Chapter 4. Current Electricity

Solution 1
An electric cell is a device in which a constant difference in potential is maintained between the two conductors by a chemical reaction. Thus, a cell can be used as a source of electrons or current. In a cell, chemical energy changes into electrical energy when it is in use.

Solution 2
An electric cell produces electricity from the chemicals stored inside it. When the chemicals in the electric cell are used up, the electric cell stops producing electricity. It has two terminals – positive and negative.
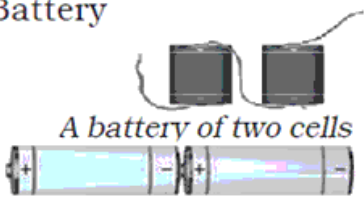

Electric cell / Symbol

When two or more cells are connected together such that the positive terminal of one cell is connected to the negative terminal of the next cell; such a combination of two or more cells is called a battery. A battery is thus a combination of two or more cells.
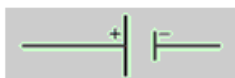

Battery / A battery of two cells / Symbol

Solution 3
An electrical circuit is a continuous path comprising of conducting wires and resistances between the terminals of a battery, along which an electric current is set up. It is represented by drawing a circuit diagram.

Solution 4
Four components of an electrical circuit:

(i) Cell

(ii) A load (bulb)


(iii) Key

(iv) Connecting wire

Solution 5
A diagram indicating how various components in an electrical circuit have been connected using symbols for those components is a circuit diagram.

Solution 6
In the given diagram, ammeter is connected in parallel and voltmeter in series, which is wrong. Also the terminals of the two devices are wrongly connected to the battery.Correct diagram:

Correct diagram:
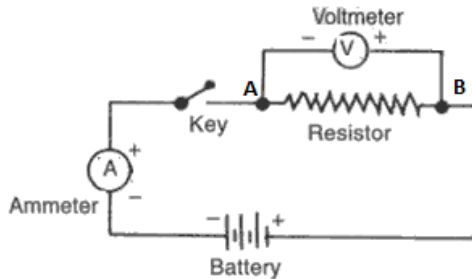
Solution 7
According to Ohm's law, the current flowing in a conductor is directly proportional to the potential difference across its ends provided the physical conditions and temperature of conductor remains constant.No, it is not always true. E.g. Diode valve, junction diode etc. do not obey Ohm's law.

Solution 8
The obstruction offered to the flow of current by the wire is called its electrical resistance. It is a kind of friction between the free electrons and the atoms of the conductor along which they flow.Its SI unit is 'ohm'.

Solution 9
The physical quantity is 'resistance'.

Solution 10
Resistance of a conductor is said to be 1 ohm, if 1 ampere current flows through it, when the potential difference across its ends is 1 volt.

Solution 11
No, Ohm's law does not hold good for semiconductors and electrolytic Solutions**.**
Solution 12
Factors on which the resistance of a conductor depends are:
(i) Nature of conductor: different materials have different concentration of free electrons and therefore resistance of a conductor depends on its material.
(ii) Length of conductor: Resistance of a conductor is directly proportional to the length of a conductor.
(iii) Area of cross-section of a conductor: Resistance of a conductor is inversely proportional to the area of cross-section of the uniform wire.
(iv) Temperature of conductor: In general for metallic conductors, higher the temperature larger is the resistance.
Solution 13
An equivalent resistor is that resistor which when replace any combination of resistors the current through the circuit is not altered or changed.

Solution 14

$$\text{Current} = \frac{\text{Potential difference (V)}}{\text{Resistance (R)}}$$

Here, $V = 24$ volt, $R = 60\ \Omega$

$$\therefore \text{Current} = \frac{24}{60} = 0.4\ \text{A}$$

Solution 15

The slope of the graph (dV/dI) gives the value of resistance.

Solution 16

The resistivity of a material is the resistance of a wire of that material of unit length and unit area of cross-section.

Solution 17

The SI unit of specific resistance is ohm-metre (Ωm).

Solution 18

Conductance of a conductor is the reciprocal of resistance of that conductor. Its unit is mho.

Solution 19

(i) Metals e.g. copper
(ii) Alloys e.g. Constantan
(iii) Semiconductors e.g. Germanium

Solution 20

In given circuit, two 2 ohm resistors in series are connected in parallel with another 2 ohm resistor;

Therefore equivalent resistance of the circuit,

$$R = \left[(2+2)^{-1} + (2)^{-1} \right]^{-1}$$

$$R = \left[\frac{1}{4} + \frac{1}{2} = \frac{3}{4} \right]^{-1}$$

$$R = \frac{4}{3}$$

$$\therefore I = \frac{V}{R} = \frac{3}{\left(\frac{4}{3}\right)} = \frac{9}{4} A = 2.25\ \text{A}$$

Solution 21

Ohm's law relates the current in a conductor to the potential difference across its ends. According to Ohm's law, the current flowing in a conductor is directly proportional to the potential difference across its ends provided the physical conditions and temperature of conductor remains constant.

Solution 22

If the conductor is made thinner, electrons get smaller area of cross-section to flow and it therefore, offers a large

resistance.

Given, heat dissipated = 60 joules, charge Q = 20 C, time t = 5s

(a) P.d. across the rsistor, $V = \dfrac{W}{Q} = \dfrac{60}{20} = 3V$

(b) Power $= \dfrac{W}{t} = \dfrac{V^2}{R}$

$\therefore R = V^2 \times \dfrac{t}{W} = (3)^2 \times \dfrac{5}{60} = 0.75\Omega$

(c) Power dissipated, $P = \dfrac{W}{t} = \dfrac{60}{5} = 12$ watt

Solution 23
At constant temperature, if current is plotted against potential difference, the plot will be a straight line making some slope with the x-axis as shown in figure below:

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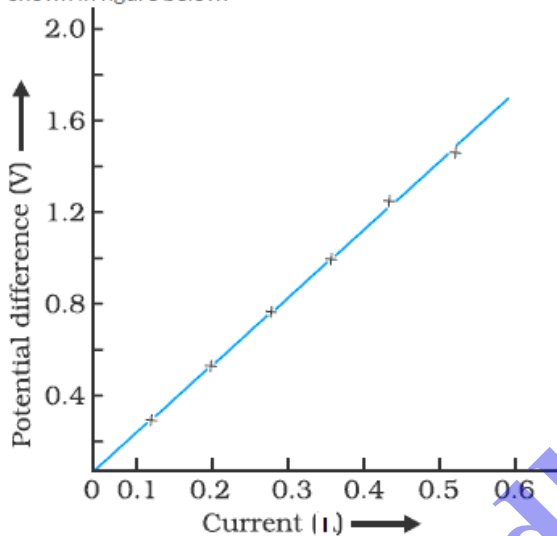
Solution 24
The instrument used to measure electric current is called an ammeter. It has a low resistance and is always connected in series.

Solution 25
The instrument used to measure electric potential or potential difference is called a voltmeter. It has a very high resistance and is always connected in parallel.

Solution 26
An ammeter has a low resistance.

Solution 27
A voltmeter has a high resistance.

Solution 28
A key acts as a switch in an electric circuit. It helps to open or close the circuit as required.

Solution 29

A rheostat is a device used in electric circuit to regulate current without changing the voltage source. It is also called variable resistance.

Solution 30

A/c to Ohm's law,

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

Here, V = 30 volt and R = 60 Ω

$$\therefore I = \frac{30}{60} = 0.5 \text{ A}$$

Solution 31

A/c to Ohm's law,

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

Here, V = 0.1 volt and I = 2 A

$$\therefore R = \frac{0.1}{2} = 0.05 \text{ Ω}$$

Solution 32

A/c to Ohm's law,

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

Here, V = 240 volt and I = 6 A

$$\therefore R = \frac{240}{6} = 40 \text{ Ω}$$

Thus, the resistance of the electric iron is 40 Ω.

Solution 33

Given, potential difference, V = 2 volt

Let R be the equivalent resistance of the circuit and I be the current flowing through it; then:

$$R = \left[\left(\frac{1}{2} + \frac{1}{2}\right)^{-1} + (1)\right]$$

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

$$\therefore I = \frac{V}{R} = \frac{2}{2} = 1 \text{ A}$$

Solution 34

Let the required potential difference be V

Given, current I = 1 A and Resistance, R = 5 Ω

A/C to Ohm's law,

V = IR = (1) × (5) = 5 volt

Solution 35

Let I be the current flowing through it.

Given, potential difference, V= 6 volt and Resistance, R = 3 Ω

A/C to Ohm's law,

$$I = \frac{V}{R} = \frac{6}{3} = 2 \text{ A}$$

Solution 36

A/C to Ohm's law;

$$R = \frac{V}{I} = \frac{20}{2} = 10 \text{ Ω}$$

Solution 37

Between A and B, the series combination of two resistors of resistances 2 ohm each is connected in parallel with the 1 ohm resistor.

∴ Equivalent series resistance between A and B, R_s = 2+2 = 4 Ω

Now, between A and B this 4 Ω resistor is connected in parallel with 1 Ω resistor.

∴ Equivalent resistance between A and B , $R = \left(\frac{1}{4}+\frac{1}{1}\right)^{-1} = \left(\frac{5}{4}\right)^{-1} = \frac{4}{5}Ω$

Solution 38

(a) In series:

Equivalent series resistance, R_S = 2+2+2+2+2 = 10 Ω

(b) In parallel:

∴ Equivalent parallel resistance, $R_p = \left(\frac{\text{Resistance of each resistor}}{\text{No. of resistors}}\right) = \frac{2}{5}$ Ω

Solution 39

Five resistors each of value 1 ohm should be connected in parallel to obtain an equivalent resistance of 0.2 ohm.

∴ Equivalent parallel resistance, $R_p = \left(\frac{\text{Resistance of each resistor}}{\text{No. of resistors}}\right) = \frac{1}{5} = 0.2$ Ω

Solution 40

Two uses of conductors:
(i) Connecting wires are made of conductors like copper.
(ii) Conductors are used as electrolytes in cells

Solution 41
(a) Ampere
(b) Volt
(c) Coulomb

Solution 42
The potential difference between two points may be defined as the work done in moving a unit positive charge from one point to the other.

Solution 43
Electrical potential is a 'scalar' quantity.

Solution 44
Electric intensity is defined as the force experienced by a unit positive charge when kept at that point.Its SI unit is newton per coulomb. It is a vector quantity.

Solution 45
Joule/coulomb is known as 'volt'.

Solution 46
Work done = charge x potential differenceOr, W = 5 x 1 = 5 J

Solution 47
(b) potential difference

Solution 48
(d) voltmeter

Solution 49
Charges move in a definite direction in a conductor when a potential difference is applied across the ends of the conductor.

Solution 50
We can maintain a potential difference between the ends of a conductor by connecting the two ends of the conductor to the two terminals of a battery or cell.

Solution 51
The rate of movement of charge from one point to another through a section of the conductor is called electric current. Current refers to rate of flow of charges in a conductor.I = Q/t

Solution 52
The direction of conventional current is taken as the direction of flow of positive charges.The direction of electronic current is taken as opposite to the direction of motion of electrons.

Solution 53
Current defines the rate of flow of charges in a conductor.

Solution 54
Current is measured by an ammeter.

Solution 55

The charge on one electron is 1.6×10^{-19} coulombs.

Therefore, 1C charge carries $\left(\dfrac{1}{1.6 \times 10^{19}}\right) = 6.25 \times 10^{18}$ electrons.

Solution 56

Given, emf, $e = 15$ v

Internal resistance, $r = 3 \, \Omega$

Resistance of given two resistors in series, $R_s = 3 + 6 = 9 \, \Omega$

(i) Current $= \dfrac{\text{emf}}{\text{Total resistance of circuit}} = \dfrac{15}{(9+3)} = \dfrac{15}{12} = 1.25$ A

(ii) Potential difference $=$ emf - voltage drop $= e - (Ir)$

Now, voltage drop $=$ current $\times$ internal resistance $= 1.25 \times 3 = 3.75$

$\therefore$ p.d. $= 15 - 3.75 = 11.25$ V

Solution 57

When a wire of uniform thickness with resistance 27 ohm is cut into three equal pieces, the resistance of each piece = 27/3 = 9 ohm.

Now, equivalent resistance of three 9 ohm resistors connected in parallel is:

$$R_p = \left[\dfrac{1}{9} + \dfrac{1}{9} + \dfrac{1}{9}\right]^{-1} = \left[\dfrac{3}{9}\right]^{-1} = 3\Omega$$

Solution 58
To get a total resistance less than 2 ohm, the given resistors should be connected in parallel because in parallel combination the equivalent resistance is less than the resistance smallest connected resistor.

Solution 59

In the given network, the series combination of resistors, r_1 and r_2 is connected in series with the parallel combination of resistors, r_3 and r_4.
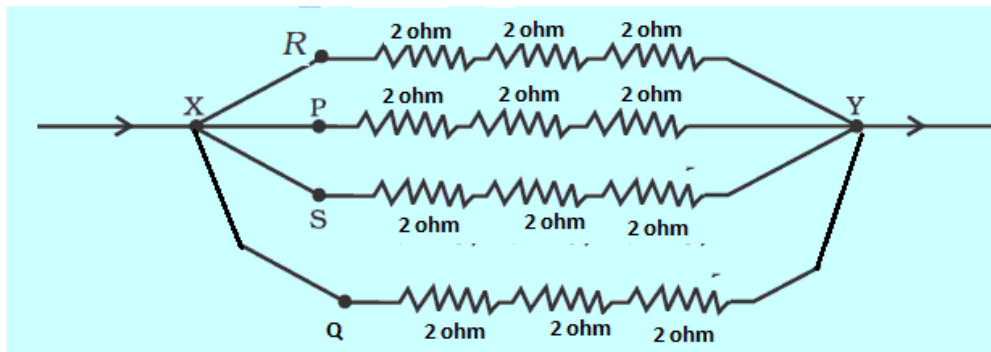
Equivalent resistance of resistor r_1 and r_2, $R_S = r_1 + r_2$

Equivalent resistance of resistor r_3 and r_4, $R_P = \left[\dfrac{1}{r_3} + \dfrac{1}{r_4}\right]^{-1} = \dfrac{r_3 r_4}{r_3 + r_4}$

$\therefore$ equivalent resistance of the given network, $R = R_S + R_P = r_1 + r_2 + \dfrac{r_3 r_4}{r_3 + r_4}$

Solution 60

The combination of resistors will be as shown in the diagram:

Equivalent resistance between R and Y = 2+2+2 = 6 Ω

Equivalent resistance between P and Y = 2+2+2 = 6 Ω

Equivalent resistance between S and Y = 2+2+2 = 6 Ω

Equivalent resistance between R and Y = 2+2+2 = 6 Ω

Equivalent resistance between X and Y = $\left[\dfrac{1}{6}+\dfrac{1}{6}+\dfrac{1}{6}+\dfrac{1}{6}\right]^{-1}=\left[\dfrac{3}{2}\right]=1.5\,\Omega$

PAGE NO-201:

Solution 1

Electrical power is defined as the rate at which energy is changed or work is done i.e., the work done per second or energy converted per second. Electrical appliances come with certain number of watts and volts written on them. Power rating of an electrical appliance gives the knowledge of the safe current limit of an appliance and also indicates the voltage above which the appliance should not be used.

Solution 2

Electrical energy is defined as the total amount of work done to maintain current in a circuit in a given time. Its SI unit is joule.

The rate at which electrical energy is consumed per unit time is called electrical power. It is denoted by P. i.e., Its SI unit is watt.

$$\text{Electrical power} = \dfrac{\text{Electrical energy}}{\text{time}}$$

The other name of kWh is Board of Trade Unit (BOTU).

Solution 3
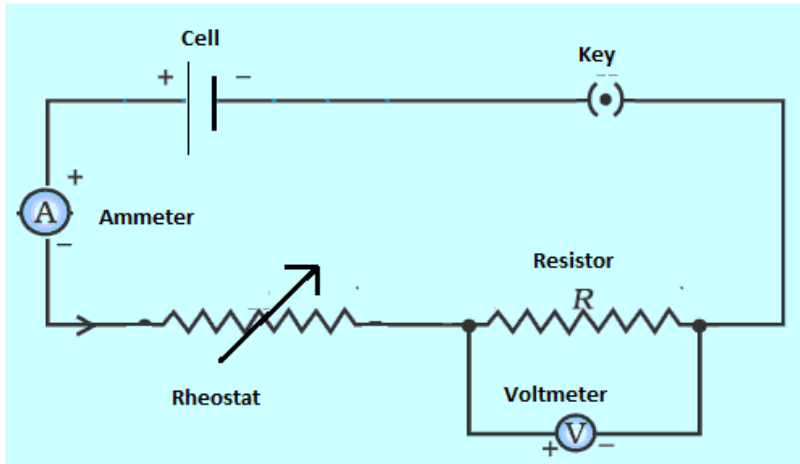
Functions:

(A) Cell- It provides the potential difference in the circuit.

(B) Key- It serves as a switch in the circuit. It supplies or cuts off current as required.

(C) Ammeter – It measures the current in the circuit.

(D) Rheostat- It helps to change the resistance of the circuit without changing its voltage.

(E) Resistor- It provides a constant resistance in the circuit.

(F) Voltmeter – It measure the potential drop across the resistor.

Solution 4

'The current rating of a fuse is 5 A' means that the maximum safe current permitted to flow through it before it breaks down is 5A.

Solution 5

We know that,

$P = VI$

$\therefore I = \dfrac{P}{V} = \dfrac{5 \times 1000}{200} = 25\,A$

Thus, safe limit of current through the appliance is 25A and a fuse of rating 8A cannot be used with an appliance of rating 5kW, 200 V.

Solution 6

We know that,

$P = VI$

$\therefore I = \dfrac{P}{V} = \dfrac{3 \times 1000}{250} = 12\,A$

Thus, it can be used in a circuit which contains a 13A fuse.

Solution 7

We know that,

$P = VI$

$\therefore I = \dfrac{P}{V} = \dfrac{2.4 \times 1000}{12} = 200\,A$

The current supplied by the battery is 200A.

Solution 8

Given, power $P = 720\ w = 0.72\ kW$

Voltage, $V = 220$ volt

(a) Electrical energy consumed in 3 h = 0.72 × 3 = 2.16 kWh

(b) Cost of energy consumption @ 60 paise per kWh = 2.16 × Rs 0.6 = Rs 1.3

Solution 9

An electric fuse is a safety device which is used to limit the current in an electric circuit. The use of a fuse thus safeguards the circuit and appliances connected in that circuit from being damaged. A fuse is generally made of an alloy of lead and tin.

Solution 10

Characteristics of fuse wire:
(i) It should have low melting point.
(ii) It should have high resistance.

Solution 11

(a) resistance, melting point
(b) low, lead, tin, melts.
(c) series, live

PAGE NO-202:

Solution 12

As per Joule's law,

$H = I^2Rt$

Here, I = 10 A, R = 5 Ω and t = 15 mins = 900s

$\therefore H = (10)^2 \times 5 \times (900) = 4.5 \times 10^5\ J$

Solution 13

A/C to Ohm's law;

$V = IR$

Here, V = 200 volt and I = 11A

$\therefore R = \dfrac{V}{I} = \dfrac{200}{11} = 18.2\ \Omega$

Solution 14

We know that,

$P = VI = I^2R$

Given, $P = 1200$ watt , $I = 5A$

$\therefore R = \dfrac{P}{I^2} = \dfrac{1200}{5 \times 5} = 48\Omega$

and, $V = \dfrac{P}{I} = \dfrac{1200}{5} = 240V$

Solution 15

The main fuse is connected between the kWh meter and distribution board of the house circuit. The main fuse is connected in the live wire.

Solution 16

Yes, kWh is the unit of electrical energy.

Solution 17

A switch is an on-off device for current in a circuit (or in an appliance). Its main function is either to connect or to disconnect an electrical appliance in an electric circuit.Switches are always connected in the live wire of circuits so that when a switch is in 'off' position, no current flows through the appliance and its live and neutral wires are at same potential and it is safe to touch the live wire leading to the appliance, even when the fuse is blown.

Solution 18

A switch should not be touched with wet hands. This is because water forms a conducting layer between the hand and the live wire of the switch through which the current passes to the hand and we may get a fatal shock.

Solution 19

'An electric bulb is rated 250 W-230V'; means that if the bulb is lighted on a 230V supply it consumes 250W electrical power or 250J of electrical energy converts into heat and light in 1 second.

The safe limit of current through the bulb is:

$I = \dfrac{P}{V} = \dfrac{250}{230} = 1.1A$

Current through a 60W lamp rated for 250V is:

$I = \dfrac{P}{V} = \dfrac{60}{250} = 0.24A$

We know that resistance of an appliance remains constant.

Resistance of the lamp =

$R = \dfrac{P}{I^2} = \dfrac{60}{(0.24)^2}\Omega$

$\therefore$ If the line voltage falls to 200 V, power =

$P = \dfrac{V^2}{R} = \dfrac{200 \times 200 \times (0.24)^2}{60} = 38.4\,\text{watt}$

Thus power of the lamp reduces to 38.4 watt.

Solution 20

The metal case of an electrical appliance is earthed so that in any case of accidental contact of live wire with the metallic body of the appliance, the earthing would provide a safe and easy path for the electric charges to flow down to the earth which acts as very large sink. Thus, user is thereby protected from any fatal electric shock.

Solution 21

Given, Voltage = 12 V, power = 24 W, time = 20 mins. = 1200 s.

(i) Currrent, $I = \dfrac{P}{V} = \dfrac{24}{12} = 2 \text{ A}$

(ii) energy liberated, $H = VIt = 12 \times 2 \times 1200 = 28{,}800 \text{ J}$

Solution 22

International convention of colour coding:1. Live wire ? Brown2. Neutral wire – Light blue3. Earth wire ? Green or yellow

Solution 23

Given, current, $I = 0.2 \text{ A}$; p.d. = 15 V

(i) A/C to Ohm's law

$V = IR$

$\therefore R = \dfrac{V}{I} = \dfrac{15}{0.2} = 75\,\Omega$

(ii) energy produced in one minutes is:

$H = I^2 Rt = (0.2)^2 \times 75 \times 60 = 180 \text{ J}$

Solution 24

Given, P = 1.5 kW = 1500 W, p.d. = 220 V

We know that,

$P = VI$

$\therefore I = \dfrac{P}{V} = \dfrac{1500}{220} = 6.8 \text{ A}$

Thus a fuse of rating 7A may be used with the appliance and

it should be connected in the live wire before connectimg it to the appliance.

Solution 25

The fuse helps to control the maximum current in an electrical circuit. The fuse protects an electrical circuit by melting and breaking the circuit, whenever the current exceeds the pre-determined limit in the circuit. Due to low melting point, the fuse wire melts and then breaks the circuit.

Solution 26

Earthing is done to save an electrical circuit or an appliance from damage. If due to some reason such as short circuiting, an excessive current flows through the line wires, it will pass to the earth if there is local earthing, otherwise it may cause a fire due to overheating of line wires.

Solution 27
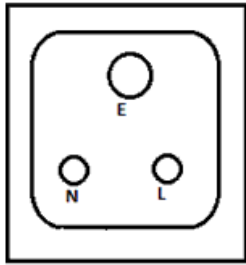
E for earth pin

L for live pin

N for neutral pin

Three-pin socket

Solution 28

One may get an electric shock from an electrical appliance if accidentally the live wire comes in contact with the metallic case of the body of the appliance due to break of insulation after constant use (or otherwise).

Solution 29

The SI unit of electrical energy is joule. The SI unit of electrical power is watt.(i) Kilowatt-hour is the household unit of electrical energy. It is defined as the quantity of electrical energy consumed in 1 hour when the rate of consumption is 1000 watts, i.e. 1000 J/s.(ii) A voltage of 220 volt is generally supplied to a house.

Solution 30

Given, P = 100 W, p.d. = 220 V

We know that,

$$P = \frac{V^2}{R}$$

$$\therefore R = \frac{V^2}{P} = \frac{(220)^2}{100} = 484\,\Omega$$

Also, we know that,

$$P = VI$$

$$\therefore I = \frac{P}{V} = \frac{100}{220} = 0.45\,A$$

Thus a fuse of rating 7A may be used with the appliance and

it should be connected in the live wire before connectimg it to the appliance.

Solution 31

Total resistance of resitors of 4 Ω and 6 Ω in parallel is:

$$R_P = \left[\frac{1}{4} + \frac{1}{6}\right]^{-1} = 2.4\,\Omega$$

Given voltage supply = 6 volt

(i) Power supplied by the battery, $P = \dfrac{V^2}{R} = \dfrac{6 \times 6}{2.4} = 15$ watt

(ii) Power dissipated in 4Ω resistor, $P_1 = \dfrac{V^2}{R} = \dfrac{6 \times 6}{4} = 9$ watt

Power dissipated in 6Ω resistor, $P_1 = \dfrac{V^2}{R} = \dfrac{6 \times 6}{6} = 6$ watt

Solution 32

A three pin-plug has three terminals:
(i) Earth pin: It provides connection for earthing.

(ii) Neutral pin: It provides connection to the neutral wire.
(iii) live pin: It provides connection to the live wire.

Solution 33
Consumer pays the bill in kilowatt-hour.

Solution 34
Given, emf = 15 V, internal resistance, r = 2 Ω

(i) Total resistance of given resistors in series, $R_s = 4 + 6 = 10\Omega$

Now, current through series combination, $I_S = \dfrac{emf}{R_s + r} = \dfrac{15}{(10+2)} = \dfrac{15}{12} = 1.25\ A$

In series, the same current will pass through each resistor

∴ electrical energy spent per minute in the 6Ω resistor, $H_S = I^2(R)\ t = (1.25)^2(6)(60) = 562.5 J$

(ii) Total resistance of given resistors in parallel, $R_p = \left(\dfrac{1}{4} + \dfrac{1}{6}\right)^{-1} = 2.4\Omega$

Current in parallel circuit, $I = \dfrac{15}{2.4+2} = 3.4A$

In parallel, each resistor is connected across the same voltage, say V.

Then, $V = e - Ir = 15 - (3.4 \times 2) = 8.18\,volt$

∴ electrical energy spent per minute in the 6Ω resistor, $H_p = \dfrac{V^2}{R}t = \dfrac{(8.18)^2}{6} \times 60 = 669.1J$

Solution 35
Kilowatt-hour is the commercial unit of electricity.

Solution 36

$$P = VI = I^2R = \dfrac{V^2}{R}$$

Solution 37
Power-voltage rating of an electrical appliance indicates the value of voltage above which the appliance should not be used. It serves as a precaution to the customer and also helps to calculate the maximum value of current that can be safely passed through the appliance.

Solution 38
The physical quantity is electric power.

Solution 39
It means that if the bulb is lighted on a 200V supply it consumes 60W electrical power or 200J of electrical energy converts into heat and light in 1 second.

Solution 40

We know that , $R = \dfrac{V^2}{P}$

Thus, voltage remaining constant, resistance is inversely proportional to the power of the appliance; which means resistance of 60 W (220V) bulb is greater.

Hence, the given statement is false.

Solution 41

We know that , $P = VI$

$\therefore I = \dfrac{P}{V} = \dfrac{40}{220} = 0.11 A$

Solution 42

Watt-hour is the commercial unit of electrical energy. One watt-hour is the electrical energy consumed by an electrical appliance of power 1 watt when it is used for 1 hour. 1Wh = 3600 J

Solution 43

Kilowatt-hour is the commercial unit of electricity.

Solution 44

We know that , $E = Pt$

Given, $P = 60\ W = 0.06\ kW$

and, $t = 50$ hours

$\therefore E = 0.06 \times 50 = 3\ kWh$

Solution 45

Case (i) Energy consumed by two bulbs per day $= 2 \times \dfrac{60}{1000} \times 4 = 0.48$ kWh

Case (ii) Energy consumed by three bulbs per day $= 3 \times \dfrac{100}{1000} \times 5 = 1.5 kWh$

$\therefore$ total energy consumed per day $= 0.48 + 1.5 = 1.98\ kWh$

Required consumption of electrical during the month of June (30 days) =

$= 1.98 \times 30 = 59.4$ kWh

Solution 1

Yes, we can produce electricity from magnetism.

Solution 2

The production of electric current by moving a straight conductor in a magnetic field is called electromagnetic induction.

Solution 3
Fleming's right hand rule can be stated as: Stretch the forefinger, the middle finger and the thumb of the right hand, such that they are mutually perpendicular to each other. If the forefinger indicates the direction of the magnetic field, thumb indicates the direction of motion of conductor, then the middle finger indicates the direction of induced current in the conductor.

Solution 4
(a)When the north-pole is pushed into the coil, a momentary deflection is observed in the galvanometer that indicates the production of a momentary current in the coil.(b) When the magnet is held at rest, there is no deflection in the galvanometer, indicating that no current is produced in the coil.(c)When the north-pole is pulled out from the coil, the deflection of the galvanometer is along the opposite direction, indicating the production of an opposite current.

Solution 5
(i) Fleming's left hand rule is used to find out the direction of Lorentz force on a conductor. (ii) Fleming's right hand rule is used to find out the direction of induced current in a conductor.

Solution 6
No, we cannot find out the magnitude of current using Fleming's right hand rule; we can find only the direction of induced current.

PAGE NO-220:

Solution 7
If the current flows along the same direction with time, it is called a direct current (D.C.).

Solution 8
If the current changes direction after equal intervals of time, it is known as alternating current (A.C.).

Solution 9
Frequency of D.C. is zero.

Solution 10
Frequency of A.C. used in India is 50 Hz.

Solution 11
An alternating changes its direction after equal intervals of time but direct current does not change its direction.

Solution 12
A generator with commutator (D.C. generator) produces D.C. current.

Solution 13
A dynamo converts mechanical energy into electrical energy.

Solution 14
A fuse is always connected in series, in household circuits.

Solution 15

Three colours are:(i) Red (for live wire)(ii) Green (for earth wire)(iii) Black (for neutral wire)

Solution 16

Short circuiting occurs when the live wire comes in direct contact with the neutral wire so a zero resistance path is provided to the current. The heavy current then passes through the appliance and wires of the circuit.

Solution 17

Precautions while using electricity:(i) One must use wires or cables of current carrying capacity higher than the current which can flow through the circuit while using all appliances.(ii) An electrical appliance must never be operated (or touched) with wet hands.

Solution 18

Earthing is a safety device which is used to prevent shocks due to short-circuiting and leakages. Earthing, means that the metal body of an appliance, or the kWh meter of the house, is connected to a thick copper wire which is buried deep in the earth and at its end ia a copper plate surrounded by a mixture of charcoal and common salt. This prevents the users from getting shocks.

Solution 19

An electric fuse is a device which is used to limit the current in an electric circuit. The use of a fuse thus safeguards the circuit and appliances connected in that circuit from being damaged. It is a short piece of wire made of an alloy of lead and tin. If the current passing through the fuse exceeds the safeguard limit the heat produced melts the fuse and this breaks the circuit.

Solution 20

Colour code for live wire is red, neutral wire is black and earth wire is green.

Solution 21

This is done to protect the appliances and circuits from any damage due to short-circuit and thus accidents like fire and fatal shocks. Earthing provides an easy and safe path to the excess current in the circuit and sends it to the ground.

Solution 22

Switches are always connected in live wire.

Solution 23

Fleming's right hand rule can be stated as: Stretch the forefinger, the middle finger and the thumb of the right hand, such that they are mutually perpendicular to each other. If the forefinger indicates the direction of the magnetic field, thumb indicates the direction of motion of conductor, then the middle finger indicates the direction of induced current in the conductor.

Solution 24

Fleming's left hand rule can be stated as: Stretch the forefinger, the middle finger and the thumb of the right hand, such that they are mutually perpendicular to each other. If the forefinger indicates the direction of the magnetic field, the middle finger indicates the direction of current in the conductor then thumb indicates the direction of force exerted on the conductor.

Solution 25

If a conducting wire is wound in form of a cylindrical coil whose diameter is less in comparison to the length, the coil is called a solenoid.

Solution 26

No, a copper wire cannot be used as a fuse wire as it has low resistance and high melting point.

Solution 27

A.C. is supplied to us in houses.

Solution 28

An alloy of lead and tin is used for making fuse wire.

Solution 29

Earthing is a safety device which is used to prevent shocks due to short-circuiting and leakages. Earthing, means that the metal body of an appliance, or the kWh meter of the house, is connected to a thick copper wire which is buried deep in the earth and at its end ia a copper plate surrounded by a mixture of charcoal and common salt. This prevents the users from getting shocks.

Solution 30

Arrangement
(a) is a series circuit.Arrangement
(b) is a parallel circuit.We would prefer a parallel circuit in household because:
(i) In parallel arrangement, each appliance works at the same voltage.
(ii) In parallel arrangement, if one bulb (or appliance0 is switched off (or fuses), the other bulbs (or appliances) continue to glow (or operate).

Solution 31

E is for earth pin, N is for neutral pin and L is for live pin.The earth pin is long so that the earth connection is made first. This ensures the safety of the user because if the appliance is defective, the fuse will blow off. The earth pin is made thicker so that even by mistake it cannot be inserted into the hole for the live or neutral connection of the socket.The pins are splitted at the ends to provide spring action so that they fit in the socket holes tightly.

Solution 32

(i) The purpose of the terminal E is to provide earth connection.
(ii) Terminal E is connected to the earth pin of the plug.
(iii) Fuse is connected in series with the wire L, so that if excess current flows through the circuit, the fuse wire get heated up and melts thus, breaking the circuit and preventing the flow of current to the appliance.

PAGE NO-223:

Solution 1

(a)
(i) 2/3 A
(b)(ii) double in value
(c)(iv) ohmic conductors
(d)(iv) 6 ?
(e) (ii) voltage
(f)(i) protect the user from electric shock by short circuiting and consequently breaking the circuit.
(g)(iii) A 13 ampere fuse is the most suitable rating to use

Solution 2

(a) Potential difference: The potential difference between two points may be defined as the work done in moving a unit positive charge from one point to the other.
(b)
(i) Coulomb: It is the unit of charge.
(ii) Ohm: It is the unit of resistance. The resistance of a conductor is said to be 1 ohm, if 1 ampere current flows through

it, when the potential difference across its ends is 1 volt.

(c) Electromotive force: When no current is drawn from a cell, when the cell is in open circuit, the potential difference between the terminals of the cell is called its electromotive force (or e.m.f.).

(d) Semiconductors: Substances whose resistance decreases with the increase in temperature are named as semiconductors. E.g. manganin, constantan etc.

(e) Superconductors: Substance whose resistance decreases tremendously with the decrease in temperature and reaches nearly zero around absolute zero temperature are named as superconductors; e.g. lead, tin etc.

Solution 3

According to Ohm's law, the current flowing in a conductor is directly proportional to the potential difference across its ends provided the physical conditions and temperature of conductor remains constant.Limitations of Ohm's law:1. Ohm's law does not apply to conductors such as diode, radio valves, metal rectifiers, where electricity passes through gases.2. Ohm's law is applicable only when the physical conditions remain constant.3. Ohm's law is applicable only when the temperature of the conductor is constant.

Solution 4

Factors on which the resistance of a conductor depends are:

(i) Nature of conductor: different materials have different concentration of free electrons and therefore resistance of a conductor depends on its material.

(ii) Length of conductor: Resistance of a conductor is directly proportional to the length of a conductor.

(iii) Area of cross-section of a conductor: Resistance of a conductor is inversely proportional to the area of cross-section of the uniform wire.

(iv) Temperature of conductor: In general for metallic conductors, higher the temperature larger is the resistance.Materials which allow electric charges to flow through them easily are known as conductors. E.g. metals and materials which do not allow the electric charge to flow through them are known as insulators. E.g. rubber, dry wood etc.

PAGE NO-224:

Solution 5

Functions:

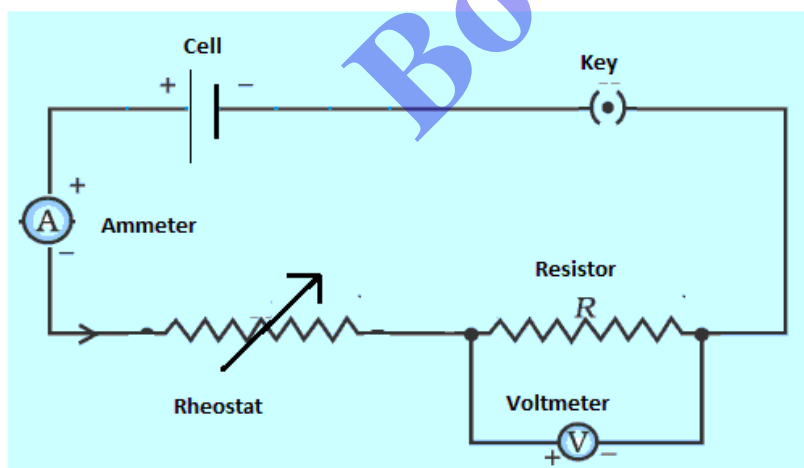(A) Cell- It provides the potential difference in the circuit.

(B) Key- It serves as a switch in the circuit. It supplies or cuts off current as required.

(C) Ammeter ? It measures the current in the circuit.

(D) Rheostat- It helps to change the resistance of the circuit without changing its voltage.

(E) Resistor- It provides a constant resistance in the circuit.

(F) Voltmeter ? It measure the potential drop across the resistor.

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(D) Rheostat- It helps to change the resistance of the circuit without changing its voltage.
(E) Resistor- It provides a constant resistance in the circuit.
(F) Voltmeter ◆ It measure the potential drop across the resistor.

Solution 6

(a) Between A and B, resistances 5Ω and 3Ω are connected in series.

$\therefore R_s = 5+3=8\Omega$

This series combination of resistances 5Ω and 3Ω is connected in parallel with the resistance 8Ω

$\therefore$ total resistance between A and B is given as:

$$R = \left[\frac{1}{8}+\frac{1}{8}\right]^{-1} = 4\Omega$$

(b) Between A and B, paralle combination of resistances 9Ω and 18Ω is connected in series with resistance 2Ω.

Parallel resistance of 9Ω and 18Ω is :

$$R_p = \left[\frac{1}{9}+\frac{1}{18}\right]^{-1} = 6\Omega$$

$\therefore$ total resistance between A and B is:

$R = 6 + 2 = 8\Omega$

(c) The situation consists of three two ohm resistors connected in series between CEFD and their combination in parallel with the fourth 2 ohm resistor between C and D.

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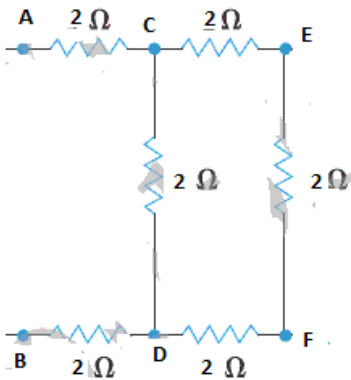
Therefore, series combination gives, $2 + 2 + 2 = 6\ \Omega$.

This 6Ω resistor is connected in parallel to the fourth $2\ \Omega$ resistor, therefore equivalent resistance between C and D,

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

$\therefore R = 1.5\ \Omega$

Now, between A and B the resistance R and two $2\ \Omega$ resistors are connected in series.

Therefore, equivalent resistance between A and B is

$R_{total} = 2+2+1.5 =5.5\ \Omega$

Solution 7

(a) Given, charge $q = 80\ C$, time $t = 2$ minutes $= 120\ s$

Current, $I = \dfrac{q}{t} = \dfrac{80}{120} = 0.67\,A$

(b) Given, current $I = 4\ A$, time $= 8\ s$

Let q be the charge passing in 8s

Then, $q = It = 4 \times 8 = 32\ C$

Solution 8

If voltage, V = 6 volt and resistance R = 3 Ω

The a/c to ohm's law, current $I = \dfrac{V}{R} = \dfrac{6}{3} = 2$ A

For filament lamp:

Given that, voltage = 3 V, current = 0.5 A.

let R be the resistance of the filament lamp;

then, $R = \dfrac{V}{I} = \dfrac{3}{0.5} = 6\Omega$

Solution 9

We know that, $R = \rho\dfrac{l}{a}$

(a) Given length of resistors P and Q made of same material is same (say = 1)

Let 'a' be the area of cross-section of Q.

Then, the area of cross-section of P is '2a'.

$$\therefore \ \dfrac{R_P}{R_Q} = \dfrac{\rho\dfrac{1}{2a}}{\rho\dfrac{1}{a}} = \dfrac{1}{2}$$

∴ the required ratio is 1:2.

(b) A/C to ohm's law,

V = IR

If resistors P and Q are connected across the same voltage supply V, then

$$\dfrac{I_P}{I_Q} = \dfrac{R_Q}{R_P} = \dfrac{2}{1}$$

∴ the required ratio of current in P to current in Q is 2:1.

Solution 10

(a) To get an equivalent resistance of 9 Ω using three 6 Ω resistors, they should be connected in parallel as shown:
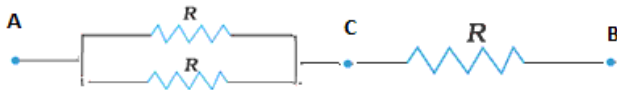
Between A and C, the equivalent resistance is

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

$$\therefore R_{parallel} = 3\Omega$$

Between A and B, the equivalent resistance is

$$R_{series} = 3 + 6 = 9\Omega$$

(b) To get an equivalent resistance of 4 Ω using three 6 Ω resistors, they should be connected in parallel as shown:
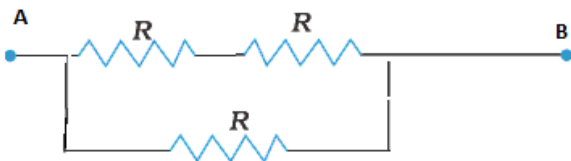
Between A and B, the series combination of two 6 Ω resistors is connected in parallel with the third 6 Ω resistor.

$$R_{series} = 6 + 6 = 12\Omega$$

$$\frac{1}{R_{equivalent}} = \frac{1}{6} + \frac{1}{12} = \frac{3}{12} = \frac{1}{4}\Omega$$

Solution 11

Circuit diagram:
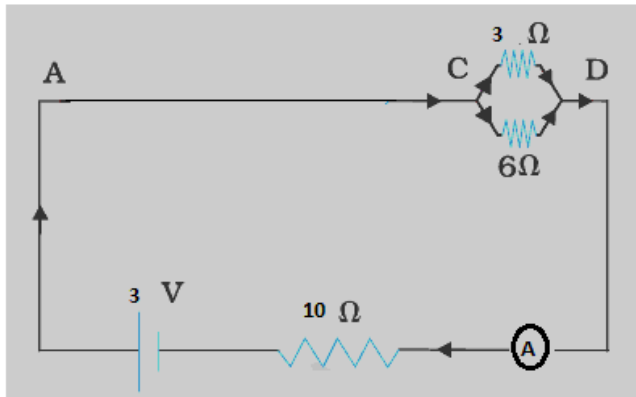
(a) Resistance of parallel combination:

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

$$\therefore R_{parallel} = 2\Omega$$

(b) Total resistance of the circuit =

$$R_{total} = 2 + 10 = 12\Omega$$

Let I be the current through the ammeter, the:

$$I = \frac{V}{R_{total}} = \frac{3}{12} = \frac{1}{4} = 0.25\,A$$

(c) Potential drop across 10 Ω resistor, $V_1 = I \times 10 = 0.25 \times 10 = 2.5V$

$\therefore$ Potential drop across 3 Ω resistor, $V_2 = e - V_1 = 3 - 2.5 = 0.5V$

(d) Current flowing through 10 Ω resistor = 0.25 A

Current flowing through 3 Ω resistor = $\frac{V_2}{R} = \frac{0.5}{3} = 0.17\,A$

Current flowing through 6 Ω resistor = 0.25 - 0.17 = 0.08 A

Solution 12

(a)
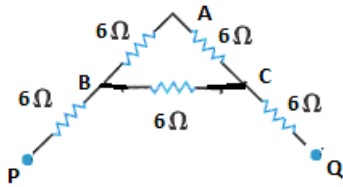
In the given network, between B and C the series combination
of two 6 Ω resistors is connected in parallel with the third 6Ω resistor.

$$\therefore \frac{1}{R_{equivalent}} = \frac{1}{6+6} + \frac{1}{6} = \frac{1}{12} + \frac{1}{6} = \frac{3}{12} = \frac{1}{4}$$

$\therefore R_{equivalent} = 4\Omega$

Now, between P and Q, two 6 Ω resistors and 4Ω resistor are connected in series.

$\therefore$ total resistance between P and Q is:

$R_{total} = 6 + 6 + 4 = 16\Omega$

(b) In the given network, the parallel combination of resistors 40 Ω and 120 Ω is
connected in series with the 10 Ω and 20 Ω resistors.

$\therefore$ Resistance in parallel is:

$$\frac{1}{R_p} = \frac{1}{40} + \frac{1}{120} = \frac{4}{120} = \frac{1}{30}$$

$\therefore R_p = 30\Omega$

Effective resistance between P and Q is

$R = 10 + 30 + 20 = 60\ \Omega$

Ans12 (C)

In the given network, the parallel combination of two 2 Ω resistors is connected in series with the parallel combination of two 3 Ω resistors.

∴ Resistance in parallel of two 2Ω resistors is:

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

∴ $R_p = 1\Omega$

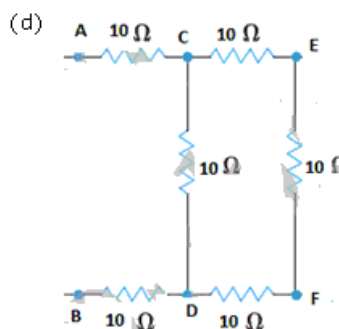Resistance in parallel of two 3Ω resistors is:

$$\frac{1}{R_p{}'} = \frac{1}{3} + \frac{1}{3} = \frac{2}{3}$$

∴ $R_p{}' = \frac{3}{2}\Omega$

Total resistance of the network:

$$R_{total} = 1 + \frac{3}{2} = \frac{5}{2}\Omega$$

(d)

The situation consists of three 10 ohm resistors connected in series between CEFD and their combination in parallel with the fourth 10 ohm resistor between C and D.

The situation consists of three 10 ohm resistors connected in series between CEFD and their combination in parallel with the fourth 10 ohm resistor between C and D.

Therefore, series combination gives, 10 + 10 + 10 = 30 Ω.

This 30Ω resistor is connected in parallel to the fourth 10 Ω resistor, therefore equivalent resistance between C and D,

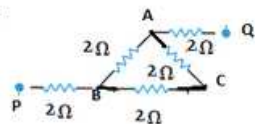Therefore, series combination gives, 10 + 10 + 10 = 30 Ω.

This 30Ω resistor is connected in parallel to the fourth 10 Ω resistor, therefore equivalent resistance between C and D,

$$\frac{1}{R} = \frac{1}{10} + \frac{1}{30} = \frac{4}{30}\Omega$$
∴ R = 7.5 Ω

Now, between A and B the resistance R and two 10 Ω resistors are connected in series.

Therefore, equivalent resistance between A and B is

$$R_{total} = 10 + 10 + 7.5 = 27.5\ \Omega$$

In the path ACB, the series combination of two 2Ω resistor is connected in parallel with the third 2Ω resistor.

∴ resistance in series = 2 + 2 = 4 Ω

This 4 Ω resistor is now connected in parallel with the 2Ω resistor.

∴ total resistance between A and B $\left(\frac{1}{R_p}\right) = \frac{1}{4} + \frac{1}{2} = \frac{3}{4}\Omega$

∴ $R_p = \frac{4}{3}\Omega$

Now, between P and Q, two 2 Ω resistors and $\frac{4}{3}\Omega$ are connected in series.

∴ total resistance of the given network, $R_t = 2 + 2 + \frac{4}{3} = \frac{6+6+4}{3} = \frac{16}{3} = 5.3\Omega$

Solution 13

(a) Given, emf (e) of the battery = 2 ×2 = 4V,
internal resistance r = 2 ×2= 4Ω
Resistance in the circuit, R = 4 Ω
Total resistance of the given series circuit = 4 + 4 = 8 Ω

∴ Current flowing through the circuit, $I = \frac{e}{(R+r)} = \frac{4}{8} = 0.5A$

(b) Given, emf of battery (e) = emf of each cell in parallel = 2V,

Total internal resistance $\frac{1}{r} = \frac{1}{2} + \frac{1}{2} = 1\,\Omega$

Resistance connected in the circuit ,R = 4 Ω

∴ Total resistance of the circuit = 1 + 4 = 5 Ω

∴ Current flowing through the circuit, $I = \frac{e}{(R+r)} = \frac{2}{5} = 0.4A$

Solution 14

(a) When the switch S is opened, resistance 60 Ω is not connected in the circuit
and current flows through the 20Ω resistor.

∴ Resistance of the circuit , when the switch is open:

R = 20 + 5 = 25 Ω

Given, voltage = 10 V

∴ current through the circuit, $I = \frac{V}{R} = \frac{10}{25} = 0.4A$

The reading of the ammeter is thus 0.4 A, when the switch is open.

(b) When the switch is closed, resistance 60 Ω gets connected to the circuit.

Thus, in the circuit the parallel combination of 60 Ω and 20Ω resistors is connected in series with the 5Ω resistor.

∴ Resistance in parallel, $\frac{1}{R_P} = \frac{1}{60} + \frac{1}{20} = \frac{1+3}{60} = \frac{4}{60}\,\Omega$

Or, $R_P = 15\,\Omega$

Now, total resistance of the circuit = 15 + 5 = 20 Ω

∴ current through the circuit, $I = \frac{V}{R} = \frac{10}{20} = 0.5A$

The reading of the ammeter is thus 0.5 A, when the switch is closed.

Solution 15

(a) Potential difference across XY = pot. diff. across 6 Ω resistor
                = 0.3 × 6 = 1.8 V

(b) Pot. difference across 9Ω resistor = pot. diff. across 6 Ω resistor = 1.8 V

∴ Current through 9Ω resistor = $\frac{1.8}{9} = 0.2A$

Current through 2.4Ω resistor = total current in the circuit = 0.3 + 0.2 = 0.5A

(c) p.d. across 2.4Ω resistor = 0.5 × 2.4 = 1.2 V

(d) emf of cell = p.d. across 2.4Ω resistor + pot. diff. across XY = 1.2 + 1.8 = 3.0 V

Solution 16

Given, emf e = 6 V, internal resistance r = 0.8 Ω

In the given circuit, parallel combination of resistances 2Ω and 3Ω is connected in series with a 3Ω resistance.

∴ Resistance in parallel , $\dfrac{1}{R_p} = \dfrac{1}{2} + \dfrac{1}{3} = \dfrac{5}{6}\Omega$

∴ $R_p = 1.2\Omega$

Total resistance of the given circuit , $R_t = 0.8 + 3 + 1.2 = 5\ \Omega$

∴ current recorded by the ammeter , $I = \dfrac{e}{R_t} = \dfrac{6}{5} = 1.2\ A$

(b) P.d. across resistor B = 1.2 × 3 = 3.6 V

(c) Current passing through resistor B = 1.2 A

Current through resistor C = $\dfrac{I \times 3}{2+3} = \dfrac{1.2 \times 3}{5} = 0.72\ A$

Current through resistor D = $\dfrac{I \times 2}{2+3} = \dfrac{1.2 \times 2}{5} = 0.48\ A$

(d) p.d. across the terminals of battery = 1.2 × 0.8 = 0.96 V

Solution 17

Quantity	Unit
1. Electrical potential	volt
2. Resistance	ohm
3. Power	watt
4. Energy	joule
5. Resistivity	Ohm-meter

Solution 18

We know that P = VI

$$\therefore I = \frac{P}{V}$$

Given voltage supply = 240 Volt

(i) Current through television = $\frac{150}{240}$ = 0.625 A

Thus, a fuse of rating 2 A should be used with it.

(ii) Current through electric iron = $\frac{750}{240}$ = 3.125 A

Thus, a fuse of rating 5 A should be used with it.

(iii) Current through immersion heater = $\frac{3000}{240}$ = 12.5 A

Thus, a fuse of rating 13 A should be used with it.

(iv) Current through hair dryer = $\frac{500}{240}$ = 2.08 A

Thus, a fuse of rating 5 A should be used with it.

(v) Energy consumed by t.v. set in 100 days when used for 4 hrs per day

$$= \frac{150}{1000} \times 4 \times 100 = 60kWh$$

Cost of running it for 100 days @ Rs. 0.6 per unit = 60 × 0.6 = Rs 36

Solution 19

(a)
An electric fuse is a device which is used to limit the current in an electric circuit. The use of a fuse thus safeguards the circuit and appliances connected in that circuit from being damaged. It is a short piece of wire made of an alloy of lead and tin. If the current passing through the fuse exceeds the safeguard limit the heat produced melts the fuse and this breaks the circuit.

(b)
A fuse wire should have high resistance and low melting point.

(c)
Maximum power that can be taken, P = VI = 240 × 5 = 1200 W.

(d)
Replacing a fuse with another fuse of higher rating would allow a large current to flow through the circuit or appliance to which the fuse is connected and thus, there is a chance of short-circuiting and the appliance may get damaged.

Solution 20

Given power P = 2kW = 2000 W, Voltage = 250 V

(a) Current $I = \dfrac{P}{V} = \dfrac{2000}{250} = 8A$

(b) Resistance, $R = \dfrac{V^2}{P} = \dfrac{(250)^2}{2000} = 31.25\,\Omega$

(c) Heat produced in 1 minute $= \dfrac{V^2}{R}t = \dfrac{(250)^2}{31.25} \times 60 = 1.2 \times 10^5 \ joules$

(d) Energy consumed per day $= P \times t = 2 \times \left(\dfrac{10}{60}\right) = 0.33\,kWh$

Energy consumed in 30 days $= 0.33 \times 30 = 10\,kWh$

Cost of running it @ Rs 3 per unit $= 10 \times 3 = Rs\ 30$

Solution 21

Given power P = 3kW = 3000 W, Voltage = 250 V

We know that, P = VI

$\therefore I = \dfrac{P}{V} = \dfrac{3000}{250} = 12A$

Thus a maximum of 12 A current can pass through the electric wire and a fuse of rating 13 A should be used with it.

Solution 22

Moment of force = applied force × perpendicular distance from the line of action

$\therefore$ 10 = 20 × perpendicular distance from the line of action

or, Perpendicular distance from the line of action = 0.5 m

Solution 23

(a) Brown wire or live wire should be connected to terminal C. Blue wire or neutral wire should be connected to terminal B. Green wire or earth wire should be connected to terminal A.
(b) No, current passes through the earth terminal i.e. terminal A in normal circumstances.
(c) The metal case of an electrical appliance is earthed so that in any case of accidental contact of live wire with the metallic body of the appliance, the earth wire would provide a safe and easy path for the electric charges to flow down to the earth which acts as very large sink. Thus, user is thereby protected from any fatal electric shock.

Solution 24

'kilowatt-hour' is the commercial unit of electricity. One kilo-watt hour is the electrical energy consumed by an electrical appliance of power 1 kW when it is used for 1 hour.

PAGE NO-227:

Solution 25

Construction and working of filament bulbList of materials used:Light bulbs have two metal contacts, which connect to the ends of an electrical circuit. The metal contacts are attached to two stiff wires, which are attached to a thin metal filament. The filament sits in the middle of the bulb, held up by a glass mount. The wires and the filament are housed in a glass

bulb, which is filled with an inert gas, such as argon.

Construction and working of filament bulb
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Light bulbs have two metal contacts, which connect to the ends of an electrical circuit. The metal contacts are attached to two stiff wires, which are attached to a thin metal filament. The filament sits in the middle of the bulb, held up by a glass mount. The wires and the filament are housed in a glass bulb, which is filled with an inert gas, such as argon.
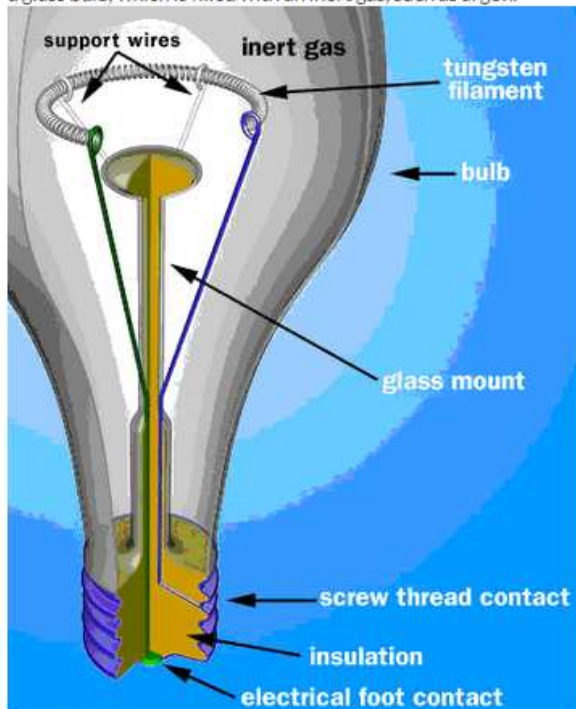
When the bulb is connected to a power supply, an electric current flows from one contact to the other, through the wires and the filament. As the electrons zip along through the filament, they are constantly bumping into the atoms that make up the filament. The energy of each impact vibrates an atom — in other words, the current heats the atoms up. Metal atoms release mostly infrared light photons, which are invisible to the human eye. But if they are heated to a high enough level — around 4,000 degrees Fahrenheit in the case of a light bulb — they will emit a good deal of visible light. Tungsten is used in nearly all incandescent light bulbs because it is an ideal filament material. In a modern light bulb, inert gases, typically argon, greatly reduce this loss of tungsten. At extreme temperatures, the occasional tungsten atom vibrates enough to detach from the atoms around it and flies into the air resulting in its evaporation. In the rpesence of argon gas around it, the chances are that it will collide with an argon atom and bounce right back toward the filament, where it will rejoin the solid structure. Also since inert gases normally don't react with other elements, there is no chance of the elements combining in a combustion reaction.

Solution 26

Energy consumed by 6 bulbs per day = $6 \times \dfrac{100}{1000} \times 4 = 2.4$ kWh

Energy consumed by 4 bulbs per day = $4 \times \dfrac{60}{1000} \times 8 = 1.92$ kWh

Energy consumed by immersion heater per day = $2.5 \times 1 = 2.5$ kWh

Energy consumed by electric iron per day = $\dfrac{800}{1000} \times 2 = 1.6$ kWh

Total energy consumed in 1 day = $2.4 + 1.92 + 2.5 + 1.6 = 8.42$ kWh

Total energy consumed in the month of April (30 days) = $8.42 \times 30 = 252.6$ kWh

Electric bill for the month of April = $252.6 \times 0.8 =$ Rs. 202.08

Solution 27
(a) Connecting wires: Materials having low resistance low resistivity and high melting point e.g. copper, aluminium.
(b) Fuse wire: Materials having high resistance and low melting point e.g. solder an alloy of lead and tin.
(c) Heating element: Materials having high resistivity and high melting point e.g. tungsten.
(d) Connecting wire of a power line: Materials having low resistance and non-corosive properties e.g. high tension wires.
(e) Earthing elements: Materials which are good conductors of electricity. Earthing elements are copper wire, copper plate, salt.

Solution 28

We know that $R = \dfrac{V^2}{P}$

$\therefore$ $\dfrac{\text{Resistance of 60 W-220V bulb}}{\text{Resistance of 60W-110V bulb}} = \dfrac{(220)^2}{60} \times \dfrac{60}{(110)^2} = \dfrac{4}{1}$

Thus, the required ratio is 4:1.

Solution 29

Given, Power P = 1.5 kW, voltage V = 250 V

(a) Current, $I = \dfrac{P}{V} = \dfrac{1.5 \times 1000}{250} = 6A$

(b) Energy consumed in 20 hrs = P x t = 1.5 × 20 = 30 kWh

(c) Cost of consumed energy @ Re.1 per unit = 1 × 30 = Rs. 30

Solution 30

Given, emf, e = 4 V, internal resistance r = 2.5 Ω, current I = 0.5A

(a) Energy provided by battery in 10 mins = Power × time = (VIt)= 4×0.5×20= 40 watt-hour

(b) Heat dissipated in the bulb in 10 minutes = I^2Rt

Let R be the resistance of the bulb, then:

$I = \dfrac{e}{R+r}$

$or, 0.5 = \dfrac{4}{R+2.5}$

$or, R + 2.5 = 8$

$or, R = 5.5\ \Omega$

$\therefore$ Heat dissipated in the bulb in 10 minutes = $I^2Rt = (0.5)^2 (5.5)(10 \times 60) = 825\ joules$

Solution 31

(a) The ring system consists of a ring of three wires namely live wire, earth wire and neutral wire, which originate from the main fuse box and after running around the rooms in the house comes back to the main fuse box, thus, completing a ring. In ring system, a separate connection is taken from the live wire of the ring for each appliance. In the ring circuit, all appliances are connected in parallel.

(b) Advantages of a parallel connection are:

(i) In parallel arrangement, each appliance works at the same voltage. For example, if several bulbs are connected in parallel, each bulb glows at the same voltage. Therefore, the glow of a bulb is unaffected if another bulb is switched on or off.

(ii) In parallel arrangement, if one bulb (or appliance

Solution 32

(a)

(a) Current flows through the person to the earth (b) The fuse melts and breaks the circuit
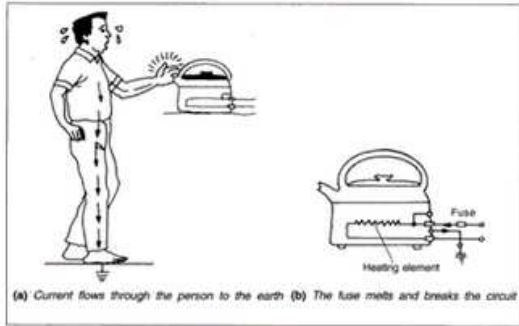
(b)

Fuse and switches are always connected to the live wire so that when the switch is in off position no current flows through the appliance and its live and neutral wires are at same potential. In case, excess current flows through the live wire, the fuse wire melts and breaks the circuit; so no excess current flows through the appliance and it is protected against any damage.

Solution 33

When no current is drawn from the cell i.e. when the cell is in open circuit, the potential difference between the terminals of the cell is called its electromotive force (or e.m.f).

Solution 34

In an open circuit no current is drawn from the cell whereas in closed circuit, an amount of energy is spent in the flow of unit positive charge through the electrolyte of the cell. Thus, the p.d. between the terminals of a storage battery is less when it is supplying current.

Given, emf e = 10 V, internal resistance r = 2.5 Ω

Two external resistances $R_1 = R_2 = 50\Omega$ (= R, say)

(a) When R_1 and R_2 are connected in series, same current flows through each resistor and hence same power is dissipated in each resistor.

Total resistance of the circuit, $R_S = R_1 + R_2 + r = 50 + 50 + 2.5 = 102.5\Omega$

$\therefore$ Current through each resistor $= \dfrac{e}{R_S} = \dfrac{10}{102.5} = 0.096 A$

Power dissipated in each resistor $= I^2 R = (0.096)^2 (50) = 0.46$ watt

(b) When R_1 and R_2 are connected in parallel, voltage across each resistor is same and hence same power is dissipated in each resistor.

Total resistance of the circuit $R_p = \left(\dfrac{1}{R_1} + \dfrac{1}{R_2}\right)^{-1} + r = 25 + 2.5 = 27.5\Omega$

Current through the circuit, $I = \dfrac{e}{R_p} = \dfrac{10}{27.5} = 0.36 A$

Voltage across each resistor, V = e - Ir = 10 - (0.36×2.5) = 9.1V

$\therefore$ Power dissipated in each resistor $P = \dfrac{V^2}{R} = \dfrac{(9.1)^2}{50} = 4140.5$ watt

Solution 35

Appliances	Voltage (V)	Power (W)	Resistance (R in Ω = V^2/P)
(a) washing machine	250	3000	20.8
(b) Television	240	160	360
(c) Electric iron	240	1500	38.4
(d) Hair curler	250	20	3125
(e) Car head lamp	12	36	4

Therefore, hair curler has the largest working resistance.

Solution 36

Given, p.d., $V = 10^8$ volt, charge $Q = 20$ coulombs

Energy given $= QV = 20 \times 10^8 = 2 \times 10^9 J$

∴ (d) $2 \times 10^9 J$

Solution 37

Incorrect statement:(a) A 13A fuse is the most appropriate value to use

Solution 38

(i) A transformer works on the principle of electromagnetic induction.
(ii) Function of a step-up transformer is to increase the a.c. voltage and decrease the current.
(iii) No, a transformer cannot work on a d.c. source. With a d.c. source, there will be no change in magnetic flux linked with the secondary coil.
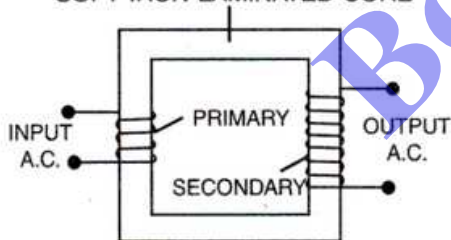
(iv)

Step-down transformer

(v)
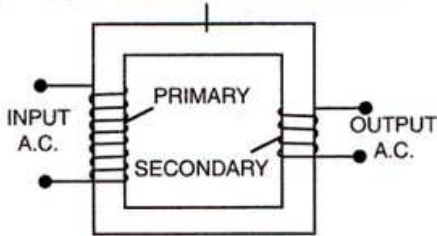
Step-up transformer

Solution 39

(i) Current at the end B of the coil X is anticlockwise therefore at this end there is north pole.
(ii) While closing the key, polarity at the end C of the coil Y will be north. There will be no polarity at the end C of the coil Y when the current becomes steady in the coil X.
(iii)
(a) While the coil Y is moved towards the coil X, the polarity at the end C of the coil Y is north.
(b) While the coil Y is moved away the coil X, the polarity at the end C of the coil Y is south.

Solution 40

(a)

(i) When the magnet is moved rapidly in the direction of arrow, the magnetic flux linked with the coil changes and there is a deflection in the galvanometer, indicating a flow of current through the coil.

(ii) On keeping the magnet still, the magnetic flux linked with the coil does not change and there is no deflection in the galvanometer, indicating that no current is flowing through the coil.

(iii) When the magnet is rapidly pulled out, there is again change in the magnetic flux linked with the coil and the galvanometer shows a deflection but this time in opposite direction, indicating that a current is flowing in opposite direction in the coil.

(b) If a more powerful magnet is used, deflection in the galvanometer will be large, indicating a greater amount of current.

Solution 41

(a) (v) leftleft left

(b) (ii) repulsion and attraction respectively

(c) (i) connecting a large resistor in series

(d) (iv) upwards and perpendicular to XY

(e) (i) 250 V

Solution 42

(a) Plastic being non-magnetic cannot be used as a material for core. It shall not intensify the formed magnetic field.(b) Steel has high retentivity. Hence, after prolonged use even when the switch is off, it may retain some magnetic property and attract the armature. (c) Using copper as a material for core will introduce eddy currents in the core and thus, interfere with the working of the bell.
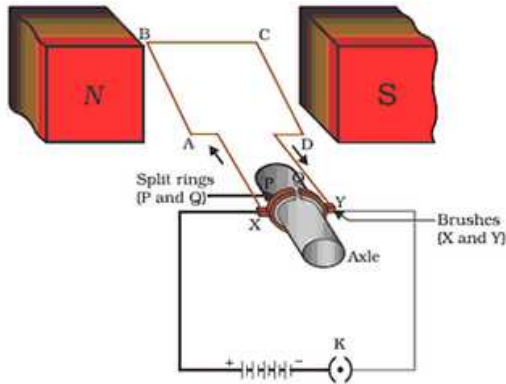
PAGE NO-229:

Solution 43
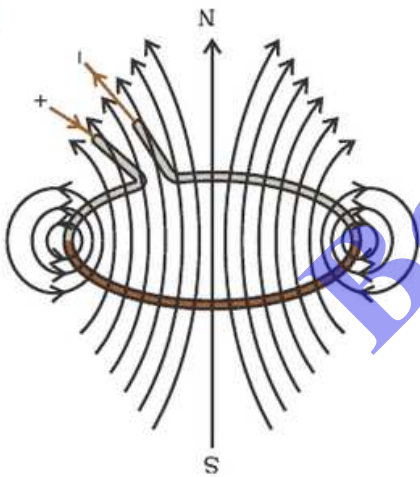
(b) Since the magnetic field lines pass through the loop in the same direction, the two sections repel each other.

(c) To increase the repulsive force, the current through the loop should be increased.

Solution 44

A d.c. motor

(a) The coil rotates because equal and opposite forces act on its arms which form a couple.

(b) The direction of rotation of armature can be reversed by interchanging the connections at the terminals of the battery joined to the brushes of the motor.

(c) The speed of rotation of the motor can be increased by increasing the current through the coil or by increasing the number of turns in the coil and by increasing the strength of the magnetic field.

Solution 45

(i) This is due to change in magnetic flux in the coil. Due to change in magnetic flux an induced emf is produced in the coil. Hence, a current flows through the galvanometer.(ii) The current appears anticlockwise when viewed from end A because end A will form north-pole.(iii) The galvanometer now deflects towards left.(iv) No deflection is observed as there is no relative motion between the magnet and the coil.

Solution 46

Given, $N_p = 800$, $N_s = 8$, $E_p = 220$ V, $E_s = ?$
We know that for a step-down transformer,

$$\frac{N_s}{N_p} = \frac{E_s}{E_p}$$

$$\therefore E_s = \frac{N_s}{N_p} \times E_p = \frac{8}{800} \times 220 = 2.2 \text{V}$$

Solution 47

A moving coil galvanometer can be converted into an ammeter by connecting a low resistance (called a shunt) in parallel to the galvanometer.A moving coil galvanometer can be converted into a voltmeter by connecting a high resistance in series with the galvanometer.

Solution 48

An ammeter is a low resistance device; hence it is connected in series.A voltmeter is a high resistance device; hence it is connected in parallel.

Solution 49

Experiment 1

(i) Take a coil of wire AB having a large number of turns.

(ii) Connect the ends of the coil to a galvanometer as shown in figure.

(iii) Take a strong bar magnet and move its north pole towards the end B of the coil.

(iv) There is a momentary deflection in the needle of the galvanometer, say to the right. This indicates the presence of a current in the coil AB. The deflection becomes zero the moment the motion of the magnet stops.

(v) Now withdraw the north pole of the magnet away from the coil. Now the galvanometer is deflected toward the left, showing that the current is now set up in the direction opposite to the first.

(vi) Place the magnet stationary at a point near to the coil, keeping its north pole towards the end B of the coil. We see that the galvanometer needle deflects toward the right when the coil is moved towards the north pole of the magnet. Similarly the needle moves toward left when the coil is moved away.

(v) When the coil is kept stationary with respect to the magnet, the deflection of the galvanometer drops to zero.
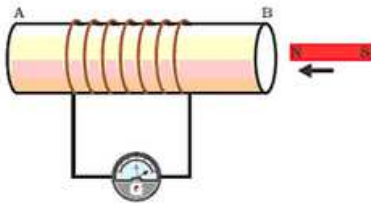
<u>Experiment 2</u>

(i) Take two different coils of copper wire having large number of turns (say 50 and 100 turns respectively). Insert them over a non-conducting cylindrical roll, as shown in figure.

(ii) Connect the coil-1, having larger number of turns, in series with a battery and a plug key. Also connect the other coil-2 with a galvanometer as shown.

(iii) Plug in the key. Observe the galvanometer. We will observe that the needle of the galvanometer instantly jumps to one side and just as quickly returns to zero, indicating a momentary current in coil-2.

(iv) Disconnect coil-1 from the battery. We will observe that the needle momentarily moves, but to the opposite side. It means that now the current flows in the opposite direction in coil-2.
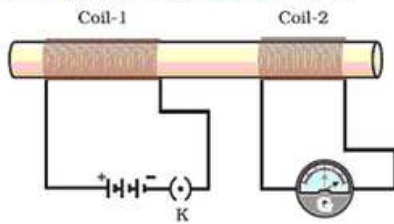
From these observations, we conclude that a potential difference is induced in the coil-2 whenever the electric current through the coil-1 is changing (starting or stopping). This process, by which a changing magnetic field in a conductor induces a current in another conductor, is called electromagnetic induction.

To determine the direction of induced current, we use Fleming's left hand rule:

Stretch the thumb, forefinger and middle finger of right hand so that they are perpendicular to each other. If the forefinger indicates the direction of the magnetic field and the thumb shows the direction of motion of conductor, then the middle finger will show the direction of induced current.

Magnitude of induced current can be measured with the help of a galvanometer.

PAGE NO-230:

Solution 50
(a) We will observe that the needle of the galvanometer instantly jumps to one side and just as quickly returns to zero, indicating a momentary current in coil connected to galvanometer.
(b) Introducing an iron bar in the tube, will increase the amount of induced current and the galvanometer will show a greater deflection.

Solution 51

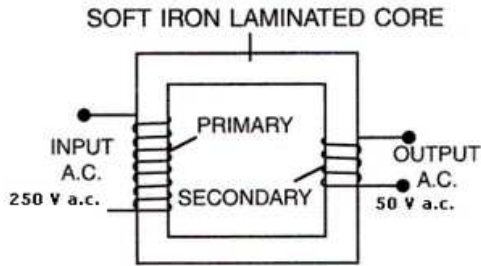(a) Soft iron is used as the material for the core of transformer.

Structure of core: The core is made by taking thin rectangular sheets or laminas of soft iron (or silicon-steel) and dipping them in an insulating paint or varnish. These insulated sheets are stacked together to form a solid looking rectangular frame. This is called the laminated core of the transformer.

(b) Given, $E_p = 250$ V, $E_s = 50$ V

We know that for transformer turn ratio $= \dfrac{N_s}{N_p} = \dfrac{E_s}{E_p}$

$\therefore \dfrac{N_s}{N_p} = \dfrac{50}{250} = \dfrac{1}{5}$

Thus, it is a step-down transformer.

SOFT IRON LAMINATED CORE

INPUT A.C. 250 V a.c. — PRIMARY — SECONDARY — OUTPUT A.C. 50 V a.c.

Step-down transformer

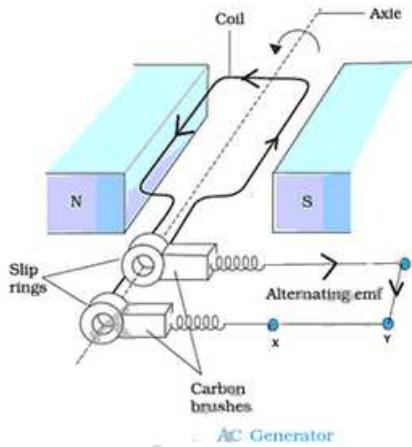(c) Given, $I_s = 2$A

Let I_p be the current through primary.

We know that for transformer turn ratio $= \dfrac{I_p}{I_s} = \dfrac{E_s}{E_p} = \dfrac{1}{5}$

$\therefore I_p = \dfrac{1}{5} \times 2 = 0.4$ A
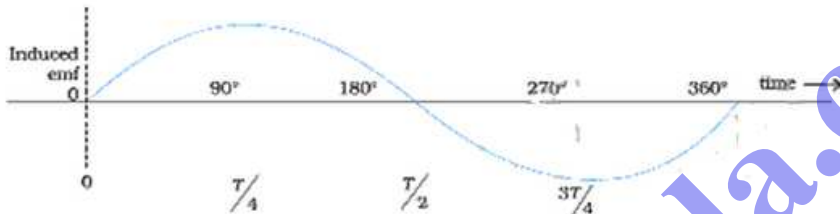
Solution 52

(a)

AC Generator

(b) Increasing the number of turns will increase the current through the coil.

(c) Terminal X will be positive.

(d) When the plane of the coil is normal to the magnetic field, the magnetic flux linked with the coil is maximum and the p.d. across its ends is zero.

(e)

Solution 53
It is a diagram of step-down transformer.
(a) Brightness of bulb will increase because increasing the number of turns in the secondary will increase the change in magnetic flux linked with the coil.
(b) Part X is the core of the transformer is removed, it shall become an open core and there shall be magnetic flux link loss; i.e. the entire magnetic field lines produced by the primary shall not be linked with the secondary.
(c) If the core of the transformer is made of copper due to the formation of eddy currents a lot of energy shall be lost.
(d) A transformer cannot be used with direct current (d.c.) since its working is based on the principle that when there is a change of magnetic field lines due to varying current of same in one coil, an induced varying current of same frequency flows in the other coil. If the current in one coil is constant (i.e. d.c.), no induced current will flow in the other coil since there will be no change in the magnetic field lines linked with the coil.

Solution 54

Since, the number of turns in the primary is more than the no. of turns in the secondary it is a step-down transformer.

Given, N_p = 400, N_s = 10, E_p = 250 V, I_p = 2A

(a) Let E_s be the secondary voltage.

We know that for transformer turn ratio $\dfrac{N_s}{N_p} = \dfrac{I_p}{I_s} = \dfrac{E_s}{E_p}$

$\therefore E_s = \dfrac{N_s}{N_p} \times E_p = \dfrac{10}{400} \times 250 = 6.25V$

(b) Let I_s be the current though secondary

We know that for transformer turn ratio $\dfrac{N_s}{N_p} = \dfrac{I_p}{I_s}$

$\therefore I_s = \dfrac{400}{10} \times 2 = 80 \text{ A}$

Solution 55

Features which provide greater efficiency to a transformer are:(i) The core of the transformer is laminated which prevents the formation of eddy currents.(ii) A closed soft-iron core is used which reduces the magnetic field link loss and hysteresis loss.

Solution 56

(a) magnet – soft iron(b) core- soft iron(c) core- soft iron, magnet – steel(d) core- soft iron, magnet – steel(e) core-soft iron

Solution 57

(i) Potential difference across the 4Ω resistor = current through the resistor × its resistance
$$= 0.25 \times 4 = 1 \text{ V}$$

(ii) Potential difference across internal resistance = current through internal resistance × internal resistance
$$= 0.25 \times 3 = 0.75 \text{ V}$$

(iii) P.d. across the R Ω or 3 Ω resistor = emf - (p.d. across 4Ω resistor + p.d. across internal resistance)
$$= 2 - (1 + 0.75) = 0.25 \text{ V}$$

(iv) We know, $e = I\left[(r + 4\Omega) + \left(\dfrac{1}{2} + \dfrac{1}{R}\right)^{-1}\right]$

$\therefore 2 = 0.25\left[7 + \left(\dfrac{2R}{R+2}\right)\right]$

or, $\dfrac{2R}{R+2} = 1$

or, $2R = R + 2$

or, $R = 2 \ \Omega$

Solution 58

Let e be the emf of the cell and r be its internal resistance.
Case I: In parallel,
total resistance, $R_P = (r + 1)$ Ω
total current = 1.2 A
∴ $e = 1.2 (r + 1)$.....................................(i)
Case II: In series,
total resistance, $R_S = (r + 4)$ Ω
total current = 0.4 A
∴ $e = 0.4 (r + 4)$.....................................(ii)
From (i) and (ii)
$1.2 (r + 1) = 0.4 (r + 4)$
or, $3 (r + 1) = (r + 4)$
or, $3r + 3 = r + 4$
or, $r = 0.5$ Ω
Putting this value of r in (ii) we get:
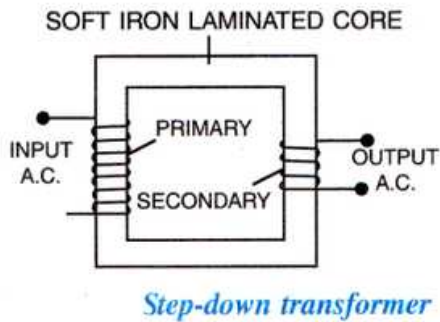$e = 0.4 (0.5 + 4)$
or, $e = 1.8$ V
∴ $r = 0.5$ Ω and $e = 1.8$ V

Solution 59

Step-down transformer

The part drawn to complete the diagram is the core.

Material of core is soft-iron.

It is a step down transformer because the number of turns in the primary is more than the number of turns in the secondary.

Solution 60

The ratio of number of turns NS in secondary coil to the number of turns NP in the primary coil (NS / NP) is called the turns ratio. A transformer cannot be used with direct current (d.c.) since its working is based on the principle that when there is a change of magnetic field lines due to varying current of same in one coil, an induced varying current of same frequency flows in the other coil. If the current in one coil is constant (i.e. d.c.), no induced current will flow in the other coil since there will be no change in the magnetic field lines linked with the coil.