb having high power rating will led to production of more heat as well as more light. So, Brightness of bulb B will be more than that of A

Question 15.
In an electrical circuit two resistors of 2 Ω and 4 Ω respectively are connected in series to a 6 V battery. The heat dissipated by the 4 Ω resistor in 5 s will be
A. 5 J

B. 10 J

C. 20 J

D. 30 J

Answer:
Since resistors are connected in series. So, net resistance R=

R1_+ R2

R = 2+4 = 6 Ω

Current will be calculated using ohm's law

I= V/R

= 6/6 = 1A

Heat dissipated will be given by: H= I2Rt

for 4 Ω resistor in 5 s

H = (1)2 × 4 × 5

H = 20 J

Question 16.
An electric kettle consumes 1 kW of electric power when operated at 220 V. A fuse wire of what rating must be used for it?
A. 1 A

B. 2 A

C. 4 A

D. 5 A

Answer:
Power = 1 kW

In Watt, P= 1000 W

Current is given by I = P/V

I= 1000/220

I = 4.5 A

So, A fuse wire of rating slightly greater than 4.5A must be used i.e. 5A.

Question 17.
Two resistors of resistance 2Ω and 4Ω when connected to a battery will have
A. same current flowing through them when connected in parallel

B. same current flowing through them when connected in series

C. same potential difference across them when connected in series

D. different potential difference across them when connected in Parallel

Answer:
In series circuit, current flowing through the resistors are same and has difference potential difference.

Question 18.
Unit of electric power may also be expressed as
A. volt ampere

B. kilowatt hour

C. watt second

D. joule second

Answer:
The S.I. unit of electric power is: Watt

1 Watt is given by : 1 Watt = 1 Volt × 1 Ampere

1 Watt = volt Ampere

<u>Short Answer Questions</u>

Question 1.
A child has drawn the electric circuit to study Ohm's law as shown in Figure 12.6. His teacher told that the circuit diagram needs correction. Study the circuit diagram and redraw it after making all corrections.

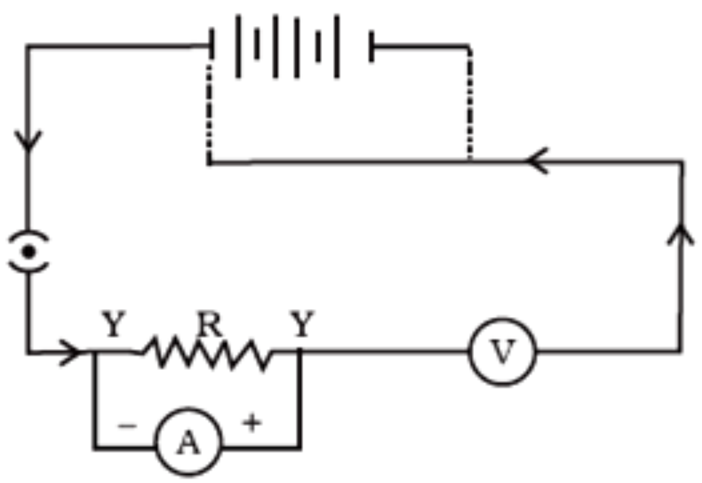
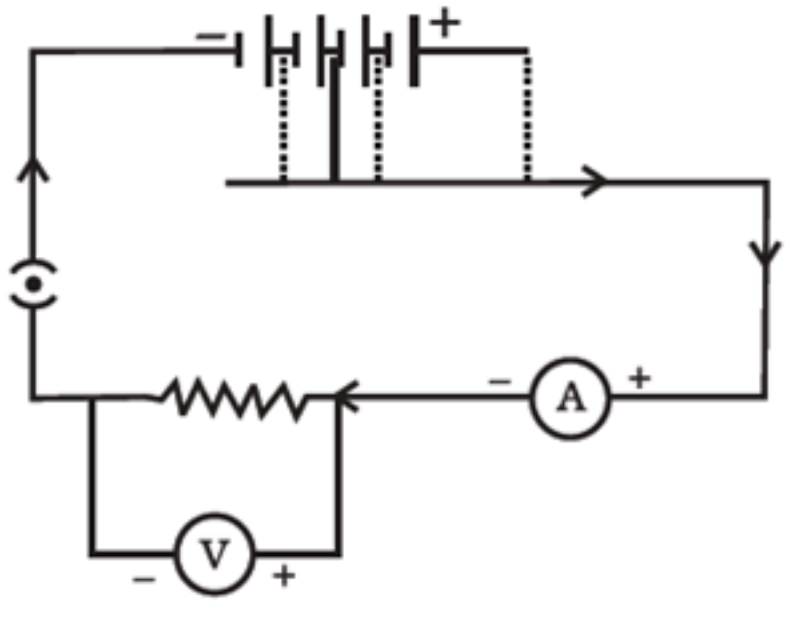


Fig. 12.6

Answer:
In the above circuit, the ammeter has been connected in parallel and the voltmeter is connected in series which is not correct. The ammeter should be connected in series and voltmeter is parallel. The correct circuit diagram will be as follows:



Question 2.
Three 2 Ω resistors, A, B and C, are connected as shown in Figure 12.7. Each of them dissipates energy and can withstand a maximum power of 18W without melting. Find the maximum current that can flow through the

three resistors?

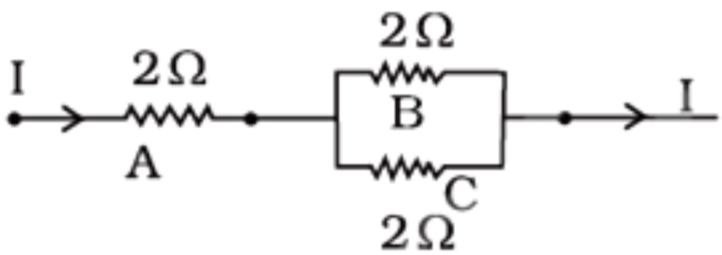


Fig. 12.7

Answer:
Resistance = 2 Ω

Power = 18W

P = I2R

I = (P/R)1/2

I = (18/2)1/2

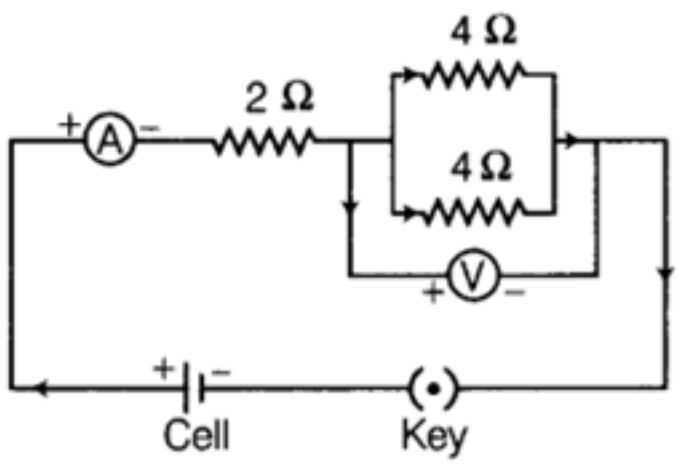
I = 3A

Question 3.
Should the resistance of an ammeter be low or high? Give reason.

Answer:
The resistance of an ammeter should be low because ammeter is connected in series in the circuit and if resistance will be high, no current will flow through the circuit.

Question 4.
Draw a circuit diagram of an electric circuit containing a cell, a key, an ammeter, a resistor of 2 Ω in series with a combination of two resistors (4 Ω each) in parallel and a voltmeter across the parallel combination. Will the potential difference across the 2 Ω resistor be the same as that across the parallel combination of 4Ω resistors? Give reason.

Answer:
Circuit diagram consisting of a cell, a key, an ammeter, a resistor of 2 Ω in series with a combination of two resistors (4 Ω each) in parallel and a voltmeter across the parallel combination is as follows:



Net resistance connected in parallel R = 2 Ω

Since resistance of 2 Ω and effective resistance of parallel combination of two 4 Ω resistances in series , same current will flow through them and therefore potential difference will be same across the 2 Ω resistor as across the parallel combination of 4 Ω resistors.

Question 5.
How does use of a fuse wire protect electrical appliances?

Answer:
An electric fuse is wire which is made of a material of high resistance and low melting point. Using an electric fuse prevents the flow of unduly high electric current and protects the appliances from the damage. Due to Joule heating, the fuse melts to break the electric circuit.

Question 6.
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:
Resistance of a uniform metallic conductor is directly proportional to the length (l) and inversely proportional to the area of cross-section.

i.e. R $\propto l$

R $\propto \frac{1}{A}$

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

ρ is constant of proportionality and is known as electrical resistivity of the material

When length of wire is doubled, the current decreases because Resistance of a uniform metallic conductor is directly proportional to the length (l) and according to Ohm's law, Resistance is inversely proportional to the current and therefore when the length of wire is increased, there is decrease in the value of current.

Question 7.
What is the commercial unit of electrical energy? Represent it in terms of joules.

Answer:
The commercial unit of electrical energy is Kilowatt hour (kWh). It can be converted into joules as follows:

1 kWh= 1000 watt $\times$ 3600 seconds

1 kWh = 3.6 $\times$ 106 watt second

1 kWh =3.6 $\times$ 106 Joule

Question 8.
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:
When 5Ω and resistance of lamp say R is connected in series:

Effective resistance R' = 5+R

Applying ohm's law:

V= IR

R = V/I = 10/1 = 10 Ω

Therefore, resistance of lamp, R= 10-5 Ω = 5 Ω

When a 10 Ω resistance is connected in parallel with the series connection

Effective resistance 1/R"= 1/10 +1/10

R" = 5 Ω

Current through the circuit I = V/R = 10/5 = 2A

So, current flowing through each circuit will be of 1 V

Potential difference across the lamp will be same because voltage is same across the circuit.

Question 9.
Why is parallel arrangement used in domestic wiring?

Answer:
If different appliances in a domestic are connected in series then if one of the appliance is switched off or stops working then the other appliances will also stop. Moreover, if they are connected in series, then then there will be different voltage for different appliances and there will be loss of voltage due to add on effects of resistances. Each appliance is connected in parallel to each other so that each appliance has an equal potential difference. That's why series arrangement is not used in domestic circuits and parallel arrangement is used in domestic wiring.

Question 10.
B1, B2 and B3 are three identical bulbs connected as shown in Figure 12.8. When all the three bulbs glow, a current of 3A is recorded by the ammeter A.

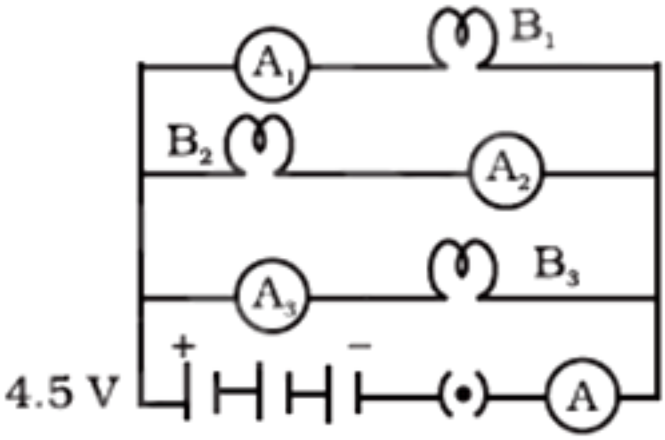


Fig. 12.8

(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) There will be no effect on glow of other two bulbs and will remain same when B1 gets fused because glowing of bulb depends on power and the potential difference and resistance remains same of other two bulbs.

(ii) When there are parallel connections:

Net resistance will be 1/R = 1/R1+1/R2+1/R3

Since resistance is same so, R' = R/3

Applying ohm's law V= IR

$R = 4.5\Omega$

Since B2 gets fused, so now only two bulbs B1 and B3 are in parallel

Therefore net resistance in parallel $1/R' = 2/R$

$R' = 4.5/2\ \Omega$

$I = V/R' = 2 \times 4.5/4.5$

$I = 2A$

So, current will be distributed in both the bulbs as 1 A each.

(iii) Power dissipated when all three bulbs glow together

$P = V \times I$

$P = 4.5 \times 3 = 13.5\ W$

Long Answer Questions

Question 1.
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 in both the circuits get fused. Will the rest of the bulbs continue to glow in each circuit? Give reason.

Answer:
(a) The bulbs which are in parallel connection will glow with more brightness than with series connection bulbs because in parallel connection, bulbs are connected with the same source. So, power in each bulb will be:

P = V2 /2R whereas in series Power through each bulb will be P= V2 /9R
Therefore, bulbs in parallel connection will glow more.

(b) If one bulb in series circuit is fused then all the bulbs in the series circuit will get fused but in cause of parallel circuit, if one bulb fused the other two fused will continue to glow because in case of series circuit, same amount of current is distributed whereas in case of parallel circuit, the current is divided among electrical gadgets and is therefore, each bulb has different value of resistance and requires different current to operate.

Question 2.
State Ohm's law? How can it be verified experimentally? Does it hold good under all conditions? Comment.

Answer:
According to Ohm's law:

The electrical current flowing through a conductor is directly proportional to the potential difference across its ends providing the temperature remains same.

$R^{\propto V}$

R= V/I

R is resistance of conductor

V is potential difference

I is current

It can be verified experimentally by following:

1. Set up an electrical circuit consisting of nichrome wire of length ×Y say 0.5m , an ammeter, a voltmeter and four cells of 1.5 V each .

2. Firstly, use one cell as source in the circuit. Note the current in the ammeter and voltmeter reading across the nichrome ×Y in the circuit.

3. Connect two cells in the circuit and note down the reading from the given circuit for the current and potential difference.

4. Repeat the same experiment for three cells and then four cells and note down the reading from Ammeter and Voltmeter.

5. Calculate the value of ratio to each pair of potential difference V and current I.

It is observed that the value of V/I is approximately same for each case and V-I graph obtained is a straight line which verifies Ohm's law.

No, it doesn't hold good under all conditions because the value of current is different for different components. Certain components offer an easy path for flow of resistance while others resists the flow.

Question 3.
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.

Answer:
Resistance of a uniform metallic conductor is directly proportional to the length (l) and inversely proportional to the area of cross-section.

i.e. R $\propto l$

R $\propto \frac{1}{A}$

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

ρ is constant of proportionality and is known as electrical resistivity of the material

S.I. unit of electrical resistivity of a material is: Ω m.

An experiment to study the factors on which the resistance of conducting wire depends can be demonstrated as follows:

1. Complete an electrical circuit which consists of a cell, an ammeter, a nichrome wire of length l.

2. Note down the reading from Ammeter.

3. Replace the nichrome wire with twice the length of earlier nichrome wire having same thickness.

4. Note down the ammeter reading in the given circuit.

5. Replace the nichrome wire with thicker nichrome wire having a large cross-section area. Note down the current through circuit.

6. Now, replace the nichrome wire with copper wire having same length and same area of cross-section.

7. Note down the value of current and observe the difference in the current in all the cases.

Following observations were noted:

1. The ammeter reading decreases to one-half when the length of wire is doubled.

2. The ammeter reading is increased when thicker wire of same material and same length is used.

3. Change in ammeter reading is observed when copper wire is used.

So, Resistance of conducting wire depends on various factors:

1. Length

2. Area of cross-section

3. Nature of material

Question 4.
How will you infer with the help of an experiment that the same current flows through every part of the circuit containing three resistances in series connected to a battery?

Answer:
The same current flows through every part of the circuit containing three resistances in series connected to a battery can be prove with the help of following experiment:

1. Connect three resistors of different values in series connection.

2. Connect the resistors with an ammeter, a plug key and a battery.

3. Let the resistors be of 1Ω, 2 Ω and 3 Ω and battery of 6V.

4. Plug the key and note down the ammeter reading.

It will be observed that the same amount of current value flows through the circuit, independent of its position in the given circuit.

Question 5.
How will you conclude that the same potential difference (voltage) exists across three resistors connected in a parallel arrangement to a battery?

Answer:
The same potential difference exists across three resistors connected in a parallel arrangement to a battery can be concluded as follows:

1. Make a parallel combination of three resistors ×Y of three resistors R1, R2 and R3. Connect the resistors with a battery, an ammeter and a plug key.

2. Connect a voltmeter in parallel with the resistors.

3. Plug the key and note the ammeter reading and also note the voltmeter reading.

4. The potential difference across each resistor is V.

5. Now, take out the plug key from the circuit. Remove the ammeter and voltmeter from the given circuit.

6. Insert the ammeter in series with the resistor R1 and note down the ammeter reading I1.

7. Similarly, note the I2 and I3 across the resistors R2 and R3.

The total current through the circuit will be given by:

$I = I_1+I_2+I_3$

Applying Ohm's law to the parallel combination of resistors

$I = V/ R_P$

For each resistor, ohm's law will be given by:

$I1 = V/ R1$; $I2 = V/ R2$; $I3 = V/ R3$

Now, $V/ RP = V/ R1+ V/ R2+ V/ R3$

$1/ RP = 1/ R1+ 1/ R2+ 1/ R3$

Hence, the same potential difference exists across three resistors connected in a parallel arrangement to a battery.

Question 6.
What is Joule's heating effect? How can it be demonstrated experimentally? List its four applications in daily life.

Answer:
If the electrical circuit is purely resistive, that is a configuration of resistors only connected to battery, the source energy continually gets dissipated in the form of heat. This is known as Joule's heating effect of electric current. Joule's law of heating is given by the relation:

$H= I2Rt$. The law implies that : heat produced in a resistor is

(i) Directly proportional to the square of current for a given resistance

(ii) Directly proportional to the resistance of given circuit.

(iii) Directly proportional to the time for which the resistance flows through the resistor.

It can be demonstrated experimentally by following:

When an electric field is applied across the ends of a conductor, the free electrons starts moving towards the electric field. These electrons suffers collision with the atoms which have lost electrons. Due to the collision, energy is transferred to the atoms and they vibrate as they gain energy due to which heat is developed in the conductor. The more is the current, the more will be heat. This is Joule's heating effect.

An electric fuse is wire which is made of a material of high resistance and low melting point. Using an electric fuse prevents the flow of unduly high electric current and protects the appliances from the damage. Due to Joule heating, the fuse melts to break the electric circuit.

The four applications in daily life are:

1. In electrical heaters.

2. In electrical iron

3. In electrical fuse wire

4. In electrical bulb

Question 7.
Find out the following in the electric circuit given in Figure 12.9
(a) Effective resistance of two 8 Ω resistors in the combination
(b) Current flowing through 4 Ω resistor
(c) Potential difference across 4 Ω resistance
(d) Power dissipated in 4 Ω resistor

(e) Difference in ammeter readings, if any.

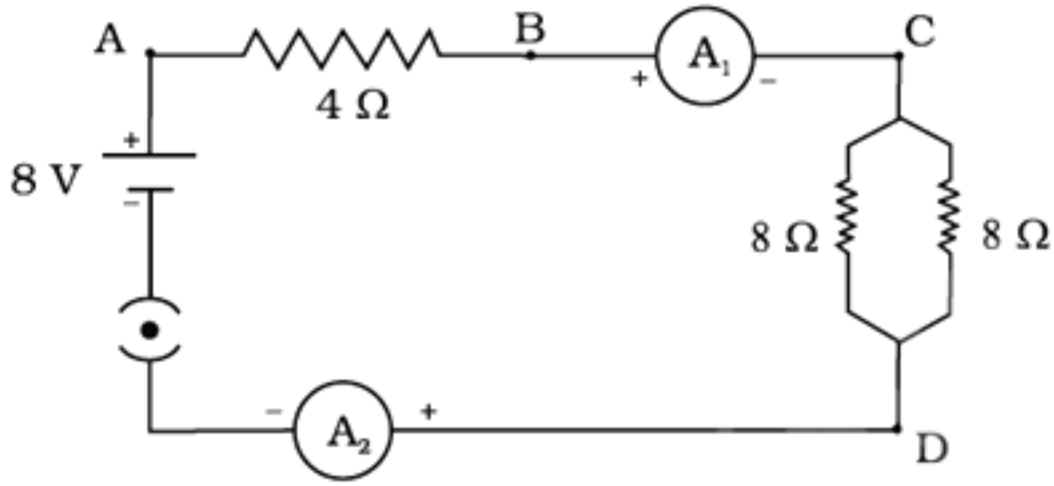


Fig. 12.9

Answer:
(i) since resistances are connected in parallel

Therefore, effective resistance 1/R' = 1/8+1/8 = 1/4

R' = 4Ω

(ii) Current can be calculated with the help of Ohm's law:

I = V/R = 8/4 = 2 A

(iii)Potential difference is given by, V= IR

V= 4 × 2 =8 Watt

(iv)Reading in ammeter A1, I = V/R = 8/4 = 2 A

Reading in ammeter A2 = 8/4

= 2 A

Difference in ammeter readings = 2- 2= 0