Question:1

By what other name is the unit joule/coulomb called?

ELECTRICITY CLASS X EXTRA QUESTIONS

Solution:

The unit joule/coulomb is called by another name, volt. Volt is the SI unit of potential difference.

Potential difference = Work done/Quantity of charge moved

Question:2

Which of the following statements correctly defines a volt?

a a volt is a joule per ampere.

b a volt is a joule per coulomb.

Solution:

b A volt is a joule per coulomb.

The potential difference between two points is said to be 1 volt if 1 joule of work is done in moving 1 coulomb of electric charge from one point to another.

1 volt = 1 joule / 1 coulomb

Question:3

a What do the letters p.d. stand for?

b Which device is used to measure p.d?

Solution:

a The acronym p.d. stands for the potential difference between two points in an electric circuit.

b Potential difference $p.d.$ is measured by a device called voltmeter.

Question:4

What is meant by saying that the electric potential at a point is 1 volt?

Solution:

When we say that the electric potential at a point is 1 volt, it means that 1 joule of work has been done in moving 1 coulomb of positive charge from infinity to that point.

Question:5

How much work is done when one coulomb charge moves against a potential difference of 1 volt?

Solution:

Charge given, $Q = 1$ C

Potential difference, $V = 1$ V

Thus, the amount of work done, *W* in moving the charge is:

$W = V \times Q$

$= 1\ \text{V} \times 1\ \text{C}$

$= 1\ \text{J}$

Question:6

What is the SI unit of potential difference?

Solution:

The SI unit of potential difference is volt and is denoted by the letter, *V*.

Question:7

How much work is done in moving a charge of 2 C across two points having a potential difference of 12 V?

Solution:

The amount of charge, *Q* that flows between two points at a potential difference, $V = 12V$ is 2 C. Therefore, the amount of work done, *W* in moving the charge is given by:

$W = V \times Q$

$= 12\ \text{V} \times 2\ \text{C}$

$= 24\ \text{J}$

Question:8

What is the unit of electric charge?

Solution:

The SI unit of electric charge is coulomb and is denoted by the letter, *C*.

Question:9

Define one coulomb charge.

Solution:

One coulomb is the quantity of electric charge which exerts a force of $9 \times 10^9 \text{N}$ on an equal charge placed at a distance of one metre from it.

Question:10

Fill in the following blanks with suitable words:

a Potential difference is measured in .... by using a .... placed in .... across a component.
b Copper is a good .... Plastic is an ....

Solution:

a Potential difference is measured in volts by using a voltmeter placed in parallel across a component.
b Copper is a good conductor. Plastic is an insulator.

Question:11

What is meant by conductors and insulators? Give two examples of conductors and two of insulators.

Solution:

The substances through which electricity can flow are called conductors. Two examples are copper and aluminium.

The substances through which electricity cannot flow are called insulators. Two examples are glass and paper.

Question:12

Which of the following are conductors and which are insulators?

Sulphur, Silver, Copper, Cotton, Aluminium, Air, Nichrome, Graphite, Paper, porcelain, Mercury, Mica, Bakelite, Polythene, Manganin.

Solution:

Conductors: silver, copper, aluminium, nichrome, graphite, manganin, mercury
Insulators: cotton, air, paper, porcelain, mica, bakelite, polythene, sulphur

Question:13

What do you understand by the term "electric potential"? $or potential$ at a point? What is the unit of electric potential?

Solution:

The electric potential $or potential$ at a point in an electric field is defined as the work done in moving a unit positive charge from infinity to that point. It is denoted by the symbol, V and its unit is volt.

Question:14

a State the relation between potential difference, work done and charge moved.
b Calculate the work done in moving a charge of 4 coulombs from a point at 220 volts to another point at 230 volts.
Solution:
a The potential difference between two points in an electric circuit is equal to the amount of work done in moving a unit charge from one point to another point.

$$\text{Potential difference}\left(\text{V}\right)=\frac{\text{Work done (W)}}{\text{Quantity of charge moved (Q)}}$$

b Here:
Potential difference, V = 230 – 220 = 10 V
Charge moved, Q = 4 C
So, using the relation V = W/Q, we have:
W = V × Q
= 10 × 4 = 40 J

Question:15
a Name a device that help to measure the potential difference across a conductor.
b How much energy is transferred by a 12 V Power supply to each coulomb of charge which it moves around a circuit?
Solution:
a The potential difference across a conductor is measured by an instrument called voltmeter.
b The term 'each coulomb' means 'every 1 coulomb'.
So, charge, *Q* = 1 C
Potential difference, *V* = 12 V
Now:
V = *W*/*Q*
12 = *W*/1
So, work done, *W* = 12 x 1 = 12 J
Since the work done on each coulomb of charge is 12 J, the energy transferred to each coulomb of charge is also 12 J.

Question:16
a What do you understand by the term "potential difference"?
b What is meant by saying that the potential difference between two points is 1 volt?
c What is the potential difference between the terminals of a battery if 250 joules of work is required to transfer 20 coulombs of charge from one terminal of battery to the other?
d What is a voltmeter? How is a voltmeter connected in the circuit to measure the potential different between two points. Explain with the help of a diagram.
e State whether a voltmeter has a high resistance of a low resistance. Give reason for your answer.

Solution:

a The potential difference between two points in an electric circuit is equal to the amount of work done in moving a unit charge from one point to another point.

$$\text{Potential difference} \left(V\right) = \frac{\text{Work done } (W)}{\text{Quantity of charge moved } (Q)}$$

The SI unit of potential difference is volt.

b The potential difference between two points is said to be one volt if one joule of work is done in moving one coulomb of electric charge from one point to the other.

Thus:

1 volt = 1 joule/1 coulomb

c Here:

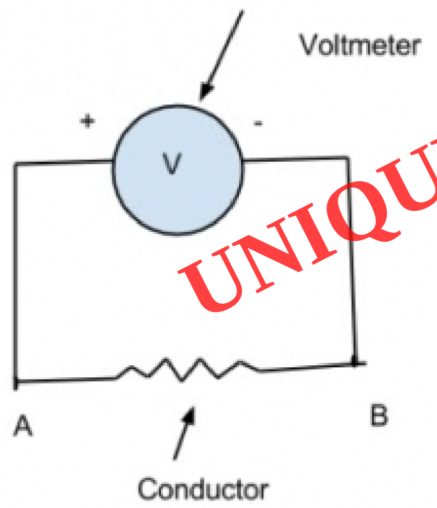
Work, W = 250 J

Charge, Q = 20 C

Using the relation, V = W/Q:

Potential difference, V = 250/20 = 12.5 V

d A voltmeter is an instrument that is used to measure the potential difference across a conductor. A voltmeter is always connected in parallel across the points where the potential difference is to be measured.



Suppose we have a conductor AB, such as a resistance wire, and we want to measure the potential difference across its ends.

So one end of the voltmeter is connected to point A and the other end to the point B. We can read the value of potential difference in volts on the dial of the voltmeter.

e A voltmeter has a high resistance so that it takes a negligible current from the circuit.

In a circuit, a voltmeter is connected in parallel across the element of whose potential difference it has to measure. Since we don't want the current diverted through the voltmeter, the voltmeter has a high internal resistance so that the circuit maintains the same current as if the voltmeter was not present.

Question:17

The work done in moving a unit charge across two points in an electric circuit is a measure of:

a current
b potential difference
c resistance
d power

Solution:

b potential difference

The work done in moving a unit charge across two points in an electric circuit is a measure of potential difference.

Question:18

The device used for measuring potential difference is known as:

a potentiometer
b ammeter
c galvanometer
d voltmeter

Solution:

d) voltmeter
It is connected in parallel across the points where the potential difference is to be measured.

Question:19

Which of the following units could be used to measure electric charge?

a ampere
b joule
c volt
d coulomb

Solution:

d coulomb
It is the SI unit of electric charge.

Question:20
The unit for measuring potential difference is:

a watt
b ohm
c volt
d kWh
Solution:
c volt
It is the SI unit of potential difference.

Question:21
One coulomb charge is equivalent to the charge contained in:

a 2.6×10^{19} electrons
b 6.2×10^{19} electrons
c 2.65×10^{18} electrons
d 6.25×10^{18} electrons
Solution:
d 6.25×10^{18} electrons
Since the charge of an electron is $1.6 \times 10^{-19} \mathrm{C}$, 6.25×10^{18} electrons taken together constitute ($6.25 \times 10^{18} \times 1.6 \times 10^{-19}$ C) or 1 coulomb of charge.

Question:22
Three 2 V cells are connected in series and used as a battery in a circuit.

a What is the p.d. at the terminals of the battery?
b How many joules of electrical energy does 1 C gain on passing through (*i*) one cell (*ii*) all three cells?
Solution:
a The potential difference across each cell is 2 V. So, the potential difference at the terminals of the battery is 3 x 2 V = 6 V.

b
i For one cell:
V = 2 V
Q = 1 C

And also:
Electrical energy gained = Work done
So using the relation, *V* = *W*/*Q* or *W* = *V* x *Q*
= 2 x 1 = 2 J
ii For three cells:
V = 6 V
Q = 1 C
So, *W* = *V* x *Q* = 6 x 1 = 6 J
So 2 joules and 6 joules of electrical energy is gained for the above two cases (*i*) one cell and (*ii*) all three cells, respectively.

Question:23
The atoms of copper contain electrons and the atoms of rubber also contain electrons. Then why does copper conduct electricity but rubber does not conduct electricity?
Solution:
In a copper atom, the electrons in the outermost orbit are lightly bound to the nucleus of the atom and so they move freely. This free flow of electrons makes copper a good conductor of electricity. In rubber, the electrons in the outermost orbits are tightly bound to the nucleus. So, they do not flow freely and hence, rubber is not a good conductor of electricity.

Question:24
a Name a device which helps to maintain potential difference across a conductor $say, abulb$.
b If a potential difference of 10 V causes a current of 2 A to flow for 1 minute, how much energy is transferred?
Solution:
a A cell or a battery helps to maintain potential difference across a conductor.
b Here:
Potential difference, *V* = 10 V
Current, *I* = 2 A
Time, *t* = 1 minute = $1x60$s = 60 s
We know that the amount of energy transferred is equal to the work done.
Now:
V = *W*/*Q*
Or *W* = *V* x *Q*
= *V* x *I* x *t* (since *Q* = *I* x *t*)
= 10 x 2 x 60
= 1200 J
Thus, the amount of energy transferred is 1200 J.

Question:25

a What is an electric current? What makes an electric current flow in a wire?

b Define the unit of electric current $or Define ampere$.

Solution:

a An electric current is the flow of electric charge called electrons in a conductor and its magnitude is the amount of electric charge passing through a given point of the conductor in one second. The potential difference between the ends of the wire makes the current flow through the wire.

b The SI unit of electric current is ampere.

When one coulomb of charge flows through any cross-section of a conductor in one second, the electric current flowing through it is said to be one ampere.

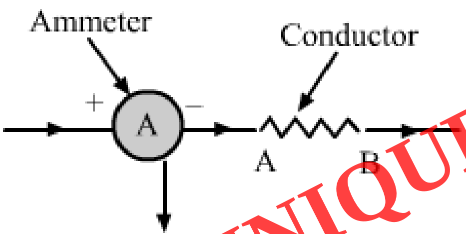
1 ampere= $\frac{1 \text{ coulomb}}{1 \text{ second}}$

Question:26

What is an ammeter? How is it connected in a circuit? Draw a diagram to illustrate your answer.

Solution:

An ammeter is an instrument that is used to measure electric current. It is always connected in series with the circuit in which the current is to be measured.



Suppose we want to find out the current flowing through a conductor AB. Here, we should connect the ammeter in series with the conductor AB as above.

Question:27

a Write down the formula which relates electric charge, time and electric current

b A radio set draws a current of 0.36 A for 15 minutes. Calculate the amount of electric charge that flows through the circuit.

Solution:

a If a charge of Q coulombs flows through a conductor in time t seconds, the magnitude, I of the electric current flowing through it is given by:

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

b Given:

Current, I = 0.36 A

Time, t = 15 minutes = (15 × 60) s = 900 s

Using the formula, $I = \frac{Q}{t}$:

or $Q = I \times t = 0.36 \times 900 = 324$ C

Thus, the amount of electric charge that flows through the circuit is 324 C.

Question:28

Why should the resistance of:

a an ammeter be very small?

b a voltmeter be very large?

Solution:

a An ammeter should have a very low resistance so that it will not change the value of the current flowing in the circuit.

b A voltmeter should have a high resistance so that it can take only a negligible amount of current from the circuit.

Question:29

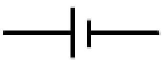
Draw circuit symbols for a fixed resistance b variable resistance c a cell d a battery of three cells e an open switch f a closed switch.

Solution:

a Fixed resistance

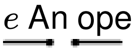
b Variable resistance

c A cell

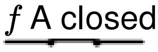


d A battery of three cells

e An open switch



f A closed switch



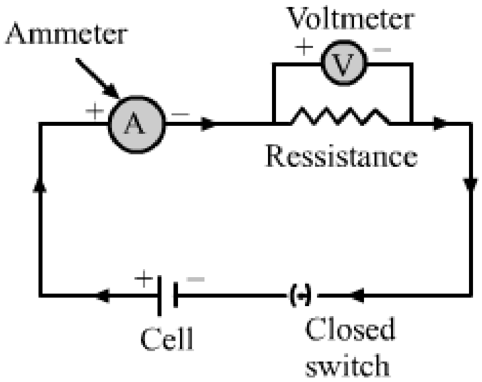
Question:30

What is a circuit diagram? Draw the labelled diagram of an electric circuit comprising of a cell, a resistance, an ammeter, a voltmeter and a closed switch $orclosedplugkey$. Which of the two has a large resistance : an ammeter or a voltmeter?

Solution:

A circuit diagram is a diagram that indicates how different components in a circuit have been connected, using electrical symbols for the components.

Here is the diagram of an electric circuit comprising a cell, a resistance, an ammeter, a voltmeter and a closed switch.



A voltmeter has a high resistance so that it takes only a negligible amount of current from the circuit.

Question:31

If the charge on an electron is 1.6 × 10^{-19} coulombs, how many electrons should pass through a conductor in 1 second to constitute 1 ampere current?

Solution:

Given:

Current, I = 1 A

Time, t = 1 s

Using the formula:

$I = \frac{Q}{t}$ or, $Q = I \times t = 1 \times 1 = 1$ C

Now, if the charge is 1.6×10^{-19}C, the number of electrons is 1.

So, if the charge is 1 C, the number of electrons is given by:

$$\frac{1}{1.6 \times 10^{-19}} \times 1 = 6.25 \times 10^{18}$$

Thus, 6.25×10^{18} electrons should pass through a conductor in 1 second to constitute 1 ampere current.

Question:32

The p.d. across a lamp is 12 V. How many joules of electrical energy are changed into heat and light when:

a a charge of 1 C passes through it?

b a charge of 5 C passes through it?

c a current of 2 A flows through it for 10 s?

Solution:

Amount of energy = Work done

a Using the formula, $V = W / Q$, we have, $W = V \times Q$

= 12 x 1 = 12 J

b $W = V \times Q$ = 12 x 5 = 60 J

c $W = V \times Q$

= $V \times (I \times t)$

= 12 x 2 x 10 = 240 J

Question:33

By what name is the physical quantity coulomb/second called?

Solution:

The electric current is the physical quantity that is expressed as coulomb/second since current, $I = Q/t$.

Question:34

What is the flow of charge called?

Solution:

The flow of electric charge in a conductor is called electric current. If a charge of Q coulombs flows through a conductor in time t seconds, the magnitude of electric current is given by, $I = Q/t$.

Question:35

What actually travels through the wires when you switch on a light?

Solution:

When we switch on a light, electrons travel through the wires. The flow of these electrons is called electric current.

Question:36

Which particles constitute the electric current in a metallic conductor?

Solution:

The flow of negatively charged particles $electrons$ in a metallic conductor constitutes electric current.

Question:37

a In which direction does conventional current flow around a circuit?
b In which direction do electrons flow?
Solution:
a The direction of conventional current is from the positive terminal of a cell or battery to the negative terminal through the outer circuit.
b The flow of electrons is from the negative terminal to the positive terminal of a cell.

Question:38
Which of the following equation shows the correct relationship between electrical units?

$1\ \mathrm{A}\ =1\ \mathrm{C}/\mathrm{s}\ \text{ or }\ 1\ \mathrm{C}\ =1\ \mathrm{A}/\mathrm{s}$
Solution:
Because current, I = Q/t, the correct relationship is $1\ \mathrm{A}=\frac{1\ \mathrm{C}}{1\ \mathrm{s}}$.

Question:39
What is the unit of electric current?
Solution:
The SI unit of electric current is ampere and is denoted by the letter, *A*.

Question:40
a How many milliamperes as there in 1 ampere?
b How many microamperes are there in 1 ampere?
Solution:
a 1 ampere = 1000 milliamperes = 10^3 milliamperes
b 1 ampere = 1,000,000 microamperes = 10^6 microamperes

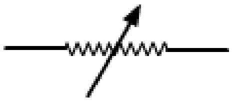
Question:41
Which of the two is connected in series : ammeter or voltmeter?
Solution:
Ammeter.
Ammeter is connected in series with the circuit, whereas voltmeter is connected in parallel across the points where the p.d. is to be measured.

Question:42
Compare how an ammeter and a voltmeter are connected in a circuit.
Solution:

The ammeter is connected in series with the circuit in which the current is to be measured, whereas the voltmeter is connected across the points where the potential difference is to be measured.

Question:43

What do the following symbols mean in circuit diagrams?



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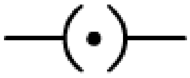


ii

Solution:

i Variable resistance or rheostat. A rheostat is used to change the resistance in a circuit.

ii A closed switch. When the switch is closed, the circuit is completed and current flows through it.

Question:44

If 20 C of charge pass a point in a circuit in 1 s, what current is flowing?

Solution:

Here:

Charge, $Q = 20$ C

Time, $t = 1$ s

We know that, $I = Q/t$

So:

Current, $I = 20/1 = 20$ A

Thus, the electric current flowing through the circuit is 20 A.

Question:45

A current of 4 A flows around a circuit for 10 s. How much charge flows past a point in the circuit in this time?

Solution:

Here:

Current, $I = 4$ A

Time, $t = 10$ s

We know that $I = Q/t$.

So:

$4 = Q/10$

or $Q = 4 \times 10 = 40$ C

Thus, the amount of electric charge that flows through the circuit is 40 coulombs.

Question:46

What is the current in a circuit if the charge passing each point is 20 C in 40 s?

Solution:

Here:

Charge, $Q = 20$ C

Time, $t = 40$ s

We know that, $I = Q/t$.

So:

$I = 20/40 = 0.5$ A

Therefore, the electric current flowing through the circuit is 0.5 A.

Question:47

Fill in the folloing blanks with suitable words:

a A current is a flow of .... .For this to happen there must be a .... circuit.

b Current is measured in .... using an .... placed in .... in a circuit.

Solution:

a A current is a flow of electrons. For this to happen, there must be a closed circuit.

b Current is measured in amperes using an ammeter placed in series in a circuit.

Question:48

In 10 s, charge of 25 C leaves a battery, and 200 J of energy are delivered to an outside circuit a result.

a What is the p.d. across the battery?

b What current flows from the battery?

Solution:

Given:

Time, $t = 10$ s

Charge, $Q = 25$ C

Energy delivered = Work done, $W = 200$ J

a Using the relation, $V = W/Q$

$V = 200/25 = 8$ V

So the p.d. across the battery is 8 volts.

b Using the relation, $I = Q/t$,

$I = 25/10 = 2.5$ A

So, a current of 2.5 A flows from the battery.

Question:49

a Define electric current. What is the SI unit of electric current.

b One coulomb of charge flows through any cross-section of a conductor in 1 second. What is the current flowing through the conductor?

c Which instrument is used to measure electric current? How should it be connected in a circuit?

d What is the conventional direction of the flow of electric current? How does it differ from the direction of flow electrons?

e A flash of lighting carries 10 C of charge which flows for 0.01 s. What is the current? If the voltage is 10 MV, what is the energy?

Solution:

a Electric current is the flow of electric charges $calledelectrons$ in a conductor such as a metal wire and its magnitude is the amount of electric charge passing through a given point of the conductor in one second.

i.e. *I* = *Q*/*t*

The SI unit of electric current is ampere.

b Here:

Charge, *Q* = 1 C

Time, *t* = 1 s

Then the current is given by:

I = *Q*/*t*

= 1/1 = 1 A

c Current is measured by an instrument called ammeter. An ammeter should be connected in series with the circuit in which the current is to be measured.

d The conventional direction of the flow of electric current is from the positive terminal of a cell or a battery to its negative terminal through the outer circuit, whereas the direction of flow of electrons is from the negative terminal to the positive terminal of a cell.

e Given:

Charge, *Q* = 10 C

Time, *t* = 0.01 s

Then the current, *I* = *Q* / *t*

So *I* = 10/0.01 = 1000 A

Also given that:

V = 10 mV = 1,00,00,000 V

So energy = Work done, *W* = *V* x *Q*

= 1,00,00,000 x 10 = 1,00,000,000 J = 100 MJ

Question:50

The other name of potential difference is:

a ampereage
b wattage
c voltage
d potential energy

Solution:

c voltage

The term voltage came from volt, which is the SI unit of potential difference.

Question:51

Which statement/statement is/are correct?

1. An ammeter is connected in series in a circuit and a voltmeter is connected in parallel.
2. An ammeter has a high resistance.
3. A voltmeter has a low resistance.

a 1, 2, 3
b 1, 2
c 2, 3
d 1

Solution:

The correct statement is:

d 1

An ammeter is connected in series in a circuit and a voltmeter is connected in parallel. The other two statements are incorrect as an ammeter should have a very low resistance and a voltmeter should have a high resistance.

Question:52

Which unit could be used to measure current?

a Watt
b Coulomb
c Volt
d Ampere

Solution:
d Ampere
It is the SI unit of electric current.

Question:53
If the current through a floodlamp is 5 A, what charge passed in 10 seconds?

a 0.5 C
b 2 C
c 5 C
d 50 C
Solution:
d 50 C

Here, current, *I* = 5 A
Time, *t* = 10 s
So, using the relation, *I* = *Q*/*t*:
Q = *I* x *t*
Charge, *Q* = 5 x 10 = 50 C
Thus, a charge of 50 C is passed in 10 s.
Hence, the correct option is d 50 C.

Question:54
If the amount of electric charge passing through a conductor in 10 minutes is 300 C, the current flowing is:

a 30 A
b 0.3 A
c 0.5 A
d 5 A
Solution:
c 0.5 A

Here, charge, *Q* = 300 C
Time, *t* = 10 minutes = $10x60$s = 600 s
Then, current, *I* = *Q* / *t*
= 300 / 600 = 0.5 A
Hence, the correct option is c 0.5 A.

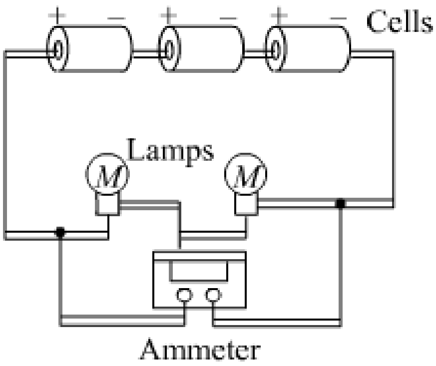
Question:55

A student made an electric circuit shown here to measure the current through two lamps.

a Are the lamps in series or parallel?

b The student has made a mistake in this circuit. What is the mistake?

c Draw a circuit diagram to show the correct way to connect the circuit. Use the proper circuit symbols in your diagram.

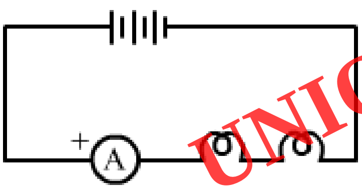


Solution:

a The lamps are connected in series.

b The student has connected the ammeter in parallel with the lamps. It should be connected in series.

c The correct diagram that shows how to connect the circuit:

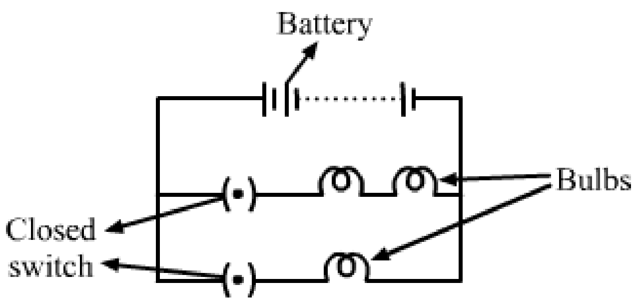


Question:56

Draw a circuit diagram to show how 3 bulbs can be lit from a battery so that 2 bulbs are controlled by the same switch the third bulb has its own switch.

Solution:

Here is the circuit diagram that shows how three bulbs can be lit from a battery so that two bulbs are controlled by the same switch. The third bulb has its own switch.



Question:57

An electric heater is connected to the 230 V mains supply. A current of 8 A flows through the heater.

a How much charge flows around the circuit each second?

b How much energy is transferred to the heater each second?

Solution:

Here, potential, *V* = 230 V

Current, *I* = 8 A

a The magnitude of the electric current is the amount of charge passing through a given point in one second. So, in this case, a charge of eight coulombs flows around the circuit each second.

b Energy transferred = Work done, *W*

Using the relation, *V* = *W*/*Q*:

W = *V* x *Q*

= 230 x 8 = 1840 J

Thus, 1840 joules of energy is transferred to the heater each second.

Question:58

How many electrons are flowing per second past a point in a circuit in which there is a current of 5 amp?

Solution:

Current, *I* = 5 A

Time, *t* = 1 s

Using the relation, *I* = *Q* / *t*:

Q = *I* x *t*

= 5 x 1 = 5 C

Now, if the charge is $1.6 \times 10^{-19} C$, the number of electrons is one.

So, if the charge is 5 C, the number of electrons is given by:

$\frac{1}{1.6\times10^{-19}} \times 5 = 31.25 \times 10^{18}$

Question:59

Name the law which relates the current in a conductor to the potential difference across its ends.

Solution:

Ohm's law gives the relationship between the current in a conductor and the potential difference across its ends. According to this law, at constant temperature, the current flowing through a conductor is directly proportional to the potential difference across its ends.

Question:60

Name the unit of electrical resistance and give its symbol.

Solution:

The SI unit of electrical resistance is ohm and its symbol is Ω.

Question:61

Name the physical quantity whose unit is "ohm".

Solution:

Electrical resistance is the physical quantity whose SI unit is ohm.

Question:62

What is the general name of the substances having infinitely high electrical resistance?

Solution:

Objects that have infinitely high electrical resistance are called insulators. An insulator does not allow electricity to flow through it.

Question:63

Keeping the resistance constant, the potential difference applied across the ends of a component is halved. By how much does the current change?

Solution:

From Ohm's law we have:

$V / I = R$

Or $I = V/R$

Now, according to the question, the resistance is constant and the potential difference is halved.

i.e. $R' = R$

and $V' = V/2$

Then the new current is given by:

$I' = V'/R'$

$= V/2/R$

$= 1/2\,(V/R)$

$= 1/2\,I$

It is clear from the above statement that the current becomes half.

Question:64

State the factors on which the strength of electric current flowing in a given conductor depends.

Solution:

The strength of the electric current flowing in a given conductor depends on two factors:

1) The potential difference across the ends of the conductor

2) The resistance of the conductor

Question:65

Which has less electrical resistance : a thin wire or a thick wire

$ofthesamelengthandsamematerial?$

Solution:

A thick wire has a greater area of cross-section, whereas a thin wire has a smaller area of cross-section. Also, the resistance of a conductor is inversely proportional to its area of cross-section. This means that a thick wire has lesser resistance than a thin wire.

Question:66

Keeping the potential difference constant, the resistance of a circuit is halved. By how much does the current change?

Solution:

From Ohm's law we have:

$V/I = R$

Or $I = V/R$

Now, according to the question, the resistance of the circuit is halved and the potential difference is constant.

i.e. $R' = R/2$

and $V' = V$

Then the new current is given by:

$I' = V'/R'$

$= V/R/2$

$= 2V/R$

$= 2I$

It is clear from the above statement that the current becomes double.

Question:67

A potential difference of 20 volts is applied across the ends of a resistance of 5 ohms. What current will flow in the resistance?

Solution:

Here:

Potential difference, $V = 20$ V

Resistance, $R = 5\ \Omega$

Substituting these values in Ohm's equation, $V/I = R$:

Current, $I = V/R = 20/5 = 4$ A

Thus, the current flowing in the circuit is 4 A.

Question:68

A resistance of 20 ohms has a current of 2 amperes flowing in it. What potential difference is there between its ends?

Solution:

Here:

Resistance, $R = 20\ \Omega$

Current, $I = 2$ A

Substituting these values in the Ohm's equation, $V/I = R$:

Potential difference, $V = I \times R = 2 \times 20 = 40$ V

Question:69

A current of 5 amperes flows through a wire whose ends are at a potential difference of 3 volts. Calculate the resistance of the wire.

Solution:

Here:

Current, $I = 5$ A

Potential difference, $V = 3$ V

Substituting these values in the Ohm's equation, $V/I = R$:

Resistance of the wire, $R = 3/5 = 0.6\ \Omega$

Question:70

Fill in the following blank with a suitable word:

Ohm's law state a relation between potential difference and ....

Solution:

Ohm's law state a relation between potential difference and <u>current.</u>

Question:71

Distinguish between good conductors, resistors and insulators. Name two good conductors, two resistance and two insulators.

Solution:

Substances that conduct electricity easily and offer very low resistance $opposition$ to the flow of current are called good conductors. Examples: copper, silver

A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors have comparatively high electrical resistance. Examples: constanan, nichrome

The substances that have infinitely high electrical resistance are called insulators. Examples: wood, rubber

Question:72

Classify the following into good conductors, resistors and insulators:

Rubber, Mercury, Nichrome, Polythene, Aluminium, Wood, Manganin, Bakelite, Iron, Paper, Thermocol, Metal coin

Solution:

Conductors: mercury, aluminium, iron and metal coin

Resistors: nichrome and manganin

Insulators: rubber, polythene, wood, paper, thermocol and bakelite

Question:73

a Why do electricians wear rubber hand gloves while working with electricity?

b What p.d. is needed to send a current of 6 A through an electrical appliance having a resistance of 40 Ω?

Solution:

a Electricians wear rubber hand gloves while working with electricity because rubber is an insulator and it will prevent them from getting electric shock, in case of short circuit or overloading.

b We know that $V = IR$

Here, $I = 6$ A

$R = 40$ Ω

So, $V = 6 \times 40$

$V = 240$ V

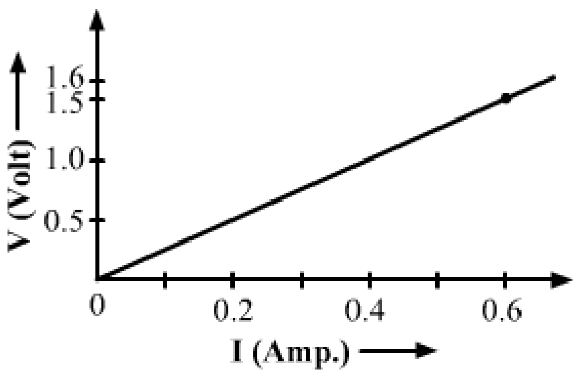
So 240 V is the potential difference needed to send a current of 6 A through an electrical appliance that has a resistance of 40 Ω.

Question:74

An electric circuit consisting of a 0.5 m long nichrome wire XY, an ammeter, a voltmeter, four cells of 1.5 V each and a plug key was set up.

i Draw a diagram of this electric circuit to study the relation between the potential difference maintained between the points '*X*' and '*Y*' and the electric current flowing through XY.

ii Following graph was plotted between *V* and *I* values:



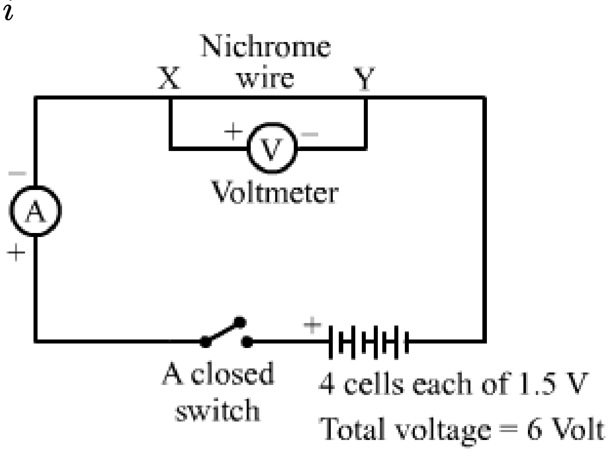
What would be the values of $\frac{V}{I}$ rations when the potential difference is 0.8 V, 1.2 V and 1.6 V respectively?

What conclusion do you draw from these values?

iii What is the resistance of the wire?

Solution:

i



ii When potential difference = 0.8 V, current = 0.32 A.

$\frac{\mathrm{V}}{\mathrm{I}} = \frac{0.8}{0.32}\ \frac{\mathrm{V}}{\mathrm{I}} = 2.5$

When potential difference = 1.2 V, current = 4.8 A.

$\frac{V}{I} = \frac{1.2}{4.8}\frac{V}{I} = 2.5$

When potential difference = 1.6 V, current = 6.4 A.

$\frac{V}{I} = \frac{1.6}{6.4}\frac{V}{I} = 2.5$

The V-I graph is a straight line with a constant slope of 2.5.

iii The resistance of the wire is 2.5 Ω.

Question:75

a What is the ratio of potential difference and current known as?

b The values of potential difference *V* applies across a resistor and the corresponding values of current *I* flowing in the resistor are given below:

Potential differences, *V* $involts$	:	2.5	5.0	10.0	15.0	20.0	25.0
Current, *I* $inamperes$	:	0.1	0.2	0.4	0.6	0.8	1.0

c Name the law which is illustrated by the above *V–I* graph.

d Write down the formula which states the relation between potential difference, current and resistance.

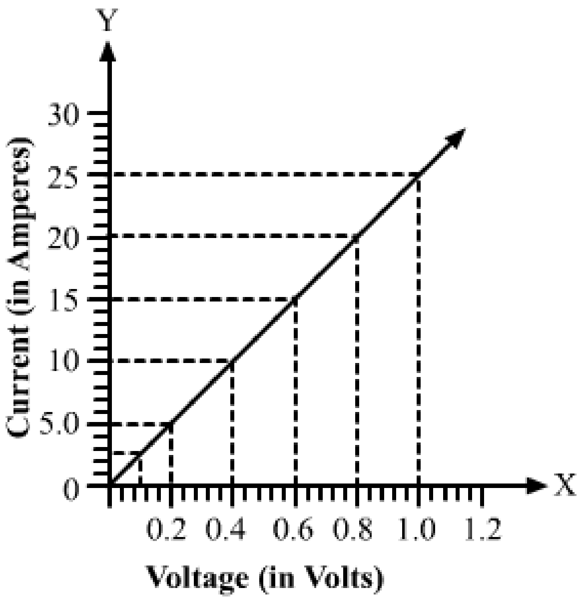
e The potential difference between the terminals of an electric iron is 240 V and the current is 5.0 A. What is the resistance of the electric iron?

Solution:

a The ratio of potential difference and current is known as resistance R.

b

From the graph, resistance, R = $\frac{V}{I} = \frac{5}{0.2} = 25\ \Omega$



c Ohm's law is illustrated by the above V–I graph.

dRelation between potential difference and current is
V = IR

e The potential difference between the terminals of an electric iron is 240 V and the current is 5.0 A.
So resistance $\mathrm{R} = \frac{V}{I} = \frac{240}{5} = 48\ \Omega$
Thus, the resistance of the electric iron will be 48 Ω.

Question:76
The p.d. across a 3 Ω resistor is 6 V. The current flowing in the resistor will be:

a $\frac{1}{2}$ A
b 1 A
c 2 A
d 6 A
Solution:

c 2 A

If the p.d. across a 3 Ω resistor is 6 V, the current flowing in the resistor will be 2 A as current I is given by the equation, I = V $Voltage$ / R $Resistance$.

or I = V/R

I = 6 V/3 Ω

I = 2 A

Question:77
A car headlight bulb working on a 12 V car battery draws a current of 0.5 A. The resistance of the light bulb is:

a 0.5 Ω
b 6 Ω
c 12 Ω
d 24 Ω
Solution:
d 24 Ω

Voltage, V = 12 V
Current, I = 0.5 A
Resistance, R = Voltage/Current
$R = V/I$
$R = 12/0.5$
$R = 24\ \Omega$
Thus, if a car's headlight bulb working on a 12 V car battery draws a current of 0.5 A, the resistance of the light bulb will be 24 Ω.

Question:78
An electrical appliance has a resistance of 25 Ω. When this electrical appliance is connected to a 230 V supply line, the current passing through it will be:

a 0.92 A
b 2.9 A
c 9.2 A
d 92 A
Solution:

c 9.2 A

Resistance = 25 Ω

Voltage = 230 V

Current = Voltage/Resistance

$I = V/R$

$I = 230/25$

$I = 9.2$ A

Thus, if an electrical appliance has a resistance of 25 Ω and when that electrical appliance is connected to a 230 V supply line, the current passing through it will be 9.2 A.

Question:79
When a 4 Ω resistor is connected across the terminals of a 12 V battery, the number of coulombs passing through the resistor per second is:

a 0.3

b 3
c 4
d 12
Solution:
b 3
The number of coulombs passing through the resistor is the current passing through it.
Current = Voltage/Resistance
I = *V*/*R*
I = 12/4
I = 3 A
Thus, when a 4 Ω resistor is connected across the terminals of a 12 V battery, the number of coulombs passing through the resistor per second will be 3.

Question:80
What is Ohm's law? Explain how it is used to define the unit of resistance.
Solution:
According to Ohm's law, the current (*I*) flowing through a wire is directly proportional to the potential difference (*V*) across it, provided its temperature remains the same.
Thus *I* α *V*.
V / *I* = Constant = *R*
V = *IR*
Here *R* is the resistance.
The unit of resistance is ohm (Ω).

One ohm Ω is the resistance of a conductor when a potential difference of one volt is applied to its ends and a current of one ampere flows through it.

Question:81
a What is meant by the "resistance of a conductor" ? Write the relation between resistance, potential difference and current.
b When a 12 V battery is connected across an unknown resistor, there is a current of 2.5 mA in the circuit. Calculate the value of the resistance of the resistor.
Solution:

a Resistance is the property of a conductor to resist the flow of charge through it. The relation between resistance, current and potential difference is *V* = *IR*.
b Voltage, *V* = 12 V
Resistance, *R* = ?
Current, *I* = 2.5 $\times 10^{-3}$ A

$V = IR$

$R = V/I$

$R = 12/2.5 \times 10^{-3}$

$R = 4800\ \Omega$

Question:82

a Define the unit of resistance $or Define the unit$ " ohm ".

b What happens to the resistance as the conductor is made thinner?

c Keeping the potential difference constant, the resistance of a circuit is doubled. By how much does the current change?

Solution:

a One ohm Ω is the resistance of a conductor when a potential difference of one volt is applied to its ends and a current of one ampere flows through it.

b The resistance of a wire can be represented by the following equation:

Resistance =

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

So, when the conductor is made thinner, its area of cross-section will decrease, since resistance is inversely proportional to the area of the conductor. Therefore, its resistance will increase.

c We know that $V = IR$

If V is constant, resistance is doubled $R' = 2R$.

Then $V' = I'R'$

$V' = V$ since V is constant

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

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

Thus, the current will get reduced to half.

Question:83

Ohm's law gives a relationship between:

a current and resistance
b resistance and potential difference
c potential difference and electric charge
d current and potential difference
Solution:
d current and potential difference
Ohm's law gives the relationship between current and potential difference.

Question:84
The unit of electrical resistance is:

a ampere
b volt
c coulomb
d ohm
Solution:
d ohm
The unit of electrical resistance is ohm.

Question:85
The substance having infinitely high electrical resistance is called:

a conductor
b resistor
c superconductor
d insulator
Solution:

d insulator
A substance having infinitely high electrical resistance is called an insulator.

Question:86
Keeping the potential difference constant, the resistance of a circuit is doubled. The current will become:

a double
b half

c one-fourth

d four times

Solution:

b half

As we know from Ohm's law:

Voltage = Current x Resistance

$V = IR$

If the voltage is constant, the resistance is doubled and the current becomes half.

Question:87

Keeping the p.d. constant, the resistance of a circuit is halved. The current will become:

a one-fourth

b four time

c half

d double

Solution:

d double

As we know from Ohm's law:

Voltage = Current x Resistance

$V = IR$

If the voltage is constant, the resistance of the circuit is halved. That is, it becomes $R / 2$.

Current, $I = V/R$

$I = V/R$

$I = V/R/2 = 2$ I

Thus by keeping the p.d. constant, the resistance of a circuit is halved and the current is doubled.

Question:88

An electric room heater draws a current of 2.4 A from the 120 V supply line. What current will this room heater draw when connected to 240 V supply line?

Solution:

An electric room heater draws a current of 2.4 A from the 120 V supply line.

So current, $I = 2.4$ A

Voltage, $V = 120$ V

Resistance, $R = V/I$

$R = 120/2.4 = 50\ \Omega$

The resistance will remain constant unless the room heater is changed.

Now when the room heater is connected to the 240 V supply line, the current drawn is:

$I = V/R$

$I = 240/50 = 4.8$ A

So the room heater will draw a 4.8 A current when connected to the 240 V supply line.

Question:89

Name the electrical property of a material whose symbol is "omega".

Solution:

Resistance is represented by the symbol Omega, Ω. Resistance has the following electrical properties:

1. The resistance of a conductor depends on its length. It is directly proportional to the length, $R \propto L$.
2. The resistance of a conductor is inversely proportional to its area of cross-section, i.e. $R \propto 1/A$.
3. Resistance depends on the nature of the material of the conductor.
4. Resistance also depends on the temperature of the conductor.

Question:90

The graph between V and I for a conductor is a straight line passing through the origin.

a Which law is illustrated by such a graph?

b What should remain constant in a statement of this law?

Solution:

a Ohm's law states that the graph between V and I for a conductor is a straight line passing through the origin.

b Ohm's law is true only if the temperature of the conductor is constant.

Question:91

A p.d. of 10 V is needed to make a current of 0.02 A flow through a wire. Wire p.d. is needed to make a current of 250 mA flow through the same wire?

Solution:

A potential difference of 10 V is needed to make a current of 0.02 A flow through a wire.

So potential difference, $V = 10$ V

Current, $I = 0.02$ A

Resistance of the wire, $R = V/I$

$R = 10/0.02 = 500\ \Omega$

The resistance will remain the same unless the wire is changed.

Now to make a current of 250 mA to flow through the wire, the potential difference required is:

$V = IR$

$V = 250 \times 10^{-3} \times 500$

$V = 125$ V

So a potential difference of 125 V is needed to make a current of 250 mA flow through the wire.

Question:92

A current of 200 mA flows through a 4 kΩ resistor. What is the p.d. across the resistor?

Solution:

A current of 200 mA flows through a 4 kΩ resistor.

So current, $I = 200$ mA $= 200 \times 10^{-3}$A

Resistance, $R = 4$ kΩ $= 4000\ \Omega$

Potential difference, $V = IR$

$V = 200 \times 10^{-3} \times 4000$

$V = 800$ V

So the potential difference across the resistor will be 800 V.

Question:93

What happens to the resistance as the conductor is made thicker?

Solution:

The resistance of a conductor is inversely proportional to its area of cross-section, i.e.$R \propto 1 / A$. So when the conductor is made thicker, its resistance decreases.

Question:94

If the length of a wire is doubled by taking more of wire, what happens to its resistance?

Solution:

We know that the resistance of the wire, $R = \rho l / A$ where the resistivity of the wire is ρ.

The length of the wire = l

The area of cross-section of the wire, $A = \pi r^2$

So when the length of the wire is doubled ($l' = 2l$) by taking more of the same wire, $itwillkeeptheresistivityandtheareaofcross - sectionthesame$, the length is doubled.

New resistance = R'

$R' = \rho l' / A$

$R' = 2\rho l / A$

$R' = 2R$

Question:95

On what factors does the resistance of a conductor depend?

Solution:

The resistance of a conductor depends on the following factors:

1. The resistance of a conductor depends on its length. It is directly proportional to the length, $R \propto l$.
2. The resistance of a conductor is inversely proportional to its area of cross-section, i.e. $R \propto 1 / A$.
3. Resistance depends on the nature of the material of the conductor.
4. Resistance also depends on the temperature of the conductor.

Question:96

Name the material which is the best conductor of electricity.

Solution:

Silver is the best conductor of electricity.

Question:97

Which among iron and mercury is a better conductor of electricity?

Solution:

Iron is a better conductor of electricity than mercury because the resistivity of iron is less than that of mercury.

Question:98

Why are copper and aluminium wires usually used for electricity transmission?

Solution:

Copper and aluminium wires are used for electrical transmission because they have a low resistance, which makes them good conductors of electricity.

Question:99

Name the material which is used for making the heating element of an electric iron.

Solution:

The coils of the heating element of an electric iron is made of alloys like nichrome because alloys have a high resistance and a high melting point.

Question:100

What is nichrome? State its one use.

Solution:

Nichrome is an alloy of nickel, chromium, manganese and iron. It is used to make the heating elements of electrical appliances because it has a high resistance and a high melting point.

Question:101

Give two reasons why nichrome alloy is used for making the heating elements of electrical appliances.

Solution:

Nichrome is used to make the heating elements of electrical appliances because it has a high resistance and a high melting point.

Question:102

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

Solution:

The coils of the heating elements of electric irons and electric toasters are made of alloys like nichrome rather than a pure metal because alloys have a high resistance and a high melting point.

Question:103

Which has more resistance:

a a long piece of nichrome wire or a short one?

b a thick piece of nichrome wire or a thin piece?

Solution:

a A long piece of nichrome wire has more resistance because the resistance of a conductor is directly proportional to its length, *R* α *l*.
b A thin piece of nichrome wire has more resistance because the resistance of a conductor is inversely proportional to its area of cross-section, i.e. *R* α 1 / *A*. The lesser the area of cross-section, the more the resistance.

Question:104
a How does the resistance of a pure metal change if its temperature decreases?
b How does the presence of impurities in a metal affect its resistance?
Solution:
a The resistance of all pure metals increases on raising the temperature and decreases on lowering the temperature. Therefore, the resistance of a pure metal will decrease on decreasing the temperature.
b The presence of impurities in a metal increases its resistivity $also resistance$ and it does not undergo oxidation easily even at a high temperature.

Question:105
Fill in the following blanks with suitable words:

Resistance is measured in .... The resistance of a wire increases as the length ....; as the temperature ....; and as the cross-sectional area ....
Solution:
Resistance is measured in ohm Ω. The resistance of a wire increases as the length increases; as the temperature increases; and as the cross-sectional area decreases.

Question:106
a What do you understand by the "resistivity" of a substance?
b A wire is 1.0 m long, 0.2 mm in diameter and has a resistance of 10 Ω. Calculate the resistivity of its material?
Solution:

a We know that resistance, $R = \frac{\rho l}{A}$

So resistivity, $\rho = \frac{RA}{l}$

When the area of cross-section, *A* is 1 m^2 and the length of the wire, *l* is 1 m, resistance is equal to resistivity.

Resistivity may be defined as the resistance offered by a conductor of length 1 m and area of cross-section 1 m^2.

b Given length of the wire, *l* = 1 m

Diameter of the wire, *d* = 0.2 mm

So the radius of the wire, *r* = 0.1 mm = 0.0001 m

Area of cross-section of the wire = $A = \pi r^2 = 3.14 \times (0.0001)^2 = 3.14 \times 10^{-8} m^2$

Resistance of the wire, *R* = 10 Ω

So resistivity = $\rho = \frac{RA}{l}$

$\rho = 3.14 \times 10^{-7} \Omega m$

Thus, the resistivity of the material, $\rho = 3.14 \times 10^{-7} \Omega m$.

Question:107

a Write down an expression for the resistance of a metallic wire in terms of the resistivity.

b What will be the resistance of a metal wire of length 2 metres and area of cross-section 1.55 × 10^{-6} m^2 if the resistivity of the metal be 2.8 × 10^{-8} Ωm?

Solution:

a Length of the cable wire = *l*

Area of cross-section = A

Resistivity of the aluminium cable wire = ρ

Resistance of the wire = R

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

b Length of the cable wire, *l* = 2 m

Area of cross-section, *A* = 1.55 × 10^{-6} m^2

Resistivity of the aluminium cable wire, ρ= 2.8 × 10^{-8} Ωm

We know that:

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

$$R = \frac{2.8 \times 10^{-8} \times 2}{1.55 \times 10^{-6}}$$

$R = 0.036\ \Omega$

Thus, the resistance of the metal wire, $R = 0.036\ \Omega$

Question:108

a Give two examples of substances which are good conductors of electricity. Why do you think they are good conductors of electricity?

b Calculate the resistance of a copper wire 1.0 km long and 0.50 mm diameter if the resistivity of copper is $1.7 \times 10^{-8}\ \Omega$m.

Solution:

a Copper and aluminium are good conductors of electricity because their resistivity is very low.

b Length of the cable wire, $l = 1$ km = 1000 m

Diameter of the cable wire, $d = 0.5$ mm

Radius of the cable wire, $r = 0.25$ mm = 0.00025 m = 2.5×10^{-4} m

Area of cross-section, $A = \pi r^2 = 3.14 \times (2.5 \times 10^{-4})^2 = 19.6 \times 10^{-8} m^2$

Resistivity of the aluminium cable wire = $1.7 \times 10^{-8}\ \Omega$m.

To find the resistance of the aluminium cable, R:

We know that $R = \frac{\rho l}{A}$

$$R = \frac{1.7 \times 10^{-8} \times 1000}{19.6 \times 10^{-8}}$$

So, $R = 86.5\ \Omega$

Thus, the resistance of the copper wire, $R = 86.5\ \Omega$

Question:109

Will current flow more easily through a thick wire or a thin wire of the same material when connected to the same source? Give reason for your answer.

Solution:

The resistance of a conductor is inversely proportional to its area of cross-section, i.e. $R \propto 1 / A$. So as the conductor is a thick wire, its resistance decreases and current will flow easily through it, in comparison with a thin wire.

Question:110

How does the resistance of a conductor depend on:

a length of the conductor?
b area of cross-section of the conductor?
c temperature of the conductor?

Solution:

1. The resistance of a conductor depends on its length. It is directly proportional to the length, $R \propto l$.
2. The resistance of a conductor is inversely proportional to its area of cross-section, i.e. $R \propto 1 / A$.
3. The resistance also depends on the temperature of the conductor. It increases on raising the temperature and decreases on lowering the temperature.

Question:111

a Give one example to show how the resistance depends on the nature of material of the conductor.
b Calculate the resistance of an aluminium cable of length 10 km and diameter 2.0 mm if the resistivity of aluminium is 27×10^{-8} Ωm.

Solution:

a If we take two similar wires with equal length and diameter, one made of copper $metal$ and the other made of nichrome $alloy$, we will find that the resistance of the nichrome wire is about 60 times more than that of the copper wire. This shows that the resistance of a conductor depends on the nature of the material of the conductor.

b
Length of the cable wire, l = 10 km = 10000 m
Diameter of the cable wire, d = 2.0 mm
Radius of the cable wire, r = 0.1 mm = 0.0001 m = 10^{-4} m
Area of cross-section, $A = \pi r^2$ = 3.14×10^{-8} m^2
Resistivity of the aluminium cable wire = 27×10^{-8} Ωm.

Let the resistance of the aluminium cable be R.

We know that $R = \frac{\rho l}{A}$

$$R = \frac{27 \times 10^{-8} \times 10000}{3.14 \times 10^{-8}}$$

$R = 86\ \Omega$

Question:112

What would be the effect on the resistance of a metal wire of:

a increasing its length?
b increasing its diameter?
c increasing its temperature?

Solution:

a The resistance of a conductor depends on its length. It is directly proportional to the length, $R \propto l$. So on increasing the length of the wire, its resistance will increase.
b The resistance of a conductor is inversely proportional to its area of cross-section, i.e. $R \propto 1 / A$. So on increasing its diameter, its resistance will decrease.
c Resistance also depends on the temperature of the conductor. So on increasing its temperature, its resistance will also increase.

Question:113

How does the resistance of a wire vary with its:

a area of cross-section?
b diameter?

Solution:

aThe resistance of a conductor is inversely proportional to its area of cross-section, i.e. $R \propto 1 / A$. So on increasing the area of cross-section, its resistance will decrease.
b We know that the area of cross-section, $A = \pi r^2 = \pi (d / 2)^2$, where r is the radius and d is the diameter of the wire. So on increasing the diameter of the wire, its resistance decreases.

Question:114

a Define resistivity. Write an expression for the resistivity of a substance. Give the meaning of each symbol which occurs in it.

b State the SI unit of resistivity.

c Distinguish between resistance and resistivity.

d Name two factors on which the resistivity of a substance depends and two factors on which it does not depend.

e The resistance of a metal wire of length 1 m is 26 Ω at 20°C. If the diameter of the wire is 0.3 mm, what will be the resistivity of the metal at that temperature?

Solution:

a We know that resistance,

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

So resistivity,

$$\rho = \frac{RA}{l}$$

When the area of cross-section, *A* = 1 m^2 and the length of the wire, *l* = 1 m, $\rho = R$.

Resistivity is the resistance of the conductor whose area of cross-section, *A* is 1 m^2 and length, *l* is 1 m.

b The SI unit of resistivity is Ωm or ohm-metre.

1 ohm-metre is the resistance of a conductor that has a resistance of 1 ohm and whose area of cross-section, *A* is 1 m^2 and length, *l* is 1 m.

c Difference between resistance and resistivity:

Resistance	Resistivity
1. It depends on the dimensions of the conductor like radius and length. 2. Resistance of a given material may change at constant temperature.	1. It does not depend on the dimensions of the conductor. 2. Resistivity of a given material does not change at constant temperature.

d Resistivity of a substance depends on the material and the temperature of the substance. It does not depend on the dimensions of the substance like length, radius etc.

e Length of the wire, *l* = 1 m

Diameter of the wire, *d* = 0.3 mm

So the radius of the wire, *r* = 0.15 mm = 0.00015 m = 1.5 x 10^{-4} m

Area of cross-section of the wire, $A = \pi r^2 = 3.14 \times \left(1.5 \times 10^{-4} \right)^2 = 7.065 \times 10^{-8}\ m^2$

Resistance of the wire, *R* = 26 Ω

So resistivity,

$$\rho = \frac{RA}{l}$$

$$p = \frac{26 \times 7.065 \times 10^{-8}}{1} p = 1.84\ \times 10^{-8}\ \Omega m$$

Thus, the resistivity of the material is $1.84 \times 10^{-8}\ \Omega m.$

Question:115

The resistance of a wire of length 300 m and cross-section area 1.0 mm^2 made of material of resistivity 1.0 × 10–7 Ωm is:

a 2 Ω
b 3 Ω
c 20 Ω
d 30 Ω

Solution:

d 30 Ω

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

Length, *l* = 300 m

Cross-section area, *A* = 1.0 mm^2 = 10^{-6} m^2

Resistivity, ρ = 1.0 × 10^{-7} Ωm

Resistance, $R = \frac{10^{-7} \times 300}{10^{-6}}$

R = 30 Ω

Question:116

When the diameter of a wire is doubled, its resistance becomes:

a double
b four times
c one-half
d one-fourth

Solution:

d one-fourth

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

When the diameter is doubled, $d' = 2d$

Radius, $r' = 2r$

Area of cross-section, $A' = \pi r'^2 = \pi (2r)^2 = 4\pi r^2 = 4A$

The area of cross-section will increase by four times.

Then the new resistance, $R' = \frac{\rho l}{A'}$

$$R' = \frac{\rho l}{4A}$$

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

Thus, the resistance will get reduced by four times.

Question:117

If the resistance of a certain copper wire is 1 Ω, then the resistance of a similar nichrome wire will be about:

a 25 Ω
b 30 Ω
c 60 Ω
d 45 Ω

Solution:

c 60 Ω

If the resistance of a certain copper wire is 1 Ω, the resistance of a similar nichrome wire will be about 60 Ω because the resistivity of nichrome is 60 times the resistivity of copper.

Question:118

If the diameter of a resistance wire is halved, then its resistance becomes:

a four times
b half
c one-fourth
d two times

Solution:

a four times

Resistance of the wire is given by:

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

When the diameter is halved:

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

Radius:

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

Area of cross-section:

$$A' = \pi r'^2 = \pi(\frac{r}{2})^2 = \frac{\pi r^2}{4} = \frac{A}{4}$$

Area of cross-section will get reduced by four times.

Then the new resistance:

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

$$R' = \frac{4\rho l}{A}$$

$$R' = 4R$$

Thus, the resistance will increase by four times.

Question:119

The resistivity of a certain material is 0.6 Ωm. The material is most likely to be:

a an insulator

b a superconductor
c a conductor
d a semiconductor
Solution:
d a semiconductor
The resistivity of a certain material is 0.6 Ωm. The material is most likely to be a semiconductor because it has moderate resistivity.

Question:120
When the area of cross-section of a conductor is doubled, its resistance becomes:

a double
b half
c four time
d one-fourth
Solution:

b half
We know that the resistance of a conductor is given by:
$R = \rho \frac{l}{A}$
where ρ = resistivity
l = length of the conductor
A = area of the cross-section of the conductor
Let the new resistance be R' when the area of cross-section of the conductor is doubled
$R' = \rho \frac{l}{2A}$

Thus, the new resistance becomes half of the previous one.

Question:121
The resistivity of copper metal depends on only one of the following factors. This factor is:

a length
b thickness
c temperature
d area of cross-section
Solution:
c temperature
The resistivity of copper depends only on temperature.

Question:122

If the area of cross-section of a resistance wire is halved, then its resistance becomes:

a one-half
b 2 times
c one-fourth
d 4 times

Solution:

b 2 times

The resistance of a conductor is inversely proportional to its area of cross-section, i.e. *R* α 1 / *A*. So, when the area of cross-section of a resistance wire is halved, its resistance will increase by two times.

Question:123

A piece of wire of resistance 20 Ω is drawn out so that its length is increased to twice its original length. Calculate the resistance of the wire in the new situation.

Solution:

We know that the resistance of a conductor is given by:

$$\mathrm{R} = \rho \frac{\mathrm{l}}{\mathrm{A}} = 20\ \Omega$$

where ρ = resistivity

l = length of the conductor

A = area of cross-section of the conductor

Now the length is increased to twice the original length. Then let the new resistance be denoted by R'.

$$\mathrm{R'} = \rho \frac{2\mathrm{l}}{\frac{\mathrm{A}}{2}} = 4\rho \frac{\mathrm{l}}{\frac{\mathrm{A}}{2}} \mathrm{R'} = 4\mathrm{R} = 4 \times 20 = 80\ \Omega$$

Thus, the new resistance will become four times.

Question:124

The electrical resistivities of three materials P, Q and R given below:

P	2.3×10^{3} Ω m
Q	2.63×10^{-8} Ω m
R	1.0×10^{15} Ω

Which material will you use for making (*a*) electric wires (*b*) handle for soldering iron, and c solar cells? Give reasons for your choices.

Solution:

a electric wires: They are made of conductors. Conductors have a low resistivity and so, we will use material Q.

Q	2.63×10^{-8} Ω m: low resistivity

b handle for soldering iron: It is made of an insulator. An insulator has a high resistivity and so, we will use material R.

R	1.0×10^{15} Ω: high resistivity

c solar cells: They are made of semiconductors. A semiconductor has moderate resistivity and so, we will use material P.

P	2.3×10^{3} Ω m: moderate resistivity

Question:125

The electrical resistivities of four materials A, B, C and D are given below:

A	110×10^{-8} Ω m
B	1.0×10^{10} Ω m
C	10.0×10^{-8} Ω m
D	2.3×10^{3} Ω m

Which material is : (*a*) good conductor (*b*) resistor (*c*) insulator, and (*d*) semiconductor?

Solution:

The electrical resistivities of the four materials A, B, C and D are given. We can classify them as follows:

A	Semiconductor	110×10^{-8} Ωm
B	Insulator	1.0×10^{10} Ωm
C	Good conductor	10.0×10^{-8} Ωm
D	Resistor	2.3×10^{3} Ωm

Question:126

The electrical resistivities of five substances A, B, C, D and E are given below:

A		5.20×10^{-8} Ω

B		$110 \times 10^{-8}\ \Omega$
C		$2.60 \times 10^{-8}\ \Omega$
D		$10.0 \times 10^{-8}\ \Omega$
E		$1.70 \times 10^{-8}\ \Omega$

a Which substance is the best conductor of electricity? Why?
b Which one is a better conductor : A or C? Why?
c Which substance would you advice to be used for making heating elements of electric iron? Why?
d Which two substances should be used for making electric wires? Why?

Solution:

a E is the best conductor of electricity because its resistivity is the least among the given values.
(b) C is a better conductor than A because its resistivity is less than that of A.
c B should be used for making heating elements of electric iron because its resistivity is the highest among the given values.
d E and C should be used for making electric wires because their resistivity is less.

Question:127

How does the resistance of a wire change when:

i its length is tripled?
ii its diameter is tripled?
iii its material is changed to one whose resistivity is three times?

Solution:

Resistance,

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

where l = length of wire

A= area of cross-section of the wire

i When the length is tripled, $l' = 3l$

New resistance,

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

$$R' = \frac{\rho 3l}{A} = \frac{3\rho l}{A}$$

$$R' = 3R$$

Thus, the resistance will become three times the original resistance.

ii When the diameter is tripled, $d' = 3d$

Radius, $r' = 3r$

Area of cross-section, $A' = \pi r'^2 = \pi(3r)^2 = 9\pi r^2 = 9A$

Thus, the area of cross-section will become nine times.

Then the new resistance,

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

$$R' = \frac{\rho l}{9A}$$

$$R' = \frac{R}{9}$$

Thus, the resistance will be reduced by nine times.

iii When the material is changed to one whose resistivity is three times:

New resistivity, $\rho' = 3\rho$

The new resistance,

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

$$R' = \frac{3\rho l}{A} = 3R$$

Thus, the resistance will become three times the original resistance.

Question:128

Calculate the area of cross-section of a wire if its length is 1.0 m, its resistance is 23 Ω and the resistivity of the material of the wire is 1.84×10^{-6} Ωm.

Solution:

Length of the wire, l =1.0 m

Resistance of the wire = 23 Ω

Resistivity of the material of the wire = 1.84×10^{-6} Ωm.

We know that,

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

Area of cross-section,

$$A = \frac{1.84 \times 10^{-6} \times 1}{23}$$

$A = 8 \times 10^{-8}$ m^2

Thus, the area the of cross-section of the wire, $A = 8 \times 10^{-8}\ m^2$

Question:129

Give the law of combination of resistances in series.

Solution:

In a series combination, the same current flows through each resistor. Let the supplied voltage, V be divided as V_1, V_2 and V_3 in resistors R_1, R_2 and R_3, respectively.

$V = V_1 + V_2 + V_3$

$IR = IR_1 + IR_2 + IR_3$

$IR = I(R_1 + R_2 + R_3)$

$R = R_1 + R_2 + R_3$

Thus, in the case of a series combination, the total resistance, R is the sum of the individual resistance R_1, R_2 and R_3.

Question:130

If five resistances, each of value 0.2 ohm, are connected in series, what will be the resultant resistance?

Solution:

If five resistors, each of value 0.2 Ω, are connected in series, the resultant resistance will be the sum of the individual resistances.

$R = R_1 + R_2 + R_3 + R_4 + R_5$

$R = 0.2 + 0.2 + 0.2 + 0.2 + 0.2$

$R = 5 \times 0.2$

$R = 1\ \Omega$

Question:131

State the law of combination of resistances in parallel.

Solution:

In a parallel combination, the voltage remains the same across each resistor but the current gets divided. Let I_1, I_2 and I_3 be the current across resistors R_1, R_2 and R_3, respectively.

$I = I_1 + I_2 + I_3$

$V = IR$, $V = I_1R_1$, $V = I_2R_2$, $V = I_3R_3$

So, the total resistance is the sum of the reciprocal of the individual resistances.

Question:132

If 3 resistances of 3 ohm each are connected in parallel, what will be their total resistance?

Solution:

If three resistors, each of 3 Ω, are connected in parallel combination, the total resistance of the parallel combination will be:

The total resistance of the parallel combination is 1 Ω.

Question:133

How should the two resistances of 2 ohms each be connected so as to produce an equivalent resistance of 1 ohm?

Solution:

The two resistors of 2 Ω each should be connected in parallel combination to produce equivalent resistance of 1 Ω.

R = 1

Total resistance, R = 1 Ω

Question:134

$V = IR$Two resistances X and Y are connected turn by turn : (*i*) in parallel, and (*ii*) series. In which case the resultant resistance will be less than either of the individual resistances?$R = R_1 + R_2 + R_3$

Solution:

When two resistors, X and Y are connected in parallel combination, the total resistance will be less than the individual resistance. The total resistance in a parallel arrangement is given by:

where as in a series combination, the total resistance is more than the individual resistances. The total resistance in a series combination is given by:

R = $R_1 + R_2$

Question:135

What possible values of resultant resistance one can get by combining two resistances, one of value 2 ohm and the other 6 ohm?

Solution:

Case 1

Connecting a 2 Ω and 6 Ω resistor in series combination:

$R = R_1 + R_2$

$R = 2 + 6 = 8$

Thus, we will get an 8 Ω resistor.

Case 2

Connecting a 2 Ω and 6 Ω resistor in parallel combination:

Thus, we will get a 1.5 Ω resistor.

Question:136

Show how you would connect two 4 ohm resistors to produce a combined resistance of (*a*) 2 ohms (*b*) 8 ohms.

Solution:

a **Case 1**

Connecting two 4 Ω resistors in parallel combination:

b **Case 2**

Connecting two 4 Ω resistors in series combination:

$R = R_1 + R_2$

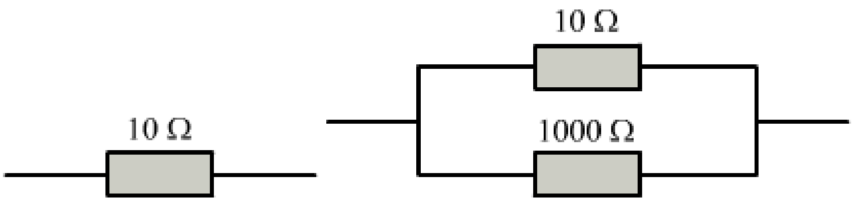
$R = 4 + 4 = 8$

Thus, we will get an 8 Ω resistor.

We should connect two 4 resistors in parallel to get a resistance of 8 .

Question:137

Which of the following arrangement, A or B, has the lower combined resistance?



Solution:

In figure A, the resistance, R_A = 10 Ω

In figure B, the resistors of 10 Ω and 1000 Ω are connected in parallel combination.
Therefore:

R_B = 9.9 Ω

So, the arrangement B has lower resistance.

Question:138

A wire that has resistance *R* is cut into two equal pieces. The two parts are joined in parallel. What is the resistance of the combination?

Solution:

A wire that has a resistance, *R* is cut into two equal pieces.
The resistance of the each piece will be .

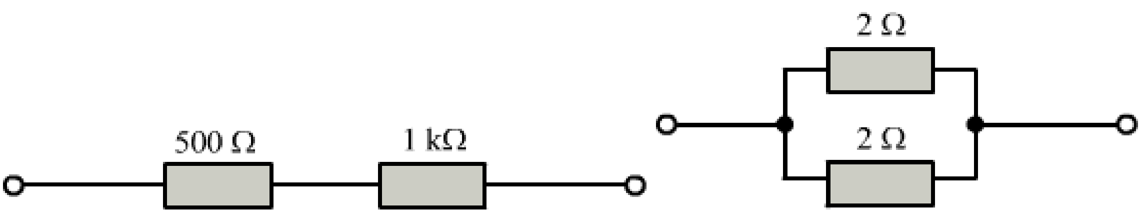
The two parts, each of resistance, are joined in parallel.

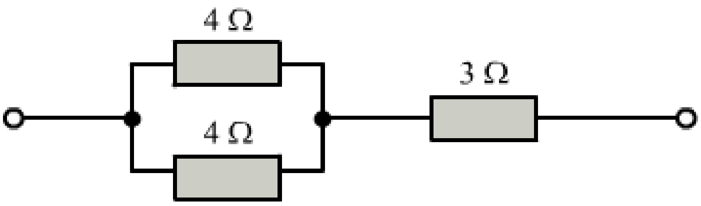
The resistance of the parallel combination:

Thus, the resistance of the combination will be *R*/4.

Question:139

Calculate the combined resistance in each case:





Solution:

Case 1

Let the total resistance of the combination shown in the diagram below be R.

Here 500 Ω and 1000 Ω resistors are connected in series combination. Their net resistance is given by $R = R_1 + R_2$

Here:

R_1=500 Ω

R_2=1000 Ω

So:

R = 500 + 1000 = 1500 Ω

Thus, the total resistance of the combination is 1500 Ω.

Case 2

In the circuit diagram shown above, two 2 Ω resistors are connected in parallel combination. Therefore:

Thus the total resistance of the combination is 1 Ω.

Case 3

In the circuit diagram shown above, two 4 Ω resistors are connected in parallel combination.

In the above circuit diagram, this 2 Ω and 3 Ω resistors are connected in series combination. So, the total resistance of the circuit can be calculated as:

$R = R_1 + R_2$

here

R_1= 2 Ω

R_2= 3 Ω

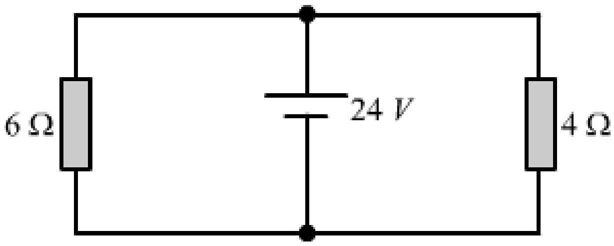
So:

R = 2 Ω + 3 Ω = 5 Ω

Thus, the total resistance of the combination is 5 Ω.

Question:140

Find the current in each resistor in the circuit shown below:



Solution:

In the given circuit, two 6 Ω and 4 Ω resistors are connected in parallel combination across a cell of 24 V. We know that in a parallel combination, the voltage across the resistor remains the same and only the current gets divided. So the current (I_1) through the 6 Ω resistor is:

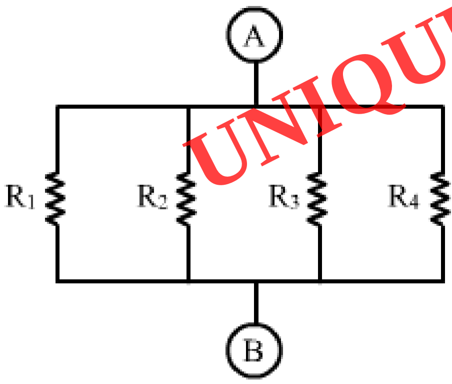
The current (I_2) through the 4 Ω resistor is:

Question:141

Explain with diagram what is meant by the "series combination" and "parallel combination" of resistances. In which case the resultant resistance is : i less, and ii more, than either of the individual resistances?

Solution:

Resistance in series



Resistance in parallel

The series resistance is given by $R = R_1 + R_2 + R_3 + R_4$. Hence, it is more than the individual resistance.

The parallel resistance is given by $1 / R = 1 / R_1 + 1 / R_2 + 1 / R_3 + 1 / R_4$. Hence, it is less than the individual resistance.

Question:142

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 0.12 Ω. How much current would flow through the 12 Ω resistor?

Solution:

When five resistors are connected in series, the total resistance is given by:

$R = R_1 + R_2 + R_3 + R_4 + R_5$

Here,

$R_1 = 0.2$,

$R_2 = 0.3$,

$R_3 = 0.4$,

$R_4 = 0.5$,

$R_5 = 0.12$

Therefore:

$R = 0.2\ \Omega + 0.3\ \Omega + 0.4\ \Omega + 0.5\ \Omega + 12\ \Omega$

$R = 13.4\ \Omega$

Total resistance of the circuit = 13.4 Ω

The current flowing through this series combination is given by $I = V / R$.

or $I = 9 / 13.4 = 0.67$ A

Now since the resistors are connected in series, the current flowing through each resistance is the same. Hence, the current through the 12 Ω resistor is equal to 0.67 A.

Question:143

An electric bulb of resistance 20 Ω and a resistance wire of 4 Ω are connected in series with a 6 V battery.

Draw the circuit diagram, and calculate:

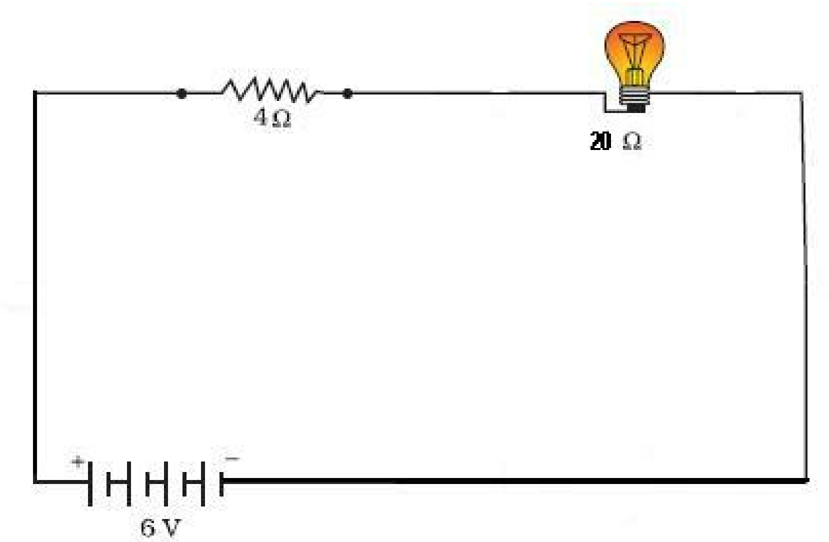
(*a*) total resistance of the circuit.

(*b*) current through the circuit.

(*c*) potential difference across the electric bulb.

(*d*) potential difference across the resistance wire.

Solution:



a Total resistance, $R = 20\ \Omega + 4\ \Omega = 24\ \Omega$

b Current through the circuit,

$I = V/R$

$I = 6/24$

$I = 0.25$ A

c Potential difference across the electric bulb,

$V_{bulb} = IR_{bulb}$

$=0.2520$

$= 5$ V

d Potential difference across the resistance wire,

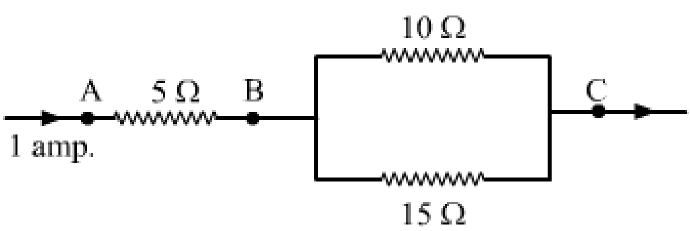
$V_{wire} = IR_{wire}$

$= 0.254$

$= 1$ V

Question:144

Three resistors are connected as shown in the diagram.



Through the resistor 5 ohm, a current of 1 ampere is flowing.

(*i*) What is the current through the other two resistors?

(*ii*) What is the p.d. across *AB* and across *AC*?

(*iii*) What is the total resistance

Solution:

i The resistance between B and C are in parallel. Hence the total resistance, R between B and C is given by:

R_{BC}= 15 x 10 / 15 + 10 = 6 Ω ... a

Potential drop across B and C = IR = 1 x 6 = 6 V

Current through the 10 Ω resistor = V / R = 6 / 10 = 0.6 A

Current through the 15 Ω resistor = V / R = 6 / 15 = 0.4 A

ii p.d. across AB:

V_{AB} = 5 x 1 = 5 V

p.d. across AC:

V_{AC} = I x R_{AC}

R_{AC} = R + 5 = 11 Ω see equation (a)

V_{AC} = 1 x 11 = 11 V

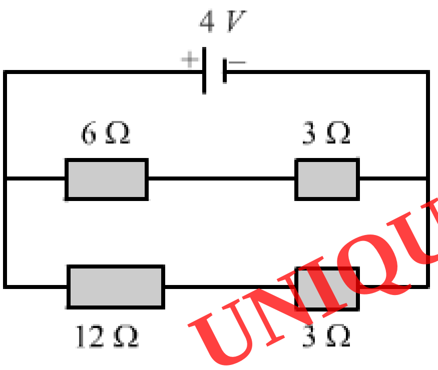
iii Total resistance, R_{AC} = R_{BC} + R_{AC}

= 6 + 5

= 11 Ω

Question:145

For the circuit shown in the diagram below:



What is the value of:

i current through 6 Ω resistor?

ii potential difference across 12 Ω resistor?

Solution:

1 The resistors of 6 Ω and 3 Ω are connected in series. Therefore, their net resistance can be calculated as:

$R = R_1 + R_2$

Here, R_1 = 6 Ω

R_2 = 3 Ω

So:

R = 6 Ω + 3 Ω = 9 Ω

The current through this branch, $I = V/R$

$I = 4/9 = 0.44$ A

In a series combination, the current remains the same. So the current through the 6 Ω resistor is 0.44 A.

2 The current through the branch with resistors of 12 Ω and 3 Ω:

$I = V/R$

$I = 4/12 + 3 = 4 / 15$ A

The potential difference across the 12 Ω resistance can be obtained by using the equation,

$V = IR$.

$V = 4 / 15 \times 12 = 3.2$ V

Question:146

Two resistors, with resistance 5 Ω and 10 Ω respectively are to be connected to a battery of emf 6 V so as to obtain:

i minimum current flowing

ii maximum current flowing

a How will you connect the resistances in each case?

b Calculate the strength of the total current in the circuit in the two cases.

Solution:

a For the minimum current flowing in the circuit, the resistors should be connected in series and for the maximum current in the circuit, the resistors should be connected in parallel with the battery.

b When the resistors are connected in parallel:

Total resistance = 3.33 Ω

Therefore, strength of the total current, $I = V / R$

$I = 6 / 3.33$

$I = 1.8$ A

When the resistors are connected in series, the resultant resistance is given by $R = R_1 + R_2$

Here, $R_1 = 5$

$R_2 = 10$

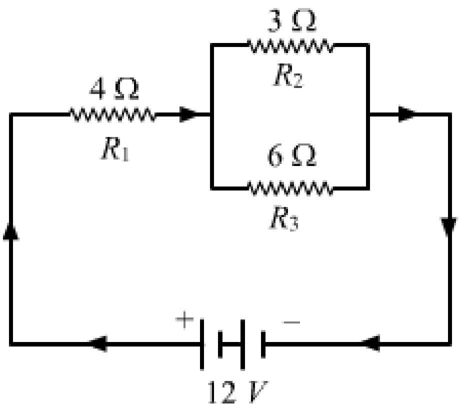
So, $R = 5 + 10 = 15$

Total resistance = 15 Ω

Therefore, strength of the total current, $I = 6 / 15 = 0.4$ A

Question:147

The circuit diagram given below shows the combination of three resistors R_1, R_2 and R_3:



Find :

i total resistance of the circuit.

ii total current flowing in the circuit.

iii the potential difference across R_1.

Solution:

i As shown in the figure, the resistors R_2 and $R3$ are connected in parallel. Their total resistance is given by:

$1/R = 1/R_2 + 1/R_3$

Here, $R_2 = 3\ \Omega$

$R_3 = 6\ \Omega$

So,

$1/R = 1/3 + 1/6$

Or $1/R = 2+1/6$

$1/R = 3/6$

$R = 2\ \Omega$

This resistance is in series with the resistor, R_1.

Total resistance = $2\ \Omega + R_1$

$R_1 = 4\ \Omega$

Therefore, total resistance = $2\ \Omega + 4\ \Omega = 6\ \Omega$

ii The current through the circuit can be calculated as follows:

Current, $I = V / R$

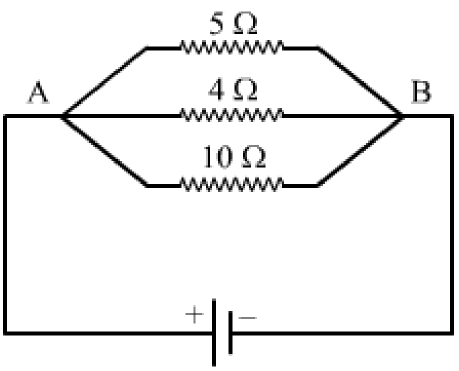
$I = 12 / 6$ A

$I = 2$ A

iii The potential difference across R_1 = 2 A x 4 Ω = 8 V

Question:148

In the circuit diagram given below, the current flowing across 5 ohm resistor is 1 amp. Find the current flowing through the other two resistors.



Solution:

Given I = 1 A Across 5 Ω

R = 5 Ω

The potential drop across AB, $V = I R$

or V = 5 Ω x 1 A = 5 V

In a parallel circuit, the potential difference across the ends of all resistors remains the same.

Therefore, the potential difference across 4 Ω and 10 Ω will be 5 V:

The current flowing through the 4 Ω resistor, $I = V/R$.

Here, V = 5 V

R = 4 Ω

So, I = 5/4 = 1.25 A

The current flowing through the 10 Ω resistor, $I = V/R$.

Here, V = 5 V

R = 10 Ω

So. I = 5/10 = 0.5 A

Question:149

A resistor has a resistance of 176 ohms. How many of these resistors should be connected in parallel so that their combination draws a current of 5 amperes from a 220 volt supply line?

Solution:

Suppose x resistors should be connected in parallel to draw a current of 5 A.

For a parallel combination, $1 / R = 1 / R_1 + 1 / R_2 + 1 / R_3 + ...$ (x times)

Here, $R_1 = R_2 = R_3 = ... = 176\ \Omega$

Then the resultant resistance, $R = 176 / x\ \Omega$

Given that the current, $I = 5$ A and voltage, $V = 220$ V

Then by Ohm's law, $V = IR$

By substituting the values, we get:

$x = 4$

Hence, four resistors of 176 Ω each should be connected in parallel to draw a current of 5 A from a 220 V supply line.

Question:150

An electric heater which is connected to a 220 V supply line has two resistance coils *A* and *B* of 24 Ω resistance each. These coils can be used separately one at a time, in series or in parallel. Calculate the current drawn when:

a only one coil *A* is used.
b coils *A* and *B* are used in series.
c coils *A* and *B* are uses in parallel.

Solution:

a When only one coil, A is used:

$V = IR$

$220 = 24\ I$

$I = 9.2$ A

b When coils, A and B are used in series:

Total resistance $R = R_A + R_B = 48\ \Omega$

$V = IR$

$220 = 48\ I$

$I = 4.58$ A

c When coils, A and B are used in parallel:

$1/R = 1/R_A + 1/R_B$

Here, $R_A = 24\ \Omega$ and $R_B = 24\ \Omega$

$1/R = 1/24 + 1/24$

or $1/R = 2/24$

$R = 12\ \Omega$

Total resistance of parallel combination, $R = 12\ \Omega$

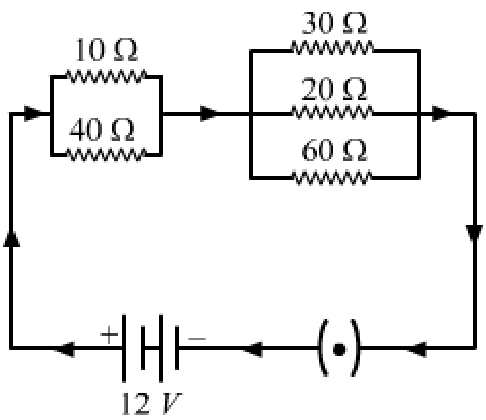
Now, $V = IR$

$220 = 12\ I$

$I = 18.33$ A

Question:151

In the circuit diagram given below five resistances of 10 Ω, 40 Ω, 30 Ω, 20 Ω, and 60 Ω are connected as shown to a 12 V battery.



Calculate:

(*a*) total resistance in the circuit.

(*b*) total current flowing in the circuit.

Solution:

a When three resistors are connected in parallel, the net resistance can be obtained as followed:

$1/R = 1/R_1 + 1/R_2 + 1/R_3$

The resistors of 30 Ω, 20 Ω and 60 Ω are connected in parallel. Therefore, the net resistance R will be:

$1/R = 1/30 + 1/20 + 1/60$

$1/R = 2 + 3 + 1/60$

$1/R = 6/60$

$R = 10\ \Omega$

Two more resistors of 10 Ω and 40 Ω are connected in parallel to each other. Therefore, their net resistance, R' will be:

$1/R' = 1/10 + 1/40$

$1/R' = 4 + 1/40$

$1/R' = 5/40$

$R' = 8\ \Omega$

The resistors of 8 Ω and 10 Ω are connected in series. Therefore, the net resistance of the circuit

$= R + R' = 8\ \Omega + 10\ \Omega = 18\ \Omega$

b The total current flowing through the circuit can be calculated as:

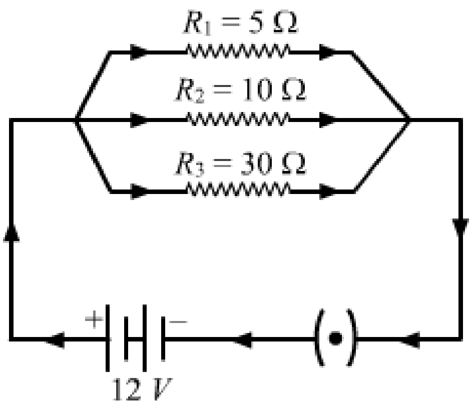
$I = V/R$

$I = 12/18$

$I = 0.67$ A

Question:152

In the circuit diagram given below, three resistors R1, R2, and R3 of 5 Ω, 10 Ω and 30 Ω, respectively are connected as shown



Calculate:

a current through each resistor.

b total current in the circuit.

c total resistance in the circuit.

Solution:

Ia Let I_1, I_2 and I_3 be the current flowing through the resistors of 5 Ω, 100 Ω and 30 Ω, respectively.

According to Ohm's law, $V = IR$

Here, $V = 12$ V and $R = 5$ Ω

$I = V/R$

$I_1 = 12/5 = 2.4$ A

$I_2 = 12/10 = 1.2$ A

$I_3 = 12/30 = 0.4$ A

b Total current through the circuit, $I = I_1 + I_2 + I_3$

= 2.4 A + 1.2 A + 0.4 A

= 4 A

c The resistors of 5 Ω, 100 Ω and 30 Ω are connected in parallel. Therefore, the net resistance will be:

$1/R = 1/R_1 + 1/R_2 + 1/R_3$

$1/R = 1/5 + 1/10 + 1/30$

$1/R = 6 + 3 + 1/30$

$I/R = 10/30$

$R = 3\ \Omega$

Question:153

A p.d. of 4 V is applied to two resistors of 6 Ω and 2 Ω connected in series. Calculate:

a the combined resistance

b the current flowing

c the p.d. across the 6 Ω resistor

Solution:

a When two resistors are connected in series, their resultant resistance is given by

$R = R_1 + R_2$

Here, $R_1 = 6$,

$R_2 = 2$

Therefore

The resulatant resistance, $R = 6 + 2 = 8\ \Omega$

b The current flowing through circuit is:

$V = IR$

$I = V/R = 4/8$

$I = 0.5$ A

c The p.d. across the 6 Ω resistor is:

$V = 0.5$ A x 6 Ω = 3 V

Question:154

A p.d. of 6 V is applied to two resistors of 3 Ω and 6 Ω connected in parallel. Calculate:

a the combined resistance

b the current flowing in the main circuit

c the current flowing in the 3 Ω resistor.

Solution:

a The resistors of 3 Ω and 6 Ω are connected in parallel. Therefore, their net resistance can be calculated as:

$1/R = 1/R_1 + 1/R_2$

Here, $R_1 = 3\ \Omega$

$R_2 = 6\ \Omega$

So:

$1/R = 1/3 + 1/6$

$1/R = 2 + 1/6$

$1/R = 3/6$

$R = 2\ \Omega$

b The current flowing through the main circuit,

$I = V/R$

$I = 6/2$ A

$I = 3$ A

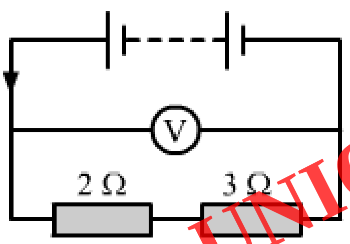
c The current flowing in the 3 Ω resistor,

$I = V/R$

$I = 6/3 = 2$ A

Question:155

In the circuit shown below, the voltmeter reads 10 V.



a What is the combined resistance?

b What current flows?

c What is the p.d. across 2 Ω resistor?

d What is the p.d. across 3 Ω resistor?

Solution:

a The resistors of 2 Ω and 3 Ω are connected in series.

Therefore their combined resistance, $R = R_1 + R_2$

Here, R_1=2 Ω

R_2=3 Ω

So, the combined resistance, $R = 2\ \Omega + 3\ \Omega$

$R = 5\ \Omega$

b The current, I in the circuit can be calculated as:

$V = IR$

or $I = 10 / 5 = 2$ A

c The p.d. across the 2 Ω resistor is:

$V = IR$

or $V = 22 = 4$ V

d The p.d. across the 3 Ω resistor:

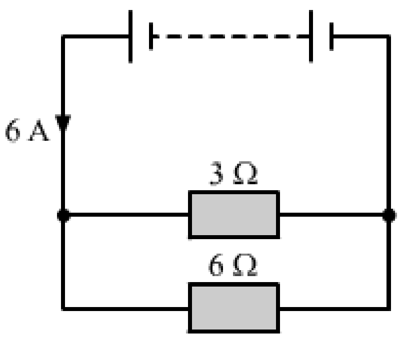
$V = IR$

or $V = 2 \times 3$

or $V = 6$ V

Question:156

In the circuit given below:



a What is the combined resistance?

b What is the p.d. across the combined resistor?

c What is the p.d. across the 3 Ω resistor?

d What is the current in the 3 Ω resistor?

e What is the current in the 6 Ω resistor?

Solution:

a The resistors of 6 Ω and 3 Ω are connected in parallel. Therefore, their combined resistance can be calculated as:

$1/R = 1/R_1 + 1/R_2$

Here, $R_1 = 6\ \Omega$,

$R_2 = 3\ \Omega$

$1/R = 1/6 + 1/3$

$1/R = 1 + 2/6$

$R = 6/3$

$R = 2\ \Omega$

b Potential difference, $V = IR$

The potential difference across the combined resistance,

$V = (6 \;\; 2)$ V

$V = 12$ V

c The potential difference across the 3 Ω resistor can be calculated as:

$V = IR$

$V = 63 = 18$ V

d The current across the 3 Ω resistor is:

$I = V/R$

$I = 12/3$

$I = 4$ A

e The current across the 6 Ω resistor is:

$I = V/R$

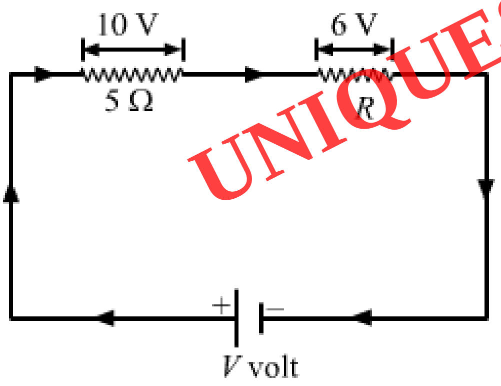
$I = 12/6$

$I = 2$ A

Question:157

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

b Two resistances are connected in series as shown in the diagram:



i What is the current through the 5 ohm resistance?

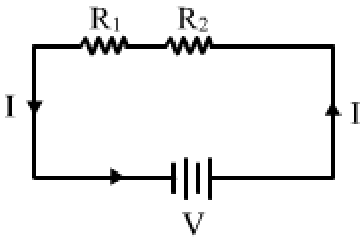
ii What is the current through R?

iii What is the value of R?

iv What is the value of V?

Solution:

a

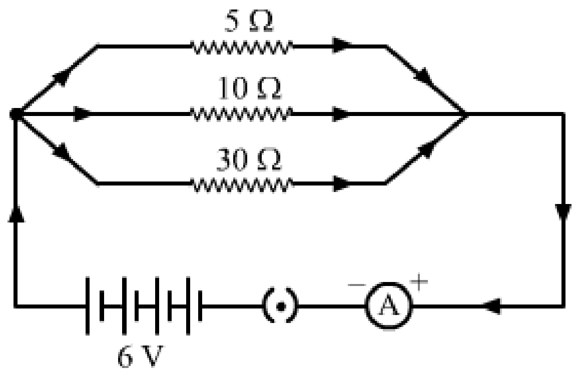


a Let the current in the circuit be I amperes and the battery be of strength V volts.
Let the combined resistance of the three resistors be R ohms.
Therefore, according to Ohm's law, we have:
$V = IR$ ... 1
We know that when resistors are connected in series, the current is the same in all the resistors but the voltage is different across each resistor.
Therefore:
$V = V_1 + V_2$
$V = IR_1 + IR_2$
$V = I(R_1 + R_2)$ ... 2
From the equations 1 and 2 we have:
$R = R_1 + R_2$

b
i The current through the 5 Ω resistance can be obtained using the equation,
$I = V/R$
or $I = 10/5 = 2$ A
ii In a series arrangement, the current remains the same across each resistance. Therefore, the current through R also will be 2 A.

iii Value of $R = V/I$
$R = 6/2 = 3\ \Omega$
iv The value of $V = IR$
$V = 2 \times (3 + 5) = 16$ V

Question:158
a With the help of a diagram, derive the formula for the resultant resistance of three resistors connected in series.
b For the circuit shown in the diagram given below:



Calculate:

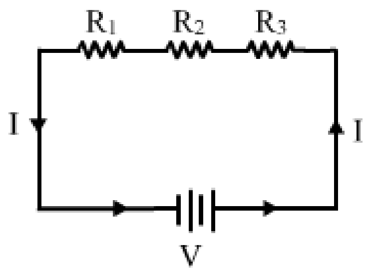
i the value of current through each resistor.

ii the total current in the circuit.

iii the total effective resistance of the circuit.

Solution:

a



Let the current in the circuit be I amperes and the battery be of strength V volts.

Let the combined resistance of the three resistors be R ohms.

Therefore, according to Ohm's law, we have:

$V = IR$ 1

We know that when the resistors are connected in series, the current is the same in all the resistors.

Therefore:

$V = V_1 + V_2 + V_3$

$V = IR_1 + IR_2 + IR_3$

$V = I(R_1 + R_2 + R_3)$ ... 2

From the equations 1 and 2 we have:

$R = R_1 + R_2 + R_3$

b The current through the 5 Ω resistor can be calculated as:

$V = IR$

$I = V/R$

$I = 6/5 = 1.2$ A

The current through the 10 Ω resistor can be calculated as:

$I = V/R$

$I = 6/10 = 0.6$ A

The current through the 30 Ω resistor can be calculated as:

$I = V/R$

$I = 6/30 = 0.2$ A

b The total current in the circuit, $I = 1.2$ A + 0.6 A + 0.2 A = 2 A

c The three resistors are connected in parallel. Therefore:

$1/R = 1/R_1 + 1/R_2 + 1/R_3$

Here, R_1=5 ,

R_2 = 10 ,

R_3= 30

$1/R = 1/5 + 1/10 + 1/30$

$1/R = 6 + 3 + 1/30$

$1/R = 10/30$

$R = 3\ \Omega$

Question:159

A 5 V battery is connected to two 20 Ω resistors which are joined together in series.

a Draw a circuit diagram to represent this. Add an arrow to indicate the direction of conventional current flow in the circuit.

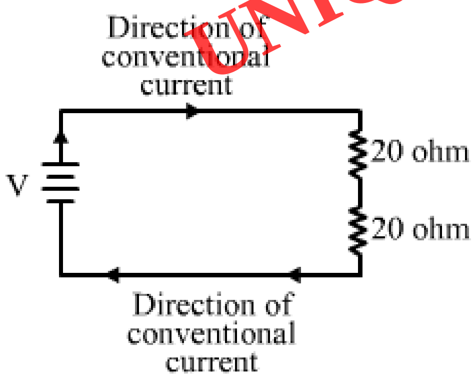
b What is the effective resistance of the two resistors?

c Calculate the current that flows from the battery?

d What is the p.d. across each resistor?

Solution:

a Circuit diagram



b Since two resistors of 20 Ω are connected in series, the effective resistance will be

$R = R_1 + R_2$

Here, R_1=20 Ω,

R_2 =20

Therefore,

R = 20 Ω + 20 Ω = 40

The effective resistance of the two resistors, R= 40 Ω c The current that flows from the battery,

$I = V / R$

$I = 5 / 40$

$I = 0.125$ A

d The p.d. across the 20 Ω resistor, $V = I R$

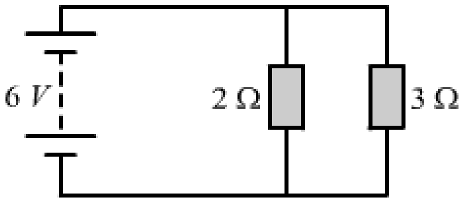
$V = 20 \times 0.125$ V

$V = 2.5$ V

Similarly, the potential difference across the second 20 Ω resistor is equal to 2.5 V.

Question:160

The figure given below shows an electric circuit in which current flows from a 6 V battery through two resistors.



a Are the resistors connected in series with each other or in parallel?

b For each resistors, state the p.d. across it.

c The current flowing from the battery is shared between the two resistors. Which resistor will have bigger share of the current?

d Calculate the effective resistance of the tow resistors.

e Calculate the current that flows form the battery.

Solution:

a The resistors are connected in parallel.

b In a parallel arrangement, the voltage remains the same across each resistor. The battery is also connected in parallel with the resistors. Therefore, the p.d across each resistor is 6 V.

c The 2 Ω resistor will have the bigger share of the current since resistance is inversely proportional to the current.

d The effective resistance of the parallel combination is:

e The current flowing through the battery, $I = 5$ A

Question:161

A 4 Ω coil and a 2 Ω coil are connected in parallel. What is their combined resistance? A total current of 3 A passes through the coils. What current passes through the 2 Ω coil?

Solution:

The coils of the resistors of 4 Ω and 2 Ω are connected in parallel. Therefore:

Combined resistance of the 4 Ω coil and the 2 Ω coil = 1.33 Ω

Total current = 3 A

The voltage across the whole cicuit,as in case of parallel circuit volatge is same scross all resistances.

$V = IR$.

$V = 3 \times 4/3 = 4$ V

Therefore, the current through the 2 Ω coil,

$I = V/R_1$.

$I = 4/2$ A

$I = 2$ A

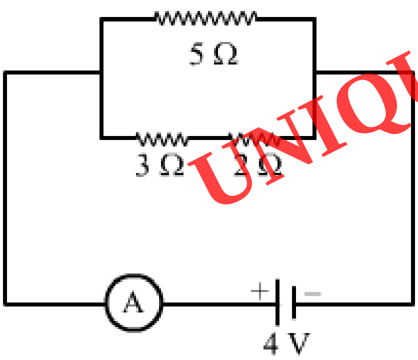
Question:162

a With the help of a circuit diagram, obtain the relation for the equivalent resistance of two resistances connected in parallel.

b In the circuit diagram shown below, find:

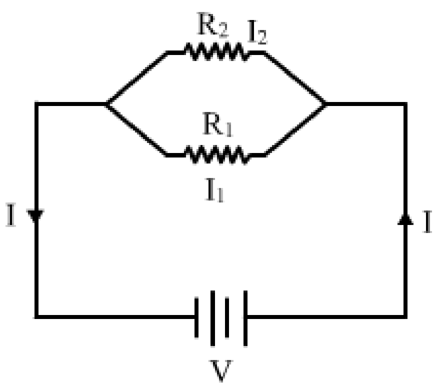
i Total resistance.

ii Current shown by the ammeter A



Solution:

a



a Let the individual resistance of the two resistors be R_1 and R_2 and their combined resistance be R. Let the total current flowing in the circuit be I and strength of the battery be V volts. Then, from Ohm's law, we have:

$V = IR$ ... 1

We know that when resistors are connected in parallel, the potential drop across each resistance is the same.

Therefore:

$I = I_1 + I_2$

$I = V/R_1 + V/R_2$

$I = V/(1/R_1 + 1/R_2)$ ... 2

From the equations 1 and 2 we have:

$1/R = 1/R_1 + 1/R_2$

b

1

ii The current shown by the ammeter *A*, i.e. the current in the circuit can be calculated as:

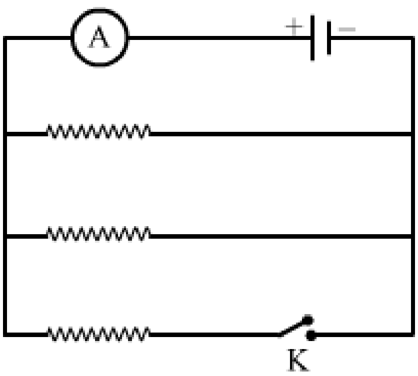
$I =$

$I == 1.6$ A

Question:163

a Explain with the help of a labelled circuit diagram, how you will find the resistance of a combination of three resistors of resistances R_1, R_2 and R_3 joined in parallel.

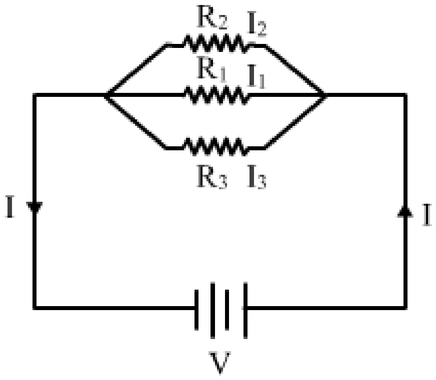
b In the diagram shown below, the cell and the ammeter both have negligible resistance. The resistor are identical.



With the switch *K* open, the ammeter reads 0.6 A. What will be the ammeter reading when the switch is closed?

Solution:

a



Let the resistance of the three resistors be R_1, R_2 and R_3, respectively. Let their combined resistance be R. Let the total current flowing in the circuit be I and the strength of the battery be V. Then from Ohm's law, we have:

$V = IR$ 1

We know that when the resistors are connected in parallel, the potential drop across each resistance is the same.

Therefore:

$I = I_1 + I_2 + I_3$

$I = V/R_1 + V/R_2 + V/R_3$

$I = V/(1/R_1 + 1/R_2 + 1/R_3)$ 2

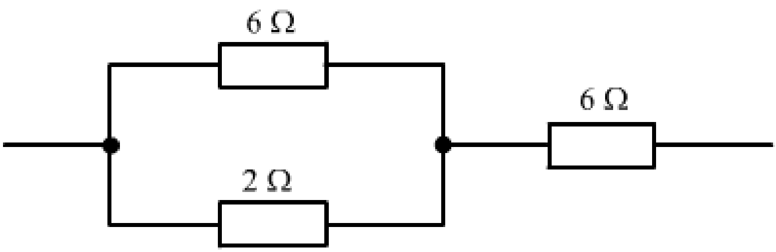
From equations 1 and 2 we have:

$1/R = 1/R_1 + 1/R_2 + 1/R_3$

b Let V be the voltage of the cell and R is the resistance of each resistor. When switch K is not closed then

Question:164

The figure given below shows three resistors?



Their combined resistance is :

a Ω
b 14 Ω
c Ω
d Ω

Solution:

d 7

The resistors of 6 Ω and 2 Ω are connected in parallel.

This arrangement is further connected in series with the 6 Ω resistor.

∴ Net resistance = = Ω

Question:165

If two resistors of 25 Ω and 15 Ω are joined together in series and then placed in parallel with a 40 Ω resistor, the effective resistance of the combination is :

a 0.1 Ω
b 10 Ω
c 20 Ω
d40 Ω

Solution:

c 20 Ω

When 25 Ω and 15 Ω are connected in series, then:

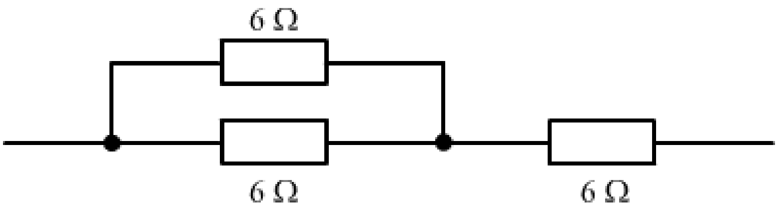
Total resistance, R = 25 + 15 = 40 Ω

This 40 Ω is connected in parallel with the 40 Ω resistor.

Therefore, the net resistance = 40 / 2 = 20 Ω

Question:166

The diagram below shows part of a circuit:



If this arrangement of three resistors was to be replaced by a single resistor, its resistance should be:

a 9 Ω
b 4 Ω
c 6 Ω
d 18 Ω

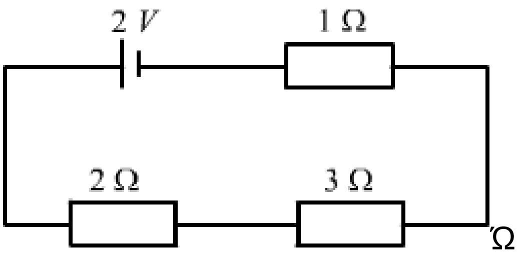
Solution:

a 9 Ω

The two resistors of 6 Ω are connected in parallel with each other. So, their net resistance 3 Ω is connected in series with a resistance of 6 Ω. So, the net resistance of the complete arrangement is 9 Ω.

Question:167

In the circuit shown below:



The potential difference across the 3 Ω resistor is:

a V
b V
c 1 V
d 2 V

Solution:

c 1V

The resistors of 1 , 2 and 3   are connected in series. Therefore, the net resistance,

$R = R_1 + R_2 + R_3$

$R = 1 + 2 + 3 = 6$

Current in the circuit will be,

$I = V/R$

or $I = 2/6 = 1/3$ A

Current = A

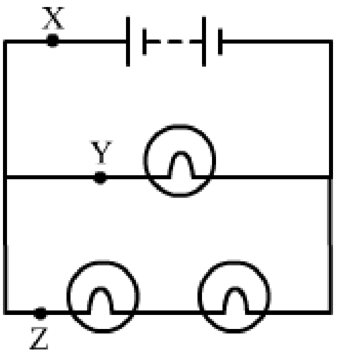
Therefore, the voltage across the 3 Ω resistor,

$V = IR$

or V= x 3 = 1 V

Question:168

A battery and three lamps are connected as shown:



Which of the following statements about the currents at X, Y and Z is correct?

a The current at Z is greater than that at Y.

b The current at Y is greater than that at Z.

c The current at X equals the current at Y.

d The current at X equals the current at Z.

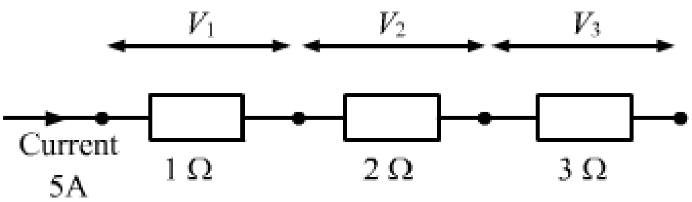
Solution:

b The current at Y is greater than that at Z.

This is so because Y alone will offer less resistance.

Question:169

V_1, V_2 and V_3 are the p.ds. across the 1Ω, 2Ω and 3Ω resistors in the following diagram, and the current is 5 A.



Which one of the columns (*a*) to (*d*) shows the correct values of V_1, V_2 and V_3 measured in volts?

	V_1	V_2	V_3
(*a*)	1.0	2.0	3.0
(*b*)	5.0	10.0	15.0
(*c*)	5.0	2.5	1.6
(*d*)	4.0	3.0	2.0

Solution:

b $V_1 = 5$, $V_2 = 10$ and $V_3 = 15$

Because $V = IR$, the net voltage can be obtained by multiplying current with resistance.

Question:170

A wire of resistance R_1 is cut into five equal pieces. These five pieces of wire are then connected in parallel. If the resultant resistance of this combination be R_2, then the ratio is:

a

b

c 5

d 25

Solution:

d 25

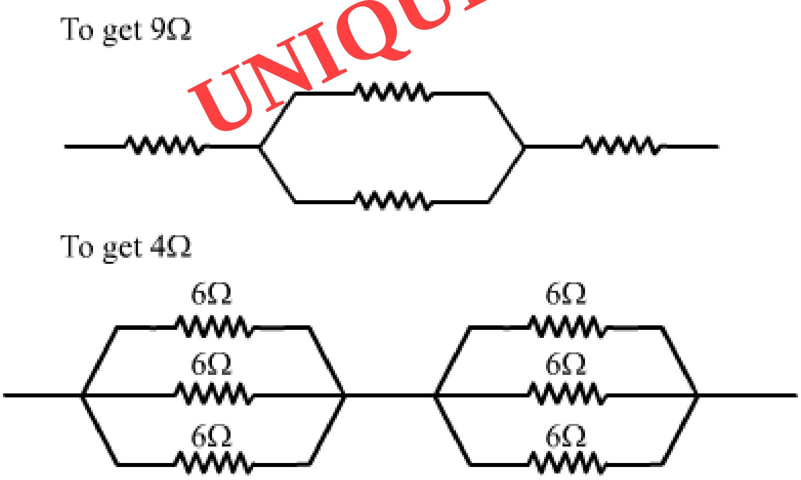
If the resistance wire is cut into five pieces, the resistance of each wire is $R/5$. If we connect the pieces in parallel, we will get the net resistance as $R/25$. Therefore, the ratio will be 25.

Question:171

Show with the help of diagrams, how you would connect three resistors each of resistance 6 Ω, so that the combination has resistance of (*i*) 9 Ω (*ii*) 4 Ω.

Solution:

i To obtain 9 Ω and 4 Ω , we should connect the resistors as follows:



Question:172

Two resistances when connected in parallel give resultant value of 2 ohm; when connected in series the value becomes 9 ohm. Calculate the value of each resistance.

Solution:

Let the resistances of the two resistors be *x* and *y*.

When they are connected in parallel, we have:

$1 / x + 1 / y = 1 / 2$ ... 1

When they are connected in series, we have:

$x + y = 9$ ... 2

On solving equations 1 and 2, we will obtain the values of the two resistors as 3 Ω and 6 Ω.

Question:173

A resistor of 8 ohms is connected in parallel with another resistor X. The resultant resistance of the combination is 4.8 ohms. What is the value of the resistor X?

Solution:

When the two resistors are connected in parallel, we have:

$x = 12\ \Omega$

Therefore, the value of $x = 12\ \Omega$

Question:174

You are given three resistances of 1, 2 and 3 ohms. Shows by diagrams, how with the help of these resistances you can get:

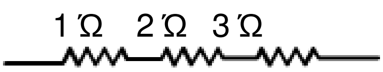
i 6 Ω

ii Ω

iii 1.5 Ω

Solution:

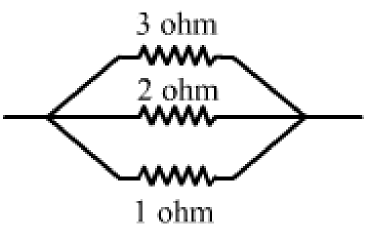
i To get a value of 6 Ω, all the resistors are to be connected in series as shown below:



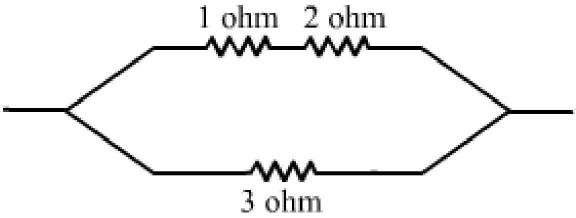
Net resistance, $R = R_1 + R_2 + R_3$

$R = 1\ \Omega + 2\ \Omega + 3\ \Omega = 6\ \Omega$

ii To get a value of 6 / 11 Ω, all the resistors are to be connected in parallel as shown below:



iii To get a value of 1.5 Ω, the 1 Ω and 2 Ω resistors should be connected in series and this arrangement should be connected in parallel with the 3 Ω resistor as shown below:



The resistors of resistance 1 Ω and 2 Ω are in series. Therefore, their net resistance is:

$R = R_1 + R_2$

$R = 1\ \Omega + 2\ \Omega$

$R = 3\ \Omega$

This 3 Ω is connected in parallel with another 3 Ω resistance.

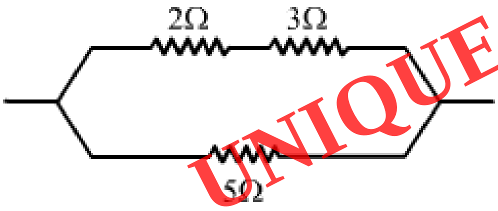
Therefore, net resistance will be:

Question:175

How will you connect three resistors of 2 Ω, 3 Ω and 5 Ω respectively so as to obtain a resultant of 2.5 Ω? Draw the diagram to show the arrangement.

Solution:

To get the resistance of 2.5 Ω, we will have to connect the resistors of values 2 Ω and 3 Ω in series and this arrangement should be connected in parallel with the resistor of value 5 Ω.



Question:176

How will you connect three resistors of resistances 2 Ω, 3 Ω, and 6 Ω to obtain a total resistance of (*a*) 4 Ω, and (*b*) 1 Ω?

Solution:

a To obtain a 4 Ω resistance, connect the 2 Ω resistor in series with the parallel combination of the resistors of values 6 Ω and 3 Ω.

b To obtain a 1 Ω resistance, connect all the resistors in parallel.

Question:177

What is a highest, and b lowest, resistance which can be obtained by combining four resistors having the following resistances?

4 Ω, 8 Ω, 12 Ω, 24 Ω

Solution:

a To get the highest resistance, all the resistors must be connected in series.

Resistance in a series arrangement is given by $R = R_1 + R_2 + R_3 + R_4$

Therefore, the highest resistance is 48 Ω.

b To get the lowest resistance, all the resistors must be connected in parallel.

Resistance in a parallel arrangement is given by:

Here $R_1 = 4$,

$R_2 = 8$,

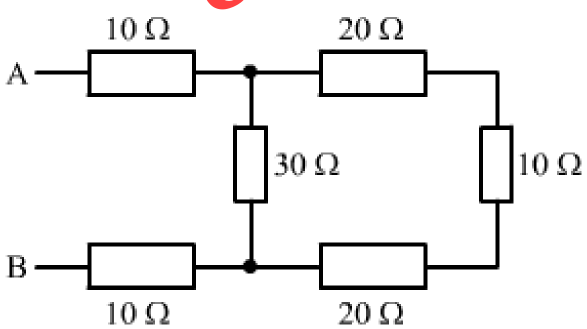
$R_3 = 12$,

$R_4 = 24$

Therefore, the lowest resistance of the arrangement is 2 Ω.

Question:178

What is the resistance between A and B in the figure given below?



Solution:

The resistors of values 20 Ω, 10 Ω and 20 Ω are connected in series. Therefore, their net resistance is:

$R = 20\ \Omega + 10\ \Omega + 20\ \Omega$

$R = 50\ \Omega$

This combination of resistors are connected in parallel with that of value 30 Ω. Therefore, the resistance R' is:

$1/R' = 1/50 + 1/30$

$1/R' = 3 + 5/150$

$R' = 150/8$

$R' = 18.75\ \Omega$

The resistance, R' is connected in series with the two resistors of values 10 Ω each. Hence, the total resistance between A and B is:

18.75 + 10 + 10 = 38.75 Ω

Question:179

You can given one hundred 1 Ω resistors. What is the smallest and largest resistance you can make in a circuit using these?

Solution:

Given: One hundred 1 Ω resistors

The largest value of resistance is obtained when the resistors are connected in series. Therefore, the largest resistance is 100 Ω.

The lowest resistance is obtained when all the resistors are connected in parallel. Therefore, the lowest resistance of the combination is 0.01 Ω.

Question:180

You are supplied with a number of 100 Ω resistors. How could you combine some of these resistors to make a 250 Ω resistor?

Solution:

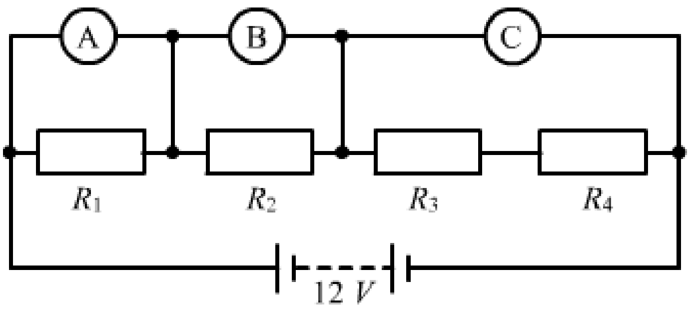
When two 100 Ω resistors are connected in parallel, the value of the combined resistance becomes 50 Ω.

Now to get a resistance of 250 Ω, we must connect two more 100 Ω resistors in series with the above combination.

Therefore, the configuration will be two 100 Ω resistors in series with a parallel combination of another two 100 Ω resistors.

Question:181

The resistors R_1, R_2, R_3 and R_4 in the figure given below are all equal in value.



What would you expect the voltmeter A, B and C to read assuming that the connecting wires in the circuit have negligible resistance?

Solution:

The p.d across all the resistors R_1, R_2, R_3 and R_4 is 12 V.

Since all the resistors are of the same value, the p.d at exactly half of the combination, i.e. the voltage shown by the voltmeter *C* will be 6 V. Similarly, the p.d. shown by the voltmeters *A* and *B* is one-fourth the p.d. across all the resistors. Therefore, *A* and *B* will have a reading of 3 V.

Question:182

Four resistances of 16 ohms each are connected in parallel. Four such combinations are connected in series. What is the total resistance?

Solution:

When four resistors of 16 Ω each are connected in parallel, the effective resistance of the combination can be obtained as:

The effective resistance of combination is 4 Ώ.

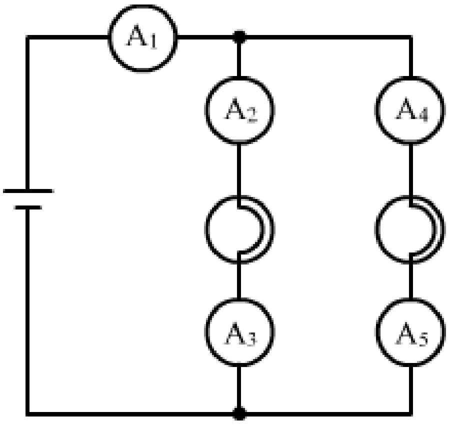
When four such combinations are connected in series, the effective resistance becomes:

$R = R_1 + R_2 + R_3 + R_4$

$R = 4\,Ώ + 4\,Ώ + 4\,Ώ + 4\,Ώ = 16\,\Omega$

Question:183

If the lamps are both the same in the figure given below and if A_1 reads 0.50 A, what do A_2, A_3, A_4 and A_5 read?



Solution:

Since the lamps are the same as given in the question, the resistance of both the lamps will be the same. Therefore, the current is distributed equally. Since the combination shows a 0.50 A current in the circuit by the ammeter A_1, the current shown by A_2, A_3, A_4 and A_5 will be the same and equal to 0.25 A.

Question:184

Are the lights in your house wired in series?

Solution:

No, the lights in the house are wired in parallel.

Question:185

What happens to the other bulbs in a series circuit if one bulb blows off?

Solution:

When a bulb in a series circuit blows off, the power supply to all other bulbs is cut off. Hence, all the other bulbs are switched off.

Question:186

What happens to the other bulbs in a parallel circuit if one bulb blows off?

Solution:

When one of the bulbs in a parallel circuit blows off, it does not affect the other bulbs.

Question:187

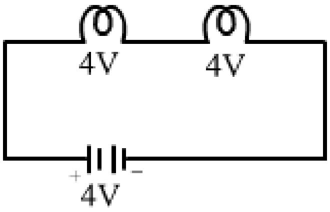
Which type of circuit, series or parallel, is preferred while connecting a large number of bulbs:

(*a*) for decorating a hotel building from outside?

(*b*) for lighting inside the rooms of the hotel?

Solution:

a Series circuit: This is so because in a series circuit, a large number of low-power decorating bulbs can be used effectively.
b Parallel circuit: This is so because in a parallel circuit, if one bulb does not work properly, it does not affect the working of the other bulbs.

Question:188
Draw a circuit diagram to show how two 4 V electric lamps can be lit brightly from two 2 V cells.
Solution:


Question:189
Why is a series arrangement not used for connecting domestic electrical appliances in a circuit?
Solution:
A series arrangement is not used for connecting domestic electrical appliances because different appliances have different resistances; this leads to the problem of unequal voltage distribution. Another reason why this arrangement is not preferred is that if one of the appliances gets damaged, the power supply to all other appliances is cut off.

Question:190
Give three reasons why different electrical appliances in a domestic circuit are connected in parallel.
Solution:
Three reasons why a parallel circuit is used in domestic wiring:
a A parallel circuit has a low resistance.
b It prevents unequal power supply as opposed to a series circuit.
c If one device in the series is damaged, it does not affect the other devices.

Question:191
Ten bulbs are connected in a series circuit to a power supply line. Ten identical bulbs are connected in a parallel circuit to an identical power supply line.

(*a*) Which circuit would have the highest voltage across each bulb?
(*b*) In which circuit, if one bulbs be brighter?

(*c*) In which circuit, if one bulb blows out, all other will stop glowing?

(*d*) Which circuit would have less current in it?

Solution:

a The parallel circuit will have the highest voltage across each bulb.

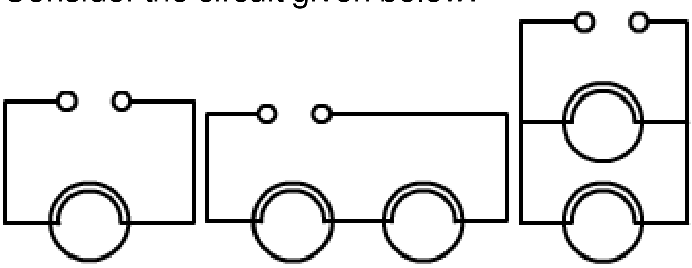
b Parallel circuit

c Series circuit

d Series circuit

Question:192

Consider the circuit given below:



a In which circuit are the lamps dimmest?

b In which circuit or circuits are the lamps of equal brightness to the lamps in circuit (*i*)?

c Which circuit gives out the maximum light?

Solution:

a The lamps will be the dimmest in the series circuit ii because the voltage will be divided between the two lamps.

b In circuit iii, the lamps will be as bright as in circuit i because circuit iii is a parallel arrangement. In a parallel arrangement, the voltage remains the same.

c Circuit iii will give the maximum light as circuit iii has a parallel arrangement. A parallel arrangement offers less resistance and thus circuit iii will give more light.

Question:193

a Which is the better way to connect lights and other electrical appliances in domestic wiring: series circuits or parallel circuits? why?

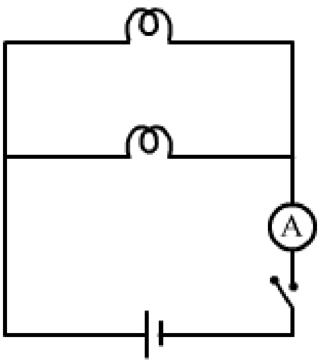
b Christmas tree lamps are usually wired in series. What happens if one lamps breaks?

c An electrician has wired a house in such a way that if a lamp gets fused in one room of the house, all the lamps in other rooms of the house stop working. What is the defect in the wiring?

d Draw a circuit diagram showing two electric lamps connected in parallel together with a cell and a switch that works both lamps. Mark an Ⓐ on your diagram to show where an ammeter should be placed to measure the current.

Solution:

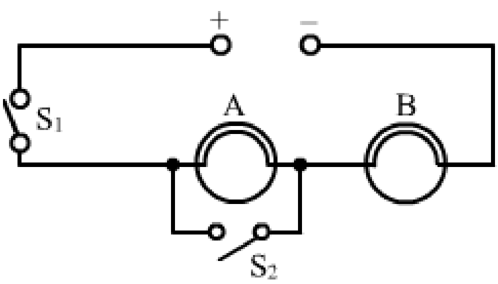
a A parallel arrangement will be a better way to connect lights and other electrical appliances in domestic wiring because a parallel arrangement has a low resistance. Also in case of any short circuiting in one appliance, the other electrical appliances remain unaffected.
b In a series arrangement, if a lamp blows off, the power supply to the other lamps is cut off. Hence, all the lamps will get switched off.
c The electrician has wired the house in a series circuit.
d



Question:194
The lamps in a house hold circuit are connected in parallel because:

a this way they required less current
b if one lamp fails the others remain lit
c this way they require less power
d if one lamp fails the other also fail
Solution:
b If one lamp fails, the others remain lit.
This is so because in a parallel circuit, if one device fails, it does not affect the working of the other devices.

Question:195
Using the circuit given below, state which of the following statement is correct?



a When S_1 and S_2 are closed, lamps A and B are lit.$_2$2 b With S_1 open and S_2 closed, A is lit and B is not lit.

c With S_2 open and S_1 closed A and B are lit.

d With S_1 closed and S_2 open, lamp A remains lit even if lamp B gets fused.

Solution:

c With S_2 open and S_1 closed, A and B are lit.

This is so because if the switch, S_2 is open, the current will flow through lamp A because it is a parallel circuit.

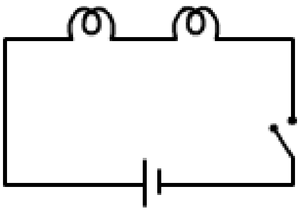
Question:196

(*a*) Draw a circuit diagram showing two lamps, one cell and a switch connected in series.

(*b*) How can you change the brightness of the lamp?

Solution:

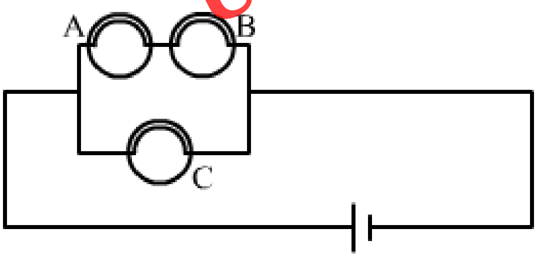
a



b The brightness of the lamp can be changed by connecting the lamps in parallel.

Question:197

Consider the circuit given below when A, B and C are three identical light bulbs of constant resistance.



(*a*) List the bulbs in order of increasing brightness.

(*b*) If C burns out, what will be the brightness of A now compared with before?

(*c*) If B burns out instead, what will be the brightness of A and C compared with before?

Solution:

a The brightness of A and B is the same. C is brighter since in A and B, the same amount of current flows but the voltage gets divided into two parts. Therefore, bulbs A and B glow dimmer.

b The brightness of A will remain the same because voltage distribution will have no effect if bulb C burns out.

c Bulb A will get switched off because the current will not flow to it if bulb B burns out since they are in a series circuit. The brightness of C will remain the same because the same current will continuously flow through bulb C.

Question:198

How do you think the brightness of two lamps arranged in parallel compares with the brightness of two lamps arranged in series both arrangements having one cell?

Solution:

The brightness of two lamps arranged in parallel will be more compared with the brightness of two lamps arranged in series because a parallel circuit offers less resistance.

Question:199

If current flows through two lamps arranged:

(*a*) in series,
(*b*) in parallel,
and the filament of one lamps breaks, what happens to the other lamp? Explain your answer.

Solution:

In a parallel circuit, if the filament of one lamp breaks, it will have no effect on the other lamp. If the same happens in a series circuit, the other lamp will stop glowing. This is because in a series circuit, if one of the bulbs blows off, the circuit is broken and the power supply to the other bulb is cut off.

Question:200

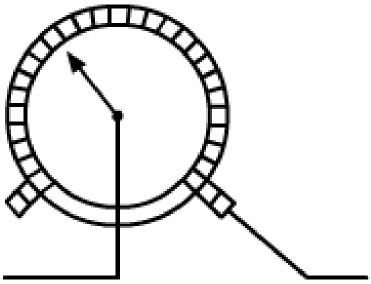
If you were going to connect two light bulbs to one battery, would you use a series or a parallel arrangement? Why? Which arrangement takes more current form the battery?

Solution:

A parallel arrangement will be preferred in this case because a parallel arrangement has less resistance than a series arrangement. Also, in case of any short circuiting, the other bulb remains unaffected. A series arrangement will draw more current from the battery.

Question:201

The figure blow shows a variable resistor in a dimmer switch.



How would you turn the switch to make the lights: (*a*) brighter, and (*b*) dimmer? Explain your answer.

Solution:

The switch is turned to the right for brighter light and is turned to the left for dimmer light. This happens because when the switch is turned to the right, it offers less resistance and when turned to the left, it offers more resistance.

Question:202

State two factors on which the electrical energy consumed by an electrical appliance depends.

Solution:

Two factors on which electrical energy consumed by an electrical appliance depends on are:

1 power

2 time

Question:203

Which one has a higher electrical resistance : a 100 watt bulb or a 60 watt bulb?

Solution:

A 60-watt bulb has a higher electrical resistance than a 100-watt bulb. Because power is inversely proportional to resistance, when the power is less, the resistance is high.

Question:204

Name the commercial unit of electric energy.

Solution:

The commercial unit of electric energy is kilowatt hour or KWh in short.

Question:205

An electric bulb is rated at 220 V, 100 W. What is its resistance?

Solution:

Given $V = 220$ V and $P = 100$ W

We know that power, $P = IV = V^2 / R$

$R = V^2 / P$

$R =$

$R = 484\ \Omega$

Question:206

What is the SI unit of (*i*) electric energy, and ii electric power?

Solution:

(*i*) The SI unit of electric energy is joule.

ii The SI unit of electric power is watt.

Question:207

Name the quantity whose unit is i kilowatt, and ii kilowatt-hour.

Solution:

i Kilowatt is the unit of power.

ii Kilowatt-hour is the unit of energy.

Question:208

Which quantity has the unit of watt?

Solution:

Watt is the unit of power.

Question:209

What is the meaning of the symbol kWh? Which quantity does it represent?

Solution:

The symbol KWh stands for kilowatt-hour. It is the commercial unit of electrical energy.

Question:210

If the potential difference between the end of a wire of fixed resistance is doubled, by how much does the electric power increase?

Solution:

We know that power and potential difference are related to each other as given in the equation $P = V^2/R$.

Now, keeping R the same, if V is doubled, power gets increased by four times.

Question:211

An electric lamp is labelled 12 V, 36 W. This indicates that it should be used with a 1 V supply. What other information does the label provide?

Solution:

The label further tells us that the total power consumed by the electric lamp will be 36 W and the current derived by it is 3 A (using the equation, $P = VI$).

Question:212

What current will e taken by a 920 W appliance if the supply voltage is 230 V?

Solution:

Given:

$P = 920$ W

$V = 230$ V

We know that power is given by $P = VI$, where I is the current consumed by the device.

Using the given values of P and V, we get:

$920 = 230\ I$

$I =$ A

Thus, the current consumed by the appliance is 4 A.

Question:213

Define watt. Write down an equation linking watts, volts and amperes.

Solution:

Watt is the unit of power. One watt can be defined as the power consumed by an electrical device if it is operated at a potential difference of 1 V and it carries a current of 1 A. That is:

1 watt = 1 volt x 1 ampere

Question:214

Define watt-hour. How many joules are equal to 1 watt-hour?

Solution:

One watt-hour is the amount of electrical energy consumed when an electrical appliance of power equal to 1 watt is used for 1 hour.

1 watt-hour = 3600 joules

Question:215

How much energy is consumed when a current of 5 amperes flows through the filament or element of a heater having resistance of 100 ohms for two hours? Express it in joules.

Solution:

Given:

$I = 5$ A

$R = 100\ \Omega$

Power consumed, $P = I^2R$

$= 5^2$ 100 watt

$=$ 2500 watts=2.5 kW

Energy consumed, $E = P$ x time

$= 2.5 \times 2$

$=$ 5 kWh

Question:216

An electric bulb is connected to a 220 V power supply line. If the bulb draws a current of 0.5 A, calculate the power of the bulb.

Solution:

Here, $V = 220$ V and $I = 0.5$ A given

Power drawn by the device is given by:

$P = VI$

Therefore:

$P = 220 \times 0.5$

$=$ 110 W

Question:217

In which of the following cases more electrical energy is consumed per hour?

(*i*) A current of 1 ampere passed through a resistance of 300 ohms.

(*ii*) A current of 2 amperes passed through a resistance of 100 ohms.

Solution:

i $I = 1$ A

$R = 300\ \Omega$

$t = 1$ h

Electrical energy consumed $= I^2\ R\ t$

$= 1^2$ 300 1

= 300 Wh

ii $I = 2$ A

$R = 100\ \Omega$

Electrical energy consumed = $I^2 \; R \; t = 2^2$ 100 1 = 400 Wh

Thus, more electrical energy is consumed in case ii.

Question:218

An electric kettle rated at 220 V, 2.2 kW, works for 3 hours. Find the energy consumed and the current drawn.

Solution:

Given:

$V = 220$ V

P = 2.2 kW = 2.2 x 10^3 w

$t = 3$ h

Electrical energy, $E = P \times t$

= 2.2 kW x 3 h

= 6.6 kWh

Current drawn, $I = P/V$

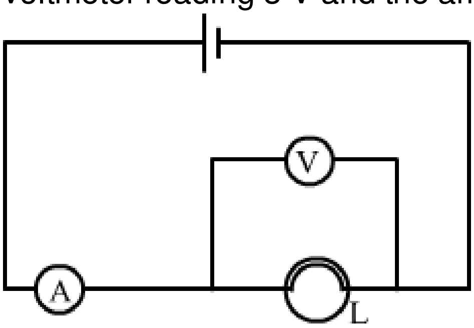
=

= 10 A

Question:219

a What is meant by " electric power"? Write the formula for electric power in terms of potential difference and current.

b The diagram below shows a circuit containing a lamp L, a voltmeter and an ammeter,. The voltmeter reading 3 V and the ammeter reading is 0.5 A.



(*i*) What is the resistance of the lamp?

(*ii*) What is the power of the lamp?

c Define kilowatt-hour. How many joules are there in one kilowatt-hour?

d Calculate the cost of operating a heater of 500 W for 20 hours at the rate of Rs 3.90 per unit.

Solution:

a Electrical power is the electric work done per unit time.

In terms of potential difference and current, electric power is given as:

Electric power, P = potential difference, V x current, I

$$P = VI$$

b Given:

Potential difference = reading of the voltmeter, V = 3 V

Current in the circuit = reading of the ammeter, I = 0.5 A

i Resistance of the lamp, R =

ii Power, $P = VI$ = 3 V x 0.5 A = 1.5 W

c One kilowatt-hour is the amount of electrical energy consumed when an electrical appliance having a power rating of one kilowatt is used for one hour.

1 kilowatt-hour = 36,00,000 joules

d Power rating of the heater, P = 500 W

Duration of the operation, t = 20 hours

Electrical energy consumed = P x t

= 500 W x 20 hours

= 10000 W = 10 kW

Rate for 1 kW = Rs. 3.90

Total cost of operating = units consumed x rate = 10 x Rs. 3.90 = Rs. 39

Question:220

When an electric lamp is connected to 12 V battery, it draws a current of 0.5 A. The power of the lamp is:

a 0.5 W

b 6 W

c 12 W

d 24 W

Solution:

b 6 W

Power, $P = VI$ = 12 V x 0.5 A = 6 W

Question:221

The unit for expressing electric power is:

a volt
b joule
c coulomb
d watt

Solution:

d watt

Watt is the unit of electric power.

Question:222

Which of the following is likely to be the correct wattage for an electric iron used in our homes?

a 60 W
b 250 W
c 850 W
d 2000 W

Solution:

c 850 W

An electric iron may use a power of 850 watts.

Question:223

An electric heater is rated at 2 kW. Electrical energy costs Rs 4 per kWh. What is the cost of using the heater for 3 hours?

a Rs 12
b Rs 24
c Rs 36
d Rs 48

Solution:

b Rs. 24

Electrical energy consumed in three hours = P x t = 2 kW x 3 hour = 6 kWh

Unit cost = Rs. 4 per kWh

Therefore, the cost of energy used for three hours = 4 x 6 = Rs. 24

Question:224

In a house two 60 W electric bulbs are lighted for 4 hours, and three 100 W bulbs for 5 hours everyday. Calculate the electric consumed in 30 days.

Solution:

Power of bulb 1, $P_1 = 60$ W

Duration that it was lit, $t_1 = 4$ h

Electric energy consumed by two bulbs, $E_1 = 2 \times P_1 \times t_1$

$= 2 \times 60 \times 4$

$= 480$ Wh

Power of bulb 2, $P_2 = 100$ W

Duration that it was lit, $t_2 = 5$ h

Electric energy consumed by three bulbs, $E_2 = 3 \times P_2 \times t_2 = 3 \times 100 \times 5 = 1500$ Wh

Total electric energy consumed in 30 days, $E = 30 \times (E_1 + E_2)$

$E = 30 \times 480 + 1500$

$E = 30 \times 1980$

$E = 59400$ Wh

$E = 59.4$ kWh

Question:225

A bulb is rated as 250 V; 0.4 A. Find its : (*i*) power, and (*ii*) resistance.

Solution:

Given:

$V = 250$ V

$I = 0.4$ A

Power, $P = VI$

$= 250 \times 0.4$

$= 100$ W

Resistance, $R =$

$=$

$= 625\ \Omega$

Question:226

For a heater rated at 4 kW and 220 V, calculate:

a the current,
b the resistance of the heater,
c the energy consumed in 2 hours, and
d the cost if 1 kWh is priced at Rs 4.60.

Solution:

Given:

$V = 220$ V

$P = 4$ kW $= 4\ \ 10^3$ W

a $I =$ A

b $R =$ Ω

c Energy consumed in two hours, $E = P\ \ t$

$= 4$ kW $\ 2$ h

$= 8$ kWh

d Cost of 1 kWh = Rs 4.6

Total cost = Energy consumed Price

= 8 4.6

= Rs 36.80

Question:227

An electric motor takes 5 amperes current form a 220 volt supply line. Calculate the power of the motor and electric energy consumed by it in 2 hours.

Solution:

Given:

$I = 5$ A

$V = 220$ V

Power of the motor,

$P = VI$

$= 5\ \ 220$

$= 1100$ W $= 1.1$ kW

Energy consumed in two hours,

$E = P\ \ t$

= 1.1 kW 2 h
= 2.2 kWh

Question:228

Which uses more energy : a 250 W TV set in 1 hour or a 1200 W toaster in 10 minutes?

Solution:

Energy consumed by the TV set,

E = *P* *t*

= 250 1 = 250 Wh

Energy consumed by the toaster,

E = *P* *t*

= 1200 W h   (10 min = h)

= 200 Wh

Thus, it is clear that the TV set consumes more electrical energy.

Question:229

Calculate the power used in the 2 Ω resistor in each of the following circuits:

(*i*) a 6 V battery in series with 1 Ω and 2 Ω resistors.
(*ii*) a 4 V battery in parallel with 12 Ω and 2 Ω resistors.

Solution:

i As the 6 V battery is connected in series, the potential difference will be different across the two given resistors. So we need the current to calculate the power.

Therefore, the net resistance, *R* of the circuit = 1 + 2 Ω = 3 Ω

Current, *I* = = = 2 A

Power consumed by the 2-ohm resistor,

$P = I^2 R$

= 2^2 x 2

= 8 W

ii As the battery is connected in parallel to the 12 Ω and 2 Ω resistors, the potential difference across them will be the same.

Therefore, the power,

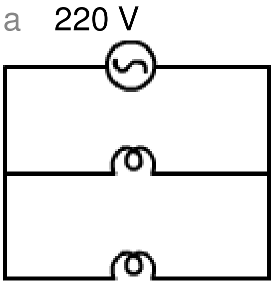
Question:230

Two lamps, one rated 40 W at 220 V and the other 60 W at 220 V, are connected in parallel to the electric supply at 220 V.

a Draw a circuit diagram to show the connections.
b Calculate the current drawn from the electric supply.
c Calculate the total energy consumed by the two lamps together when they operate for one hour.

Solution:

a



b Current drawn by the 40 W bulb, I_1 =

Current drawn by the 60 W bulb, I_2=

Total current drawn, $I = I_1 + I_2 = 0.18\text{ A} + 0.27\text{ A} = 0.45\text{ A}$

c Total energy consumed, $E = \Sigma (P \times t) = 40 \times 1 + 60 \times 1 = 100\text{ Wh} = 0.1\text{ kWh}$

Question:231

An electric kettle connected to the 230 V mains supply draws a current of 10 A. Calculate:

(*a*) the power of the kettle.
(*b*) the energy transferred in 1 minute.

Solution:

a Power, $P = VI = 230 \;\; 10 = 2300$ W
b Energy transferred in one minute = $P \;\; t$
= 2300 W 60 s 1 minute = 60 s
= 138000 J
= 138 kJ

Question:232

A 2 kWh heater, a 200 W TV and three 100 W lamps are all switched on from 6 p.m. to 10 p.m. What is the total cost at Rs 5.50 per kWh?

Solution:

Energy consumed by the TV in 1 hour, $E_1 = P \times t = 200\text{ W} \times 1\text{ hour} = 200\text{ Wh} = 0.2\text{ kWh}$

Energy consumed by the three bulbs in 1 hour, E_2 = 3 x P x t = 3 x 100 W x 1 hour = 300 Wh = 0.3 kWh

Energy consumed by the heater in 1 hour, E_3 = 2 kWh

Total energy consumed, $E = E_1 + E_2 + E_3$

= 0.2 kWh + 0.3 kWh + 2 kWh

= 2.5 kWh

Total energy, consumed from 6 p.m. to 10 p.m., E = 4 x 2.5 kW = 10 kWh

Total cost at base price, Rs. 5.5 per kWh = E x 5.5 = 10 x 5.5 = Rs. 55

Question:233

What is the maximum power in kilowatts of the appliance that can be connected safely to a 13 A ; 230 V mains socket?

Solution:

Maximum power, $P = VI$

= 13 A 230 V

= 2990 W = 2.99 kW

Question:234

An electric fan runs from the 230 V mains. The current flowing through it is 0.4 A. At what rate is electrical energy transferred by the fan?

Solution:

Rate of electrical energy transfer = Power consumed

∴ Rate of electrical energy transfer, $P = VI$

= 230 V 0.4 A

= 92 W = 92 J/s

Question:235

The SI unit of energy is :

a joule

b coulomb

c watt

d ohm-metre

Solution:

a joule

Joule is the SI unit of energy.

Question:236

The commercial unit of energy is :

a watt
b watt-hour
c kilowatt-hour
d kilo-joule

Solution:

c kilowatt-hour

Kilowatt-hour is the commercial unit of electrical energy.

Question:237

How much energy does a 100 W electric bulb transfer in 1 minute?

a 100 J
b 600 J
c 3600 J
d 6000 J

Solution:

d 6000 J

Energy transferred, *E* = power x time = 100 W x 60 s = 6000 J

Question:238

An electric kettle for use on a 230 V supply is rated 3000 W. For safe working, the cable connected to it should be able to carry at least:

a 2 A
b 5 A
c 10 A
d 15 A

Solution:

d 15 A

Current drawn by the kettle, *I* =

So the cable should be able to carry more current than this and hence the answer is 15 A.

Question:239

How many joules of electrical energy are transferred per second by a 6 V; 0.5 A lamp?

a 30 J/s

b 12 J/s

c 0.83 J/s

d 3 J/s

Solution:

d 3 J / s

Electrical energy transferred per second, $E = V \times I \times t = =$ 3 J/s

Question:240

At a given time, a house is supplied with 100 A at 220 V. How many 75 W, 220 V light bulb could be switched on in the house at the same time if they are all connected in parallel?

a 93

b 193

c 293

d 393

Solution:

c 293

Total power provided in the house, $P = VI = 100$ A 220 V = 22000 W

This is the maximum power that can be drawn in the house.

Total power drawn by x bulbs = $75x$ W

∴ Maximum power x bulbs can draw = 22000 W

$75x = 22000$

$x =$

Question:241

If the potential difference between the ends of a fixed resistor is halved, the electric power will become:

a double

b half

c four times

d one-fourth

Solution:

d one-fourth

Since $P =$, when the potential difference is halved, the power becomes one-fourth.

Question:242

State whether an electric heater will consume more electrical energy or less electrical energy per second when the length of its heating element is reduced. Give reasons for your answer.

Solution:

The electric heater will consume more electrical energy when the length of its heating element is reduced because resistance is directly proportional to length ($R = \rho$). Hence, resistance will decrease. Power is inversely proportional to resistance ($P =$). Hence, power will increase. Thus, a decrease in resistance means an increase in the power consumed.

Question:243

The table below shows the current in three different electrical appliances when connected to the 240 V mains supply:

Appliance	Current
Kettle	08.5 A
Lamp	0.4 A
Toaster	4.8 A

a Which appliance has the greatest electrical resistance? How does the data show this?

b The lamp is connected to the mains supply by using a thin, twin-cored cable consisting of live and natural wires. State two reasons why this cable should not be used for connecting the kettle to the mains supply.

c Calculate the power rating of the kettle when it is operated from the 240 V mains supply.

d A main takes the kettle abroad where the mains supply is 120 V. What is the current is the kettle when it is operated from the 120 V supply?

Solution:

a The lamp has the greatest electrical resistance because the current drawn by it is the least. $R =$ and hence resistance varies inversely with the current.

b The reasons for this are as follows:

1. The kettle draws a large amount of current. So the wire may melt down due to heating.
2. For the device to be safe, it needs to be have an earthing system. This is missing here.

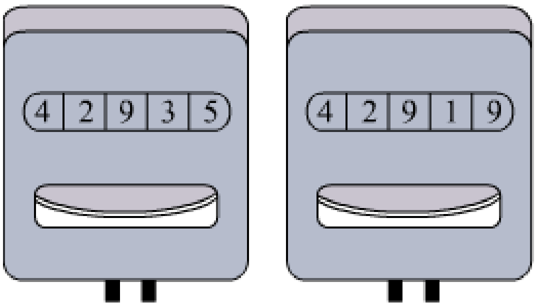
c The power, *P* will be:

$P = VI = 240\ V \times 8.5\ A = 2040\ W$

d As current is directly proportional to potential difference, halving the potential will halve the current too. Therefore, the new current value will be 4.25 A.

Question:244

A boy noted the reading on his home's electricity meter on Sunday at 8 AM and again on Monday at 8 AM see Figures below.



(*a*) What was the meter reading on Sunday?
(*b*) What was the meter reading on Monday?
(*c*) How many units of electricity have been used?
(*d*) In how much time these units have been used?
e If the rate is Rs 5 per unit, what is the cost of electricity used during this time?

Solution:

a The meter reading on Sunday was 42919.
b The meter reading on Monday was 42935.
c Total units consumed = Meter reading on Monday – Meter reading on Sunday
= 42935 – 42919
= 16
d These units have been consumed in 24 hours.
e Price of one unit = Rs. 5
Total units consumed = Meter reading on Sunday – Meter reading on Monday
= 42935 – 42919
= 16
Total cost of units consumed = 16 5 = Rs. 80

Question:245

An electric bulb is rated as 10 W, 220 V. How many of these bulbs can be connected in parallel across the two wires of 220 V supply line if the maximum current which can be drawn is 5 A?

Solution:

Maximum power that can be drawn from the circuit = VI = 220 V x 5 A = 1100 W

Let x be the number of 10 W bulbs used.

Then the maximum power x bulbs can draw from the circuit = 1100 W

$10x = 1100$

x = bulbs

Question:246

Two exactly similar electric lamps are arranged i in parallel, and ii in series. If the parallel and series combination of lamps are connected to 220 V supply line one by one, what will be the ratio of electric power consumed by them?

Solution:

Let R be the resistance of the lamp and V be the potential difference applied.

<u>In a series connection</u>:

Net resistance of the circuit, $R_1 = R + R = 2R$

Power drawn, $P_1 = V^2/R_1 = V^2/2R$

<u>In a parallel connection</u>:

Net resistance of the circuit, R_2 will be:

or R_2 =

Power drawn, $P_2 = V^2/R_2 = 2V^2/R$

Therefore, $P_2:P_1 = 4:1$

Question:247

a Derive the expression for the heat produced due to a current 'I' flowing for a time interval 't' through a resistor 'R' having a potential difference 'V' across its ends. With which name is this relation known?

b How much heat will an instrument of 12 W produce in one minute if it is connected to the heat produced by it?

c The current passing through a room heater has been halved. What will happen to the heat produced by it?

d What is meant by the heating effect of current? Give two applications of the heating effect of current.

e Name the material which is used for making the filaments of an electric bulb.

Solution:

a Since a conductor offers resistance to the flow of current, some work must be done by the current continuously to keep itself flowing. When an electric charge, Q moves against a potential difference, V, the amount of work done is given by:

$W = Q \times V$ 1

From the definition of current, we know that:

Current, $I =$

So, $Q = I \times t$ 2

And from Ohm's law, we have:

or $V = I \times R$ 3

Now, substituting $Q = I \times t$ and $V = I \times R$ in equation 1, we get:

$W = I \times t \times I \times R$

So, the work done, $W = I^2 \times R \times t$

Assuming that all the electrical work done is converted into heat energy:

Heat produced = Work done in the above equation

Thus heat produced, $H = I^2 \times R \times t$ joules

This is known as Joule's law of heating.

b Given: Power rating (P) = 12 W

Time interval (t) = 1 minute = 60 s 1 minute = 60 seconds

Potential difference (V) = 12 V

Heat = I^2Rt

But, we know that $P = I^2R$

Therefore, $H = P \times t$ = 12 W x 60 s = 720 joules

c The heat produced by the room heater will become one-fourth the previous quantity when the current passing through it is halved because the heat produced is directly proportional to the square of the current.

d When an electric current is passed through a high resistance wire, like nichrome wire, the resistance wire becomes very hot and produces heat. This is called the heating effect of current. The heating effect of current is used in electric irons, electric heaters, electric ovens, filament bulbs etc. and it is also utilised in electric fuses.

e Tungsten is used for making the filament of an electric bulb.

Question:248

The heat produced by passing an electric current through a fixed resistor is proportional to the square of:

(*a*) magnitude of resistance of the resistor
(*b*) temperature of the resistor
(*c*) magnitude of current
(*d*) time for which current is passed

Solution:

c magnitude of current

We know that:

$H = I^2Rt$

It shows that the heat produced is proportional to the square of the current.

Question:249

How does the heat *H* produced by a current passing through a fixed resistance wire depend on magnitude of current *I*?

Solution:

Heat produced by a current passing through a wire with a fixed resistance depends on the square of current, *I*.

Heat, $H = I^2 \times R \times t$

Question:250

If the current passing through a conductor is doubled, what will be the change in heat produced?

Solution:

If the current passing through a conductor is doubled, the heat produced will increase by four times because the heat produced is directly proportional to the square of the current.

Question:251

Name two effects produced by electric current.

Solution:

The two effects produced by an electric current are:

i Heating effect
ii Chemical effect

Question:252

Which effect of current is utilised in an electric light bulb?

Solution:

The heating effect of current is utilised in an electric bulb.

Question:253

Which effect of current is utilised in the working of an electric fuse?

Solution:

The heating effect of current is utilised in the working of an electric fuse.

Question:254

Name two devices which work on the heating effect of electric current.

Solution:

The two devices that work on the heating effect of electric current are a bulb and an electric fuse.

Question:255

Name two gases which are filled in filament type electric light bulbs.

Solution:

Two gases that are filled in the filament type of electric bulbs are:

i argon

ii nitrogen

Question:256

Explain why, filament type electric bulbs are not power efficient.

Solution:

Filament type of electric bulbs are not power efficient because a lot of power gets wasted as heat.

Question:257

Why does the connecting cord of an electric heater not glow hot while the heating element does?

Solution:

It is so because the connecting cord has a very low resistance. So, it does not get enough heat to glow.

Question:258

a Write down the formula for the heat produced when a current *I* is passed through a resistor *R* for time *t*.
b An electric iron of resistance 20 ohms draws a current of 5 amperes. Calculate the heat produced in 30 seconds.
Solution:
a $H = I^2Rt$ where *H* is the heat energy produced, *I* is the current, *R* is the resistance and *t* is the time.
b $I = 5$ A, $R = 20\ \Omega$ and $t = 30$ s
$H = I^2Rt = 5^2$ x 20 x 30 = 25 x 20 x 30 = 15000 J

Question:259
State three factors on which the heat produced by an electric current depends. How does it depend on these factors?
Solution:
The heat produced by an electric current depends on the square of the current, the resistance of the device and the time for which the current is passed through the device, i.e.:
$H = I^2Rt$

Question:260
(*a*) State and explain Joule's law of heating.
(*b*) A resistance of 40 ohms and one of 60 ohms are arranged in series across 220 volt supply. Find the heat in joules produced by this combination of resistances in half a minute.
Solution:
a Joule's law of heating states that heat, *H* produced in a wire is directly proportional to:
- i the square of the current, I^2
- ii the resistance of the wire, *R*
- iii the time, *t* for which the current is passed

That is, $H = I^2Rt$

b The net resistance of the circuit, $R = 40 + 60 = 100\ \Omega$
Time for which current is passed = minute = 30 s
Current in the circuit =
Heat produced = $I^2Rt = 2.2^2$ 100 30 = 4.84 x 100 x 30 = 14520 J

Question:261
Why is an electric light bulb not filled with air? Explain why argon or nitrogen is filled in an electric bulb.
Solution:
If air is filled in an electric bulb, the extremely hot tungsten filament would burn up quickly because

of the oxygen present in the air. So, a bulb is filled with a chemically unreactive gas like argon or nitrogen.

Question:262

Explain why, tungsten is used for making the filaments of electric bulbs.

Solution:

Tungsten is used for making the filaments of electric bulbs because it has a very high melting point $3380°C$. It does not melt down and thus remains white hot.

Question:263

Explain why, the current that makes the heater element very hot, only slightly warms the connecting wires leading to the heater.

Solution:

The current that makes the heater element very hot, only slightly warms the connecting wires leading to the heater because the connecting wires have a low resistance. So they do not get hot. But the heater element has a very high resistance and so it gets very hot.

Question:264

When a current of 4.0 A passes through a certain resistor for 10 minutes, 2.88×10^4 J of heat are produced. Calculate

(*a*) the power of the resistor.
(*b*) the voltage across the resistor.

Solution:

$I = 4.0$ A
$H = 2.88 \times 10^4$ J
$t = 10$ minutes $= 10 \times 60 = 600$ s

a Power =

b $V =$

Question:265

A heating coil has a resistance of 200 Ω. At what rate will heat be produced in it when a current of 2.5 A flows through it?

Solution:

$I = 2.5$ A

$R = 200\ \Omega$

Rate of heat produced = Power = $I^2R = 2.5^2 200 = 1250$ J/s

Question:266

An electric heater of resistance 8 Ω takes a current of 15 A from the mains supply line. Calculate the rate at which heat is developed in the heater.

Solution:

$I = 15$ A, $R = 8\ \Omega$

Rate of heat produced = Power = $I^2R = 15^2 8 = 1800$ J/s

Question:267

A resistance of 25 Ω is connected to a 12 V battery. Calculate the heat energy in joules generated per minute.

Solution:

$V = 12$ V

$R = 25\ \Omega$

$t = 1$ minute = 60 s

Current, $I =$

Heat generated = $I^2Rt = 0.48^2 25 60 = 345.6$ J

Question:268

100 joules of heat is produced per second in a 4 ohm resistor. What is the potential difference across the resistor?

Solution:

Given $R = 4\ \Omega$

$H = 100$ J

$t = 1$ s

We know that, $H = I^2Rt$

$I^2 =$

$I = 5$ A

Now:

$V = IR$

$V = 5 \times 4 = 20$ V

Question:269

The current passing through an electric kettle has been doubled. The heat produced will become:

(*a*) half
(*b*) double
(*c*) four time
(*d*) one-fourth

Solution:

c four times

Heat produced is directly proportional to the square of the current.

Question:270

An electric fuse works on the:

(*a*) chemical effect of current
(*b*) magnetic effect of current
(*c*) lighting effect of current
(*d*) heating effect of current

Solution:

d heating effect of current

An electric fuse works on the heating effect of current.

Question:271

The elements of electrical heating devices are usually made of:

(*a*) tungsten
(*b*) bronze
(*c*) nichrome
(*d*) argon

Solution:

c nichrome

Nichrome has a high resistance.

Question:272

The heat produced in a wire of resistance 'x' when a current 'y' flows through it in time 'z' is given by:

(a) $x^2 \times y \times z$
(b) $x \times z \times y^2$
(c) $y \times z^2 \times x$
(d) $y \times z \times x$

Solution:

b $x z$

This is so because heat, $H = I^2Rt$

Question:273

Which of the following characteristic is not suitable for a fuse wire?

a thin and short
b thick and short
c low melting point
d higher resistance than rest of wiring

Solution:

b thick and short

This is so because in this case, the resistance of the wire will be low.

Question:274

In a filament type light bulb, most of the electric power consumed appears as:

(a) visible light
(b) infra-red-rays
(c) ultraviolet rays
(d) fluorescent light

Solution:

b infra-red rays

This is so because of the heat produced when a filament type light bulb glows.

Question:275

Which of the following is the most likely temperature of the filament of an electric light bulb when it is working on the normal 220 V supply line?

(*a*) 500°C
(*b*) 1500°C
(*c*) 2500°C
(*d*) 4500°C
Solution:
c 2500°C

It is the temperature of an electric bulb filament when it glows.

Question:276
If the current flowing through a fixed resistor is halved, the heat produced in it will become:

(*a*) double
(*b*) one-half
(*c*) one-fourth
(*d*) four times
Solution:
(*c*) one-fourth
This is so because heat produced is directly proportional to the square of the current passing through the resistor.

Question:277
The electrical resistivities of four materials *P*, Q, R and S are given below:

P		6.84×10^{-8} Ωm
Q		1.70×10^{-8} Ωm
R		1.0×10^{15} Ωm
S		11.0×10^{-7} Ωm

Which material will you use for making: (*a*) heating element of electric iron (*b*) connecting wires of electric iron (*c*) covering of connecting wires? Give reason for your choice in each case.
Solution:
a Material S will be used for making the heating element of an electric iron as it has a high resistivity .
b Material Q will be used for making the connecting wires of an electric iron as it has a low resistivity.
c Material R will be used for making the covering of the connecting wires as it has an extremely

high resistivity.

Question:278

(*a*) How does the wire in the filament of a light bulb behave differently to the other wires in the circuit when the current flows?

(*b*) What property of the filament wire accounts for this difference?

Solution:

a

Filament of a light bulb	Connecting wire
The wire in the filament of a light bulb has a high resistance and a high melting point. So, it heats up without melting and glows when the current flows through it.	The connecting wire in a circuit has a low resistance and a low melting point. So, it does not heat up much when the current flows through it and thus does not glow.

b It is the high melting point of the filament wire that is accountable for this difference.

Question:279

Two exactly similar heating resistances are connected (*i*) in series, and (*ii*) in parallel, in two different circuits, one by one. If the same current is passed through both the combinations, is more heat obtained per minute when they are connected in series or when they are connected in parallel? Give reason for your answer.

Solution:

Let the resistance be *R*.

In a series combination:

Net resistance = $R + R = 2R$

In a parallel combination:

Net resistance =

It is clear that the net resistance is more in the series combination. Therefore, more heat will be obtained in a series connection, as the heat produced is directly proportional to the resistance in the circuit.

Question:280

An electric iron is connected to the mains power supply of 220 V. When the electric iron is adjusted at 'minimum heating' it consumes a power of 360 W but at 'maximum heating' it takes a power of 840 W. Calculate the current and resistance in each case.

Solution:

In the case of minimum heating:

$P = 360$ W

$V = 220$ V

where the symbols used have their usual meanings.

We know that $P = VI$

$I =$

Resistance, $R =$

$R = \Omega$

In the case of maximum heating:

$P = 840$ W

$V = 220$ V

where the symbols used have their usual meanings.

We know that $P = VI$

$I =$

Further, $R =$

$R = \Omega$

Question:281

Which electric heating device in your home do you think have resistors which control the flow of electricity?

Solution:

The following electric heating devices have resistors to control the flow of electricity:

1. Electric iron
2. Electric geyser

3. Electric oven
4. Electric heater

Typesetting math: 59%