10. Electric Current

Exercise Questions

1. Question

If 2 ampere current is passed in conductor from a battery of volt, then what will be resistance of conductor?

A. 3 Ohm

B. 2.5 Ohm

C. 10 Ohm

D. 2 Ohm

Answer

We are given with current and voltage of battery and we have to find the resistance of conductor, so we will use Ohm's law relation which is, V = IR.

So, by putting values,

$$R = \frac{V}{I} = \frac{5}{2} = 2.5\ \Omega$$

2. Question

On which of the following resistivity depends?

A. Length of conductor

B. Area of cross section of conductor

C. Material of conductor

D. None of these

Answer

Resistance is the property which depends upon the dimensions of the conductor whereas Resistivity is the property which depends on the nature or material of conductor. Resistance can be changed by changing the dimensions of the conductor but Resistivity remains constant. Also resistivity is the constant of proportionality in the relation,

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

ADDITIONAL INFORMATION – Resistivity changes with temperature.

3. Question

Volt is unit of:

A. Current

B. Potential difference

C. Charges

D. Work

Answer

We are going to solve the question by considering the Ohm's law relation, V = IR, which is equivalent to 1volt = 1ampere × 1Ω,

So 1 volt is the potential difference across a resistor having 1Ω resistance and when 1A of current is passing through it.

4. Question

In an electric circuit three resistors of capacity 1Ω, 2Ω and 3Ω are connected in series. Their equivalent resistance will be :

A. less then 1Ω

B. less than 3Ω

C. more than 1Ω

D. more than 3Ω

Answer

When the resistors are placed in series connection then the net or total resistance can be evaluated by simply adding all the resistances in series like we add positive integer numbers.

But the total resistance will be 1Ω+2Ω+3Ω = 6Ω, which is the net resistance of the circuit.

5. Question

In India value of frequency of current is :

A. 45 Hrtz

B. 50 Hrtz

C. 55 Hrtz

D. 60 Hrtz.

Answer

In India, we use 50 Hertz because it was built and used by Britishers and in the USA the frequency is 60 Hertzthe .

6. Question

If the resistors of various values are connected in parallel in the circuit and connected with the source of current. In each resistors—

A. The value of current and the potential difference will differ.

B. The value of current and potential difference will same.

C. The value of current will differ but the potential difference will be the same.

D. The value of current will same but the potential difference will differ.

Answer

The amount of current passing through resistors in parallel combination depends upon their values but the potential difference across the resistors in parallel combination is same always and do not depend on values of resistors and is equal to the voltage of the battery.

7. Question

In any circuit 2 coulomb charge is passed for 0.5 second. The value of current in ampere will be :

A. 1 ampere

B. 4 ampere

C. 1.5 ampere

D. 10 ampere.

Answer

By applying the equation,

$$I = \frac{q}{t} = \frac{ne}{t}$$

We can calculate the amount of current passing through the circuit.

We are given with the charge flowing and the time for which it is flowing.

Putting values, we get,

$$I = \frac{2}{0.5} = 4\,A$$

8. Question

It is not device based on the heating effect of electricity :

A. Heater

B. Press

C. Toaster

D. Refrigerator

Answer

The refrigerator is used to preserve food by cooling it but it releases heat outside it in the room to lower the temperature from the inside of it and hence it gives us heat by using current.

Joule's law of heating is, $H = I^2Rt$

9. Question

What is S.I. unit of specific resistance or resistivity?

Answer

The SI unit of Resistivity(ρ) is Ωm because by considering the relation,

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

$$\rho = \frac{RA}{l} = \frac{1\Omega \times 1m^2}{1m} = \Omega m$$

We get to know that resistivity is a constant quantity and has units of resistance and length.

10. Question

Define electric current.

Answer

Electric current is the amount of charge passing per unit time through a cross-section area and has units Ampere and has direction from the positive terminal to negative terminal of the battery that is opposite to the flow of electrons. 1A is the amount of current when 1C of charge is passing through a cross-sectional area in 1 second. It is considered to be a scalar quantity.

11. Question

What is electrical potential difference?

Answer

The potential difference is the amount of work done to take a unit positive charge from one point to another point whereas Electric potential is the amount of work done to take a unit positive charge from one point to infinity or from infinity to one point. The potential difference has units Volt, where 1V is the amount of potential difference formed between two points when 1J of work is done on a charge of 1C to take it to one point from another point.

By the relation V = WQ

12. Question

What do you mean by 1 Ohm resistance?

Answer

Resistance has units of ohm(Ω), By the relation V = IR, we can say that 1ohm is the amount of resistance offered by a conductor when 1A of current is passing through it, when there is 1V of a potential difference across the conductor at a constant temperature.

13. Question

How does resistance depend up area of cross section?

Answer

By the relation of resistance and resistivity, which is,

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

Thus,

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

Resistance is inversely proportional to Area of cross-section, which means that when R increases A decreases and vice versa.

14. Question

Define resistivity.

Answer

Resistivity is the property of the material of the conductor and is independent of dimensions, the shape of the conductor; and it is also a constant of proportionality from the relation,

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

And has units ohm m or Ωm, where 1Ωm is the amount of resistivity possessed by the conductor having a resistance of 1Ω and length of 1m along

with the area of cross-section $1m^2$.

15. Question

What is electric power?

Answer

Electric Power(P) is the rate of doing work or it is the ratio of work(W) divided by the time is taken (t). The units of power are Watt or Kilowatt or Joules/second.

Hence by the relation,

$$\text{Electric Power(P)} = \frac{\text{work done(W)}}{\text{time(t)}}$$

1 watt = 1 J/s and 1 watt is the power of appliance which consumes energy at the rate of 1 J/s or 1 watt is defined as when 1 Joule of work is done on a particle in 1 second.

16. Question

100 W-220 volt is written on an electric bulb. What do you mean by it?

Answer

The rating 100 Watt and 220V mean that the bulb should be operated at 220 V for its maximum glow or brightness and the power consumed by the bulb is 100 Joules(watt) in 1 second or 0.1 kWh.

17. Question

How the electric combination of various application done in homes?

Answer

The combination of various appliances at homes is done in parallel combination because when we have to switch off one appliance in parallel we can but in series, if we switch off one appliance all appliances get switched off and also in series potential difference across each appliance will be different, so we do not want that.

18. Question

What is the difference between series combination and the parallel combination of resistors?

Answer

In series combination of resistors the current going in each resistor is same but the potential difference across each resistor is different and in parallel combination of resistors potential difference across every resistor is same but the current in each resistor is different and if we stop the supply of

current in one resistor the current in other resistors does not stop flowing in case of parallel but in case of series the current flowing in the circuit stops.

19. Question

What is electrical power? Write the essential formula for it.

Answer

Electric Power(P) is the rate of doing work or it is the ratio of work done(W) divided by the time is taken (t) or it is the rate of consumption of energy. The units of power are Watt or KiloWatt or Joules/second.

Hence the main relation of power is,

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

1 watt = 1 J/s and 1 watt is the power of appliance which consumes energy at the rate of 1 J/s or 1 watt is defined as when 1 Joule of work is done on a particle in 1 second.

Another relation of power is, $P = VI = I^2R$.

20. Question

Two resistors are made up of same material and same length. If their area of cross section ratio is 2: 11 then calculate the ratio of their resistances.

Answer

As the two resistors are made up of the same material which means their resistivity(ρ) are same, they have the same length but the are of the cross-section is different and we are given with its ratio. So we will do this question by finding the resistances and then dividing them both.

Let the area of the cross section for the two wires be 2k and 11k, so,

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

$$R_1 = \rho\frac{l}{2k}$$

$$R_2 = \rho\frac{l}{11k}$$

Now divide R_1 by R_2, we get,

$$\frac{R_1}{R_2} = \frac{\rho\frac{l}{2k}}{\rho\frac{l}{11k}} = \frac{11}{2}$$

So, therefore R_1:R_2 = 11:2 .

21. Question

Define electric potential and potential difference.

Answer

Electric potential is the amount of work done on a unit positive charge to take it from one point to infinity or from infinity to one point whereas potential difference is the amount of work done on a unit positive charge to take it from one point to another point which is at a finite distance from each other. Both have the same units that are Volts and both have same formula equation,

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

22. Question

What is the difference between alternate current generation and direct current generation?

Answer

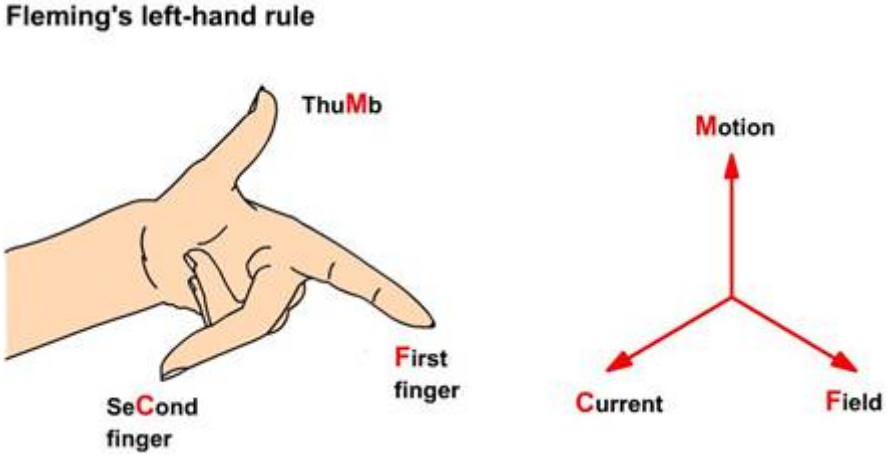
The major difference between AC and DC current generators is a DC generator has a split ring type commutator and an AC generator has two split rings and each split ring has one brush attached to it which help the coil of the generator to reverse the direction current after each half rotation.

23. Question

Write right-hand thumb rule and right-hand rule.

Answer

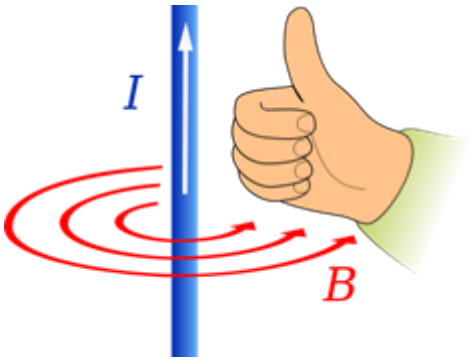
Fleming's right-hand rule: Stretch the thumb, forefinger and middle finger of the right hand so that they are mutually perpendicular to each other. **If the index finger indicates the direction of the magnetic field and the thumb shows the direction of motion of conductor, then the middle finger will show the direction of induced current**.



Right-hand screw rule: The direction of these circular magnetic lines is dependent upon the direction of the current.

When we stretch our thumb and all the four fingers are making a fist then **the direction of circular magnetic field lines are represented by the closing direction of the fingers and the direction of stretched thumb gives the direction of the current**.

The direction of the circular magnetic field lines can be given by Maxwell's right-hand grip rule or Right handed corkscrew rule.



24. Question

Calculate the joules in 1-kilowatt hour.

Answer

1 Joule = 1 Watt second, but we have to calculate the number of Joules in 1 kWh = 1 kilo Watt hour =

3600 kilo Watt second = 3600000 Watt second,

Therefore there are 3600000 Joules in 1 kWh.

Always remember kWh is the unit of energy.

25. Question

Write joules heating effect rule.

Answer

Joule's Heating effect rule is given by three statements,

I. H is directly proportional to I^2, $H \alpha I^2$.

II. H is directly proportional to R, $H \alpha R$.

III. H is directly proportional to t, $H \alpha t$.

Where H is heat generated by resistance ; R is the resistance ; I is the current through resistance ; t is the time of current passing.

W = QV

W = (It)V [Q = It by the equation of charge and current]

H = (It) × (IR) [V = IR by Ohm's law]

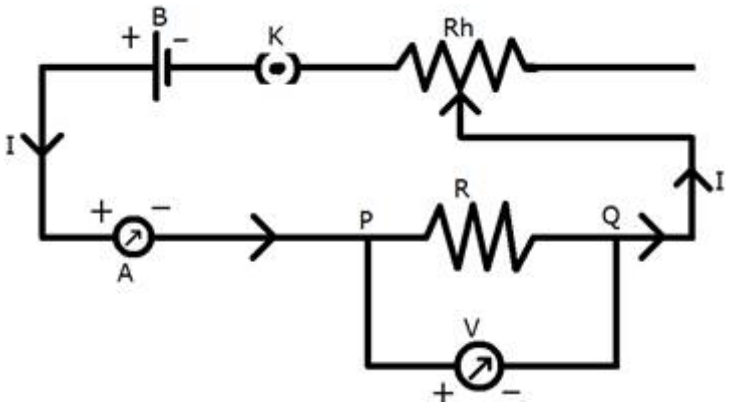
$H = I^2Rt$

26. Question

Draw a circuit diagram for the verification of Ohm's and label it.

Answer

The circuit diagram for the verification of Ohm's law is,



B – Battery

K – plug key

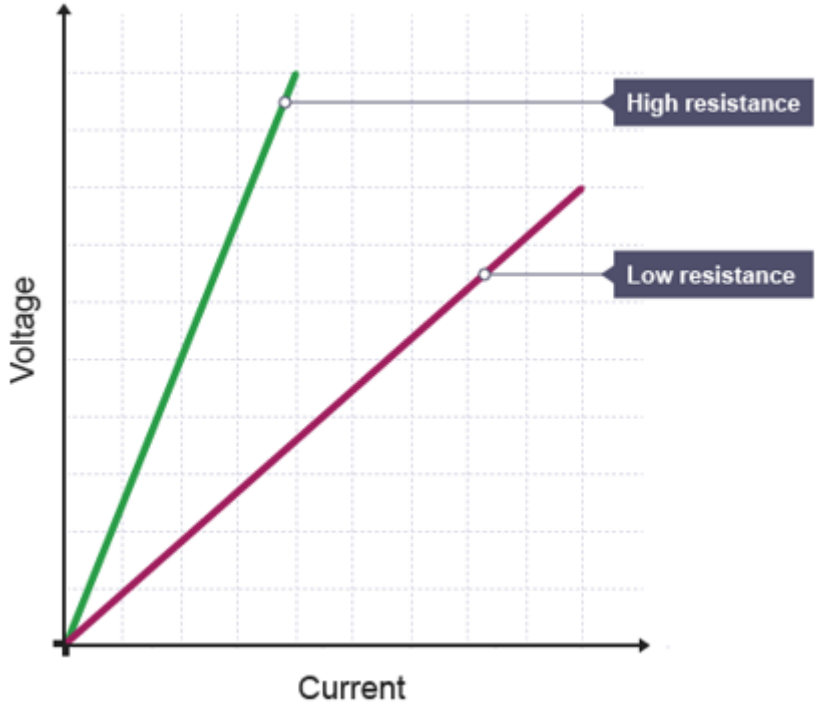
A – ammeter

V – voltmeter

R – resistance

Rh – rheostat

And there is V vs. I graph whose slope is R .

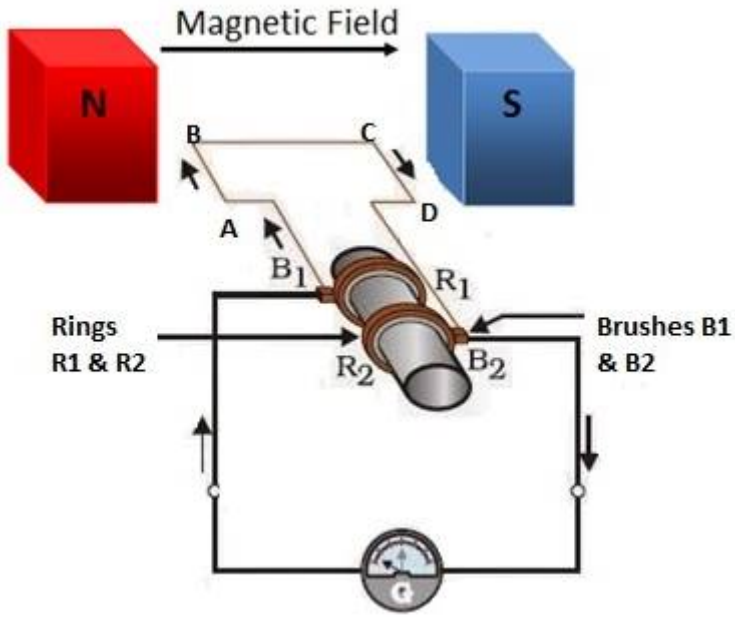


27. Question

Explain the construction and working of the alternate current generator and also draw the essential diagram.

Answer

An electric generator is a device which converts mechanical energy into electrical energy with the help of using electromagnetic induction.



CONSTRUCTION – **Parts of an AC Electric Generator are:-**

● **Insulated Copper wire**: A rectangular rotating coil of wire ABCD made of copper due to its low resistivity.

● **Magnet Poles**: A magnet as placed above that is the North Pole and the South Pole. The rectangular coil is placed between these magnets, so that it

rotates and cuts the magnetic field. The higher the magnetic field the greater the amount of induced emf is produced.

● **Split Rings**: Two disjoint C-shaped rings R1 and R2 are internally attached to the Axle.. Ends of the coil are connected to R1 and R2. The inner portion of these rings are made of non-conducting material

● **Axle**: The split rings are placed on the axle which is made to rotate freely from an external source.

● **Brushes**: The outside of the split rings are connected to conducting brushes B1 and B2. B1 and B2 are kept pressed on R1 and R2.

● **Galvanometer**: To find the presence of current, formed due to electromagnetic induction galvanometer shows deflection. The deflection changes in it after each half rotation because of change in direction of induced emf.

WORKING – **Steps:-**

● The axle is rotated in the clockwise direction that is **AB moves up and CD moves down.** In the first half rotation.

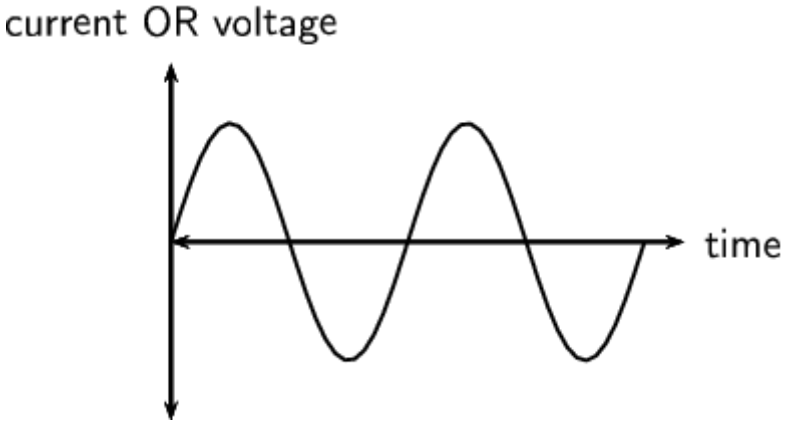
● According to **Fleming's Right-Hand rule**, the induced current is setup in the coil along B1-> AB -> BC -> CD -> B2. **This means that the external current flows from B2 to B1**. In order to complete the circuit.

● In the second half of rotation, arm **CD starts move up and AB moves down**. That is in the opposite direction of the first half.

● According to **Fleming's Right-Hand rule**, the induced current is setup in the coil along B2-> AB -> BC -> CD -> B1. **This means that the external current flows from B1 to B2.**

● Thus after every half rotation of the coil, the current changes direction due to induced e.m.f. properties. **This is called an AC current or alternating current.**

● **AC current(Alternating current)**: Changes its **direction after equal intervals of time**.



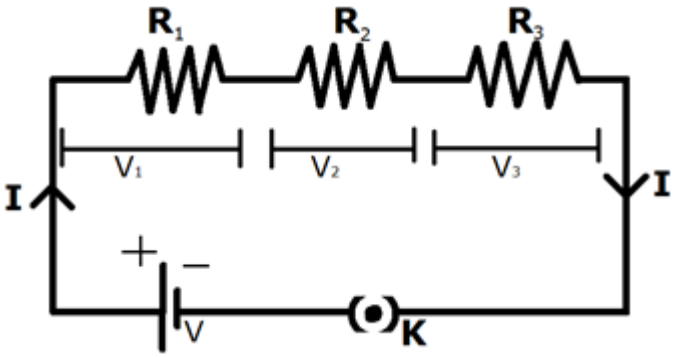
● It is easier to transmit this current over long distances due to lesser loses and hence this is the current that is supplied to our houses from the electricity department with the help of transformers.

28. Question

Draw the series combination circuit diagram derive the essential formula to calculate the equivalent resistance.

Answer

First, we will look at the circuit diagram of the resistors in series and as we know that resistors in series have the same amount of current passing through them but the potential difference across each resistor is different.



The potential difference V is equal to the sum of potential differences V_1, V_2, and V_3. That is the total potential difference across a combination of resistors in series is equal to the sum of a potential difference across the individual resistors. That is,

$V = V_1 + V_2 + V_3$

Let I be the current through the circuit as shown in the above figure.

1. The current through each resistor is I.

2. We can replace these three resistors by an equivalent single resistor of resistance R.

3. The potential difference V and current I should remain the same.

Applying the Ohm's law to the entire circuit, we have

$V = I R$

On applying Ohm's law to the three resistors separately, we further

Have

$V_1 = I R_1$

$V_2 = I R_2$

and $V_3 = I R_3$

$I\ R = I\ R_1 + I\ R_2 + I\ R_3$

or

$Rs = R_1 + R_2 + R_3$

We can conclude that when several resistors are joined in series, the

the resistance of the combination Rs equals the sum of their individual

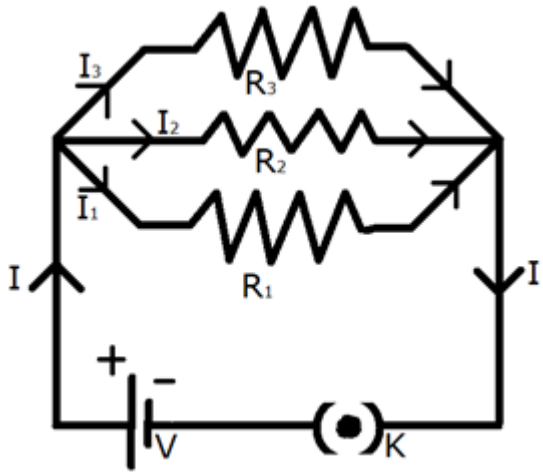
resistances, R_1, R_2, R_3, and is thus greater than any individual resistance.

29. Question

Draw the parallel combination circuit diagram and establish the essential formula to calculate equivalent resistance.

Answer

First, we will look at the circuit diagram of the resistors in parallel combination and as we know that resistors in parallel have the same amount of potential difference across them but the amount of current passing through each resistor is different.



The total current I, is equal to the sum of the

separate currents through each branch of the combination.

$I = I_1 + I_2 + I_3$

Let Rp be the equivalent resistance of the parallel combination of

resistors. By applying Ohm's law to the parallel combination of resistors, we have

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

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

$$I_1 = \frac{V}{R_1};\ I_2 = \frac{V}{R_2};\ \text{and}\ I_3 = \frac{V}{R_3}$$

we have

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

or

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

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

30. Question

Calculate the maximum and minimum resistance by combining the resistor of 1Ω, 2Ω, and 3Ω.

Answer

REMEMBER – If we make a combination of resistors in series then we will have maximum possible resistance and if we make a combination of resistors in parallel then we will have minimum possible resistance.

By using the rule mentioned above the maximum resistance will be only when these three resistors are in series which is 1+2+3 = 6, hence the maximum resistance will be 6Ω.

Now to evaluate the minimum resistance possible we have to place these resistors parallel to each other, so, applying the parallel equation to the resistors,

$$\frac{1}{R} = \frac{1}{1} + \frac{1}{2} + \frac{1}{3} = \frac{11}{6}$$

R = 6/11 Ω .

31. Question

If by passing the current of 10 milliampere in a wire a potential difference of 2.5 volt is produced across the end of wire. Calculate the resistance of wire.

Answer

Now we are given with the Potential difference(V) across a wire which is 2.5 volt, when 10mA of current(I) passes through it and we have to find the resistance of the wire,

By using Ohm's law equation, which is, **V = IR**,

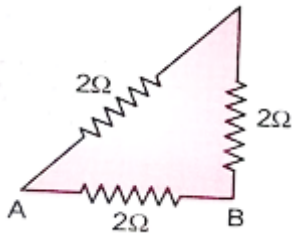
$$\mathbf{R = \frac{V}{I}}$$

Now putting values in the equation,

$$\mathbf{R = \frac{2.5}{10 \times 10^{-3}} = 2.5 \times 10^{2} = 250\,\Omega}$$

32 A. Question

Calculate the equivalent resistance between A and B in the following circuits :

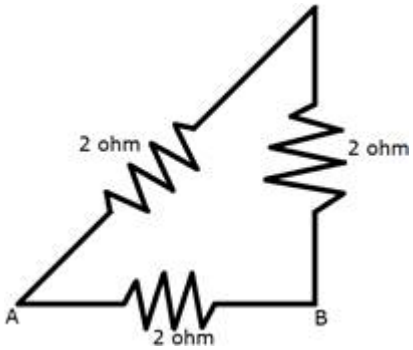


Answer

To evaluate the resistance between two points A and B which are called given points, we will do the questions by imagining that a battery is attached to these two points A and B and there is formation of complete circuit, so these two points would have potential difference(V) and hence resistors attached to these two points by both sides would be parallel to each other because of same potential difference across the ends.

Therefore we can't merge these two points, **we can't merge the other points just by looking at them blindly.**

We will solve the questions by diagram wise and not by writing for proper understanding.

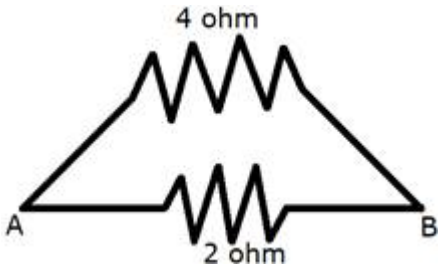


The diagram above is our question figure, Now the 2 ohm resistors other than the triangle base resistor or not including the triangle base resistor, the other two resistors are in series and hence we can add them simply to get a new resistor,

2ohm + 2ohm = 4 ohm,

Due to the change in potential difference of the top point these two resistors are in series. As we know if the potential difference is same then the resistors are parallel.

Hence our figure is resolved, which is,



Now the 4 ohm resistor and the 2 ohm resistor are in parallel as we have discussed before about the two given points which are

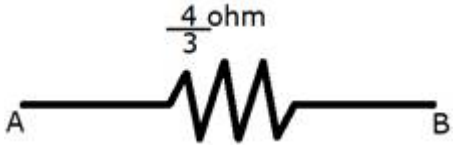
A and B.

So,

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{2} = \frac{3}{4}$$

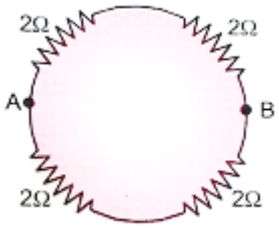
R = 4/3 ohm,

Hence our answer is 4/3 ohm and the answer is always when there is only one resistor remaining.



32 B. Question

Calculate the equivalent resistance between A and B in the following circuits :



Answer

To evaluate the resistance between two points A and B which are called given points, we will do the questions by imagining that a battery is attached to these two points A and B and there is formation of complete circuit, so these two points would have potential difference(V) and hence resistors attached to these two points by both sides would be parallel to each other because of same potential difference across the ends.

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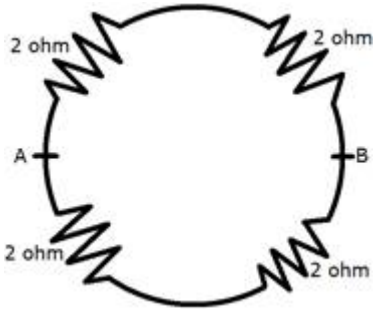
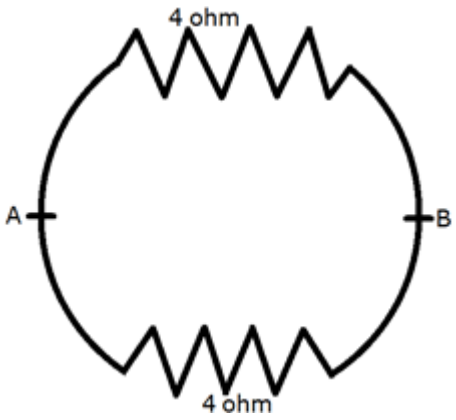


This figure is given in the question, now we do not need to get afraid and be confuse that the wires are curved or anything, make the curved wires straight if you want to make it more easy to solve.

Now the 2 ohm resistors on upper half of circle are in series to each other and the 2 ohm resistors in the lower half of circle are in series to each other, so the net resistances in both the halves is,

2ohm + 2 ohm = 4 ohm,

So our figure resolves to,



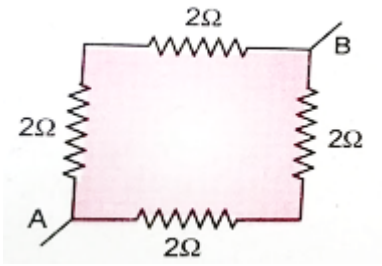
Now both the 4 ohm resistors are in parallel to each other because of the two given points between them A and B.

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$$

R = 2 ohm.

32 C. Question

Calculate the equivalent resistance between A and B in the following circuits :



Answer

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Therefore we can't merge these two points, **we can't merge the other points just by looking at them blindly.**

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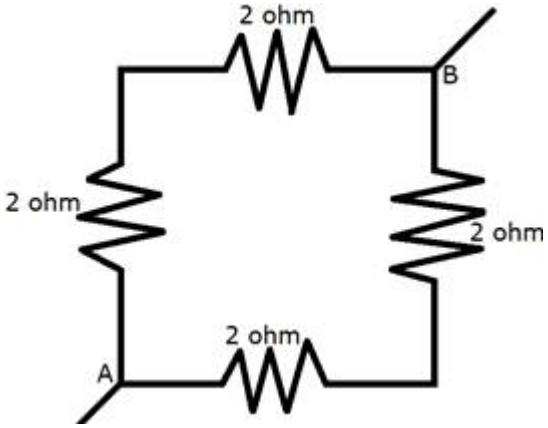
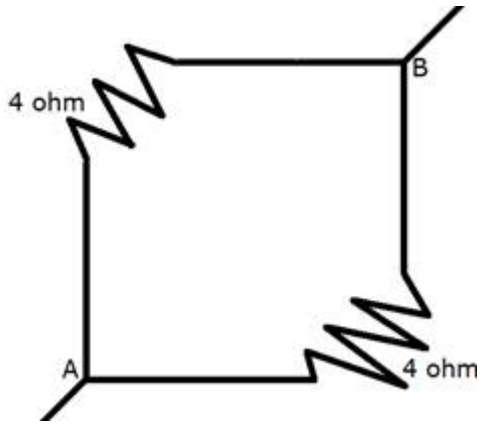


Now this is the figure given in the question, and by doing our previous questions we can see that 2 ohm resistors in upper and left directions are in series to each other and in the same way the 2 ohm resistors in the lower and right directions are in series to each other, so by solving we get,

2ohm + 2ohm = 4 ohm,

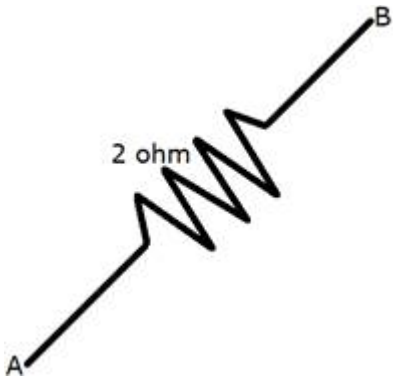
The figure gets resolved to,



Now the two 4 ohm resistors are in parallel combination to each other because of the two given points A and B, so,

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$$

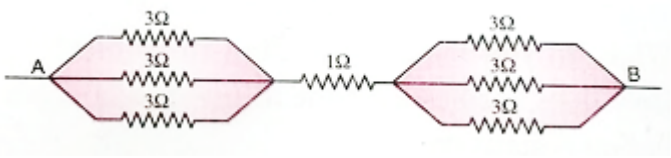
R = 2 ohm,



Which is our final figure.

32 D. Question

Calculate the equivalent resistance between A and B in the following circuits :

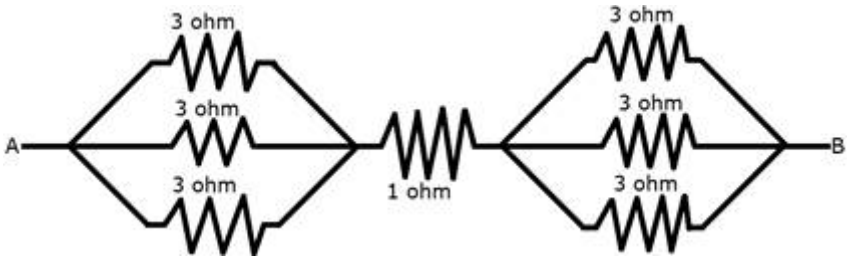


Answer

To evaluate the resistance between two points A and B which are called given points, we will do the questions by imagining that a battery is attached to these two points A and B and there is formation of complete circuit, so these two points would have potential difference(V) and hence resistors attached to these two points by both sides would be parallel to each other because of same potential difference across the ends.

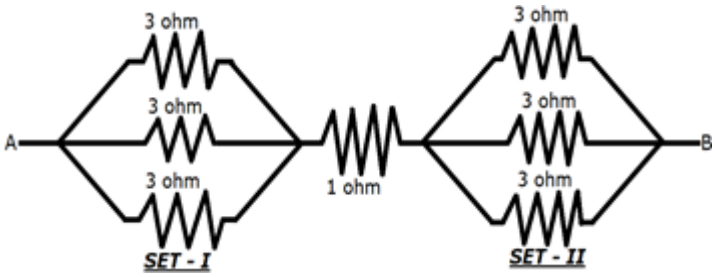
Therefore we can't merge these two points, **we can't merge the other points just by looking at them blindly.**

We will solve the questions by diagram wise and not by writing for proper understanding.



This is the figure given in the question, Now we are given with two sets in which there are three 3 ohm resistors in parallel combination to each other.

So let's first name these sets, the left set is set 1 and the right set is set 2 and the middle 1 ohm resistor is in series to these two sets.



Now let's solve these two sets first to minimize the number of resistors, so,

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

R = 1 ohm,

So our figure resolves to,

Now as we can see these three 1 ohm resistors are in series to each other, so they will get add up algebraically like simple numbers,

1ohm + 1ohm + 1ohm = 3 ohm.

Now our figure resolves to,

Which is our final figure.

33. Question

An immersion rod of 1500 watt is used 3 hour daily for heating the water. If the cost electricity is Rs 5.00 per unit, then calculate the cost of electricity consumed in 30 days.

Answer

To proceed to the question first we need to understand the meaning of 1 unit that is, 1 unit is simply equal to 1kiloWatthour or when 1000 Watt of power is consumed in 1 hour.

Now we are given with the power(P) of the immersion rod which is 1500 Watt and we are given with the time limit for each day which is 3 hours and the number of days for which the rod was used which is 30 days, so let's calculate the total time(t) in the question, which is 3 hours × 30 days = 90 hours, we have converted into hours because of units used in power above.

We are also given with the cost of 1 unit which is Rs. 5 hence expense of 1 kWh energy and we have to calculate the amount of money spend in the month for that we have to calculate the amount of energy used in kWh.

So,

Rs. 5 = 1000Watt × 1 hour = 1kwh

Therefore we have 1500 watt power, so,

1.5 × Rs. 5 = 1500 Watt × 1 hour

We also have 90 hours of using the rod, so,

90 × 1.5 × Rs. 5 = 1500 Watt × 90 hours

Therefore the amount of money spend in the month will be Rs. 675.