(i) Electric heater, electric iron and water heater, etc. work on the principle of the heating effect of current.
(ii) Electric bulb glows when electric current flows through the filament of the bulb.
(iii) Electric fuse in the electric circuit melts when large current flows in the circuit.

ELECTRIC POWER

The rate at which electric energy is consumed is called electric power.

$$\text{Power} = \frac{\text{Work}}{\text{Time}}$$

It is measured in 'watt'.

$$P = \frac{W}{t} = I^2R = VI = \frac{V^2}{R}$$

where P is the power, I is current flowing, V is the potential difference and R is the resistance.

Units of Power

SI unit of power is **watt (W)**

1 watt = 1 volt × 1 ampere = 1VA

1 kW = 1 Kilo Watt = 10^3W

1 MW = 1 Mega Watt = 10^6 W

1 GW = 1 Giga Watt = 10^9 W

$$\boxed{1\,\text{hp} = 746\,\text{watt}}$$

The commercial unit of electrical energy is Kilo Watt Hour (kWh). It is also called 'unit' or B.O.T. (Board of Trade Unit).

$$\boxed{1\,\text{kWh} = 3.6\times10^6\,\text{joule}}$$

MAGNETIC FIELD

Every magnet has a region around it in which it's force (attraction or repulsion) can be experienced. This region is known as magnetic field.

Direction of Magnetic Field

It is given by direction of hypothetical north pole. When this north pole is placed in a magnetic field produced by another magnet, it will move in a di-

rection within the field. This direction indicates the direction of magnetic field (MF).

Magnetic Lines of Force (or Magnetic Field Lines)

The path (straight or curved) along which unit north pole moves in a magnetic field (if it is free to do so) is called magnetic lines of force. They are imaginary lines.

Properties of Magnetic Lines of Force

(i) Magnetic lines of force always start from the north pole of the magnet and end at the south pole of the magnet out-side the magnet.

(ii) Magnetic lines of force are very close to each other near the poles and widely separated when away from the poles.

(iii) Magnetic lines of force never intersect each other.

(iv) Closer the magnetic lines of force, stronger is the field and vice-versa.

(v) They are closed continuous loops.

Types of Magnetic Fields

(i) **Uniform Magnetic Field : -** The magnetic field is said to be uniform if its magnitude is equal and direction is same at every point in the space.

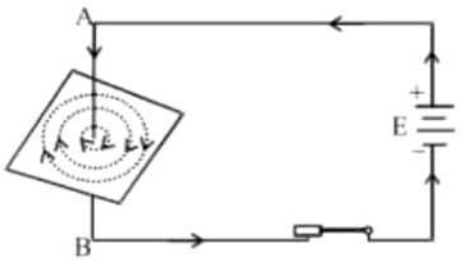
(ii) **Non-Uniform Magnetic Field :-** The magnetic field is said to be non-uniform if its magnitude is not equal and direction is not same at every point in space.

Magnetic Field Due to a Current Carrying Straight Conductor

It is found that when current flows through the conductor, iron fillings arrange themselves in the form of concentric circles, around the wire.

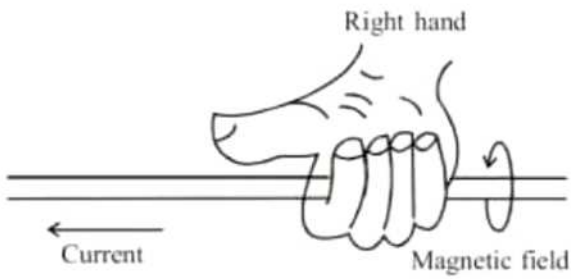
These concentric circles represent magnetic lines of force of the wire carrying current. The direction of these lines of force can be observed by using a magnetic needle. The direction in which the north pole of the needle points is the direction of magnetic lines of force. When the

current is flowing from A to B, direction of magnetic lines of force is clockwise.



Right Hand Thumb Rule

According to this rule, if we imagine that we are holding a wire carrying current and thumb is stretched in the direction of current then the direction in which fingers will be wrapped gives the direction of magnetic lines of force. It means if the current is flowing in the upward direction then the direction of magnetic lines of force will be anticlockwise and if current is flowing in the downward direction then the direction of field will be clockwise.



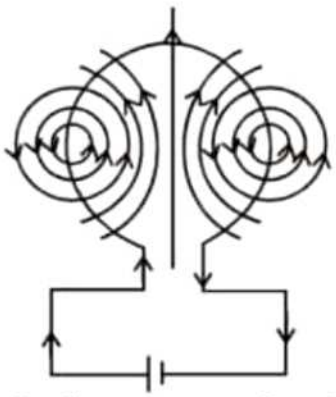
Factors on which strength of magnetic field around a straight wire carrying current depends:

(i) Strength of this magnetic field depends on current i.e., it is directly propotional to the current flowing through the conductor.

(ii) Distance from the wire : Strength of the Magnetic Field is inversely proportional to the distance from the wire carrying current.

Magnetic Field Around a Circular Loop Carrying Current

When current passes through a circular wire, it produces a magnetic field around it. The lines of force of this field can be obtained by fixing a circular wire in a cardboard as shown in fig.



Factors on which the strength of magnetic field around a circular wire depends :

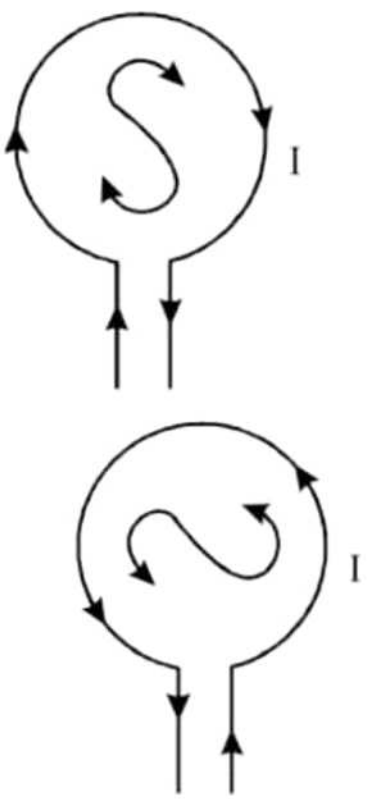
(i) The strength of field is directly proportional to the current flowing through the conductor.

(ii) It is inversely proportional to the radius of coil.

(iii) It is directly proportional to the number of turns of the circular wire.

Clock Rule

It is applicable for circular loops. If the current flowing appears to be in anticlockwise direction in any circular loop, then this face acts as North Pole of the magnet. While if the current flowing appears to be in clockwise direction in a circular loop, then this face acts as South Pole of the magnet.

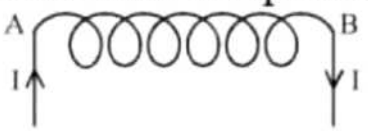


Clockwise direction

Anticlockwise direction

SOLENOID

A solenoid is a coil of many turns of an insulated wire closely wound in the shape of a tight spring.



Magnetic Field Produced by a Solenoid

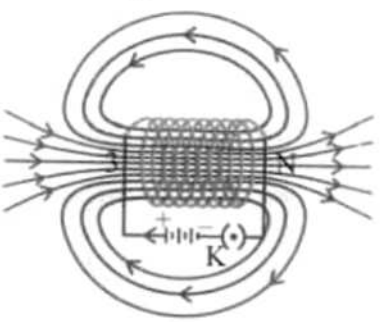
It is insulated copper wire which has given a large number of turns to form a cylinder. When current flows through this solenoid, it behaves like a magnet i.e. a magnetic field is produced around it may be noted that :

(i) Magnetic field inside the solenoid is uniform.

(ii) Magnetic field outside the solenoid is non uniform.

(iii) Inside the solenoid, the field lines moves from S to N pole and outside the solenoid, they move from N to S pole.

(iv) Magnetic field produced due to a solenoid is similar as a bar magnet.



Field lines of the magnetic field through and around a current carrying solenoid.

Factors on which Magnetic Field Due to a Solenoid Depends

(i) The number of turns of the wire forming a solenoid.

(Magnetie field) $B \alpha n$

(ii) The strength of current

$B \alpha I$

(iii) Nature of material inside the solenoid

$B \alpha \mu$ (where μ is permeability of material).

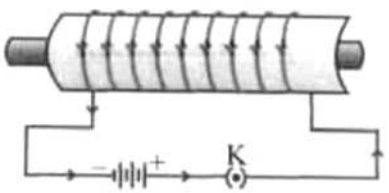
ELECTROMAGNET

It is a piece of magnetic material like soft iron or hard steel which is placed inside a solenoid through which current is flowing.

There are two types of electromagnet :

(i) Permanent electromagnets.

(ii) Temporary electromagnets.



A current-carrying solenoid coil is used to magnetise steel rod inside it–an electromagnet.

Permanent Electromagnet

It is a type of electromagnet which is obtained by placing magnetic material like hard steel in the strong magnetic field produced by a coil.

These electromagnets are widely used in microphones, loudspeakers, voltmeters, speedometer etc.

Temporary Electromagnet

It is a type of electromagnet. It behaves like a magnet till the current flows through it, i.e., it stops behaving like a magnet when the flow of current is stopped.

It is obtained by using soft iron as a core material i.e., by placing soft iron in a coil through which current is flowing.

Uses of Electromagnets

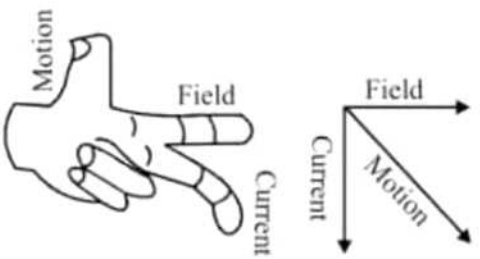
(i) They are used to lift heavy iron pieces.

(ii) They are used in many devices like electric bell, electric horn, telephone reciever etc.

Fleming's Left Hand Rule

According to this rule stretch thumb, fore finger and central finger of left hand in such a way that these fingers are perpendicular to each other. If fore finger is placed in the direction of Magnetic

Field and middle finger in direction of current, then thumb will point towards the direction of force.



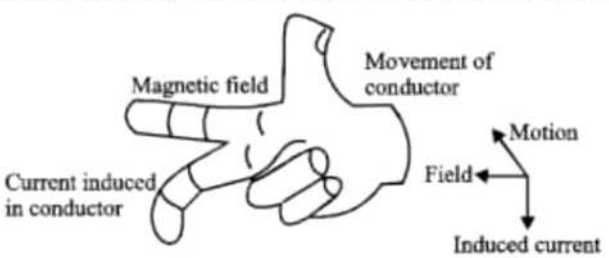
Electric Motor - DC Motor

It is a device which is used to convert electrical energy into mechanical energy.

- **Principle** : It is based on the fact that when a conductor carrying current is placed in a Magnetic Field, a force is exerted on it.
  So, when a rectangular coil is placed in a magnetic field and current flows through it, then torque is produced and acts on the coil and it rotates.

Fleming's Right Hand Rule

According to Fleming's right hand rule, stretch thumb, fore finger and middle finger in such a way that these three are perpendicular to each other. Now adjust thumb and fore finger in such a way that thumb indicates the direction of the motion of the conductor and the fore finger indicates the direction of MF, then the direction in which middle finger points is the direction of flow of current.



Electromagnetic Induction

It is known that when a conductor carrying current is placed in a magnetic field, a force is exerted on the conductor. On the basis of this relation between magnetic field, current and the motion of conductor, Michael Faraday discovered that when a straight conductor moves in a magnetic

field, current is generated in the conductor. This phenomenon of production of electric current is known as electro magnetic Induction and the current so obtained is called induced current.

Galvanometer

A galvanometer is an instrument that can detect the presence of a current in a circuit.

ELECTRIC GENERATOR

Principle: It is based on the fact that when a straight conductor moves in a magnetic field, induced current is produced.

If a rectangular coil which has large number of turns rotates in a magnetic field, large amount of induced current is produced which can be further utilized.

D.C. Electric Generator

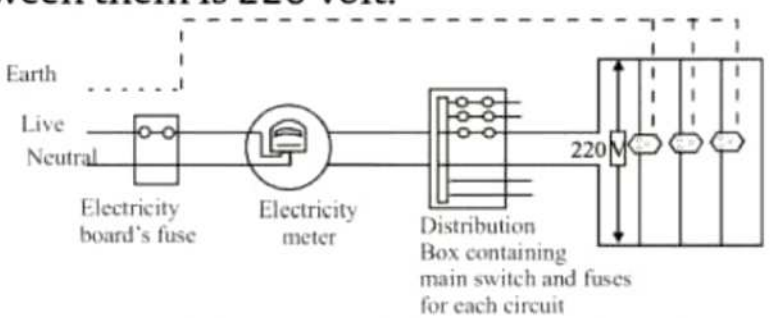
It is a type of generator which is used to produce induced current which forms in one direction (unidirectional called Direct Current).

A.C. Generator

It generates alternating current (a.c.) that changes its polarity after every half rotation.

DOMESTIC CIRCUIT

We receive supply of electric power through mains. One of the wires in the supply has red insulation called live wire. Another wire with black insulation is called neutral wire. Potential difference between them is 220 volt.



A schematic diagram of one of the common domestic circuits.

Short Circuit

It occurs when the insulation of wires get damaged and live and neutral wires touch each other.

Over Loading

When large number of electric appliances of high power rating are switched on at the same time, large amount of current is drawn in the circuit due to which copper wire gets heated which may lead to fire.

Fuse

Fuse is a safety device having a very thin wire which is made up of either tin or alloy of tin and lead (or tin and copper).

Fuse wire should be :

(i) Very thin so that it has high resistance due to which it can produce more heating effect.

(ii) It should have low meling point.

Copper wire is not used as a fuse wire because :

(i) Copper wire has high melting point,

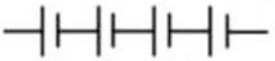
(ii) Copper wire has low resistance.

Exercise

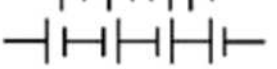
1. Among the following statements :
   (i) A discharge lamp uses a discharge tube which is filled with a gas at a very low pressure.
   (ii) Always white light is emitted independent of gas taken in the lamp.
   (a) Only (i) is true
   (b) Only (ii) is true
   (c) Both (i) and (ii) are true
   (d) Both (i) and (ii) are false
2. Among identical spheres A and B having charges as – 5 C and – 16 C
   (a) – 5C is at higher potential
   (b) – 16 C is at higher potential
   (c) both are at equal potential
   (d) it cannot be said
3. Direction of conventional current is from
   (a) Negative terminal to positive terminal
   (b) Positive terminal to negative terminal
   (c) In any direction
   (d) In both the directions
4. A piece of wire of resistance R is drawn to double its length. The new resistance is
   (a) R
   (b) 2 R
   (c) 4 R
   (d) $\frac{R}{4}$
5. Direction of the force experienced by a current-carrying conductor when placed in a magnetic field is dependant on
   (a) direction of the current alone
   (b) direction of the magnetic field alone
   (c) direction of current as well as the direction of magnetic field

(d) None of these

6. The proper representation of series combination of cells obtaining maximum potential is

(a) 

(b) 

(c) 

(d) 

7. Potential difference is defined as

(a) the amount of work done in moving a unit charge in a unit time

(b) distance between two terminals

(c) length of the connecting wire

(d) the amount of work done in moving a unit charge

8. A cooler of 1500 W, 200 volt and a fan of 500 W, 200 volt are to be used from a supply. The rating of fuse to be used is

(a) 2.5 A

(b) 5.0 A

(c) 7.5 A

(d) 10A

9. A fuse wire repeatedly gets burnt when used with a good heater. It is advised to use a fuse wire of

(a) more length

(b) less radius

(c) less length

(d) more radius

10. Rheostat is a device used to vary

(a) voltage

(b) current

(c) resistance

(d) power

11. The length of a wire is doubled, but its cross-section remains the same, then its resistance will become

(a) 4 times

(b) 2 times

(c) $\frac{1}{2}$ times

(d) 8 times

12. Electric iron uses wires of alloy as
    (a) they do not oxidise at high temperatures
    (b) they do not burn at high temperatures
    (c) both (1) and (b)
    (d) neither (1) or (b)
13. A student records that 36,000 joule of energy is used by him in an hour. The amount of electrical energy required to be used is
    (a) 36 kW h
    (b) 100 kW h
    (c) 0.001 kW h
    (d) 0.01 kW h
14. To increase the resistance in a network, one has to connect any given resistor in
    (a) parallel
    (b) series
    (c) can be (1) or (b)
    (d) only (1)
15. Heat produced due to flow of current through a conductor is given by the formula
    (a) $H = I^2 R t$
    (b) $H = V I t$
    (c) $H = V^2 t / R$
    (d) All of the above
16. A boy records that 4000 joule of work is required to transfer 10 coulomb of charge between two points of a resistor of50 Ω. The current passing through it is
    (a) 2 A
    (b) 4 A
    (c) 8 A
    (d) 16 A
17. The two forms of energy released by a tungsten filament used in a bulb are
    (a) electrical and light
    (b) light and heat
    (c) heat and electrical
    (d) electrical only
18. The combined resistance of any number of resistances connected in series is equal to
    (a) The sum of individual resistances

(b) The sum of reciprocals of individual resistances

(c) Product of individual resistances

(d) Highest individual resistance

19. An air conditioner of 2000 W, a fan of 500 W, a bulb of 40 W and a computer offering 30 W are used in a house hold using 220V. The power rating of the fuse to be used in this case is

(a) 10 A

(b) 15 A

(c) < 20 A

(d) < 5 A

20. Appliances : Parallel

Fuse : _____

(a) Series

(b) Parallel

(c) Series in appliances always

(d) Parallel in fuse always

21. The magnitude of the force experienced by a current-carrying conductor when placed in a magnetic field will be

(a) maximum if the directions of current and magnetic field are perpendicular to each other

(b) minimum if the directions of current and magnetic field are perpendicular to each other

(c) maximum if the directions of current and magnetic field are opposite to each other

(d) maximum if the directions of current and magnetic field are same

22. The reciprocal of the combined resistance of any number of resistances connected in parallel is equal to

(a) the sum of reciprocals of individual resistances

(b) reciprocal of the product of individual resistances

(c) reciprocal of sum of all the resistances

(d) None of the above

23. A current of 1 A is drawn by a filament of an electric bulb. Number of electrons passing

through a cross-section of the filament in 16 seconds would be roughly

(a) 10^{20}

(b) 10^{16}

(c) 10^{18}

(d) 10^{23}

24. Which of the following represents voltage?

(a) $\frac{\text{Work done}}{\text{Current} \times \text{time}}$

(b) Work done × Charge

(c) $\frac{\text{Work done} \times \text{Time}}{\text{Current}}$

(d) Work done × Charge × Time

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

(a) 100 %

(b) 200 %

(c) 300 %

(d) 400 %

26. When two or more resistors are connected in parallel,

(a) The current passing through each resistor is same

(b) The potential difference across each resistor is same

(c) Both of the above

(d) None of the above

27. A small rod is wound round with certain coils and current is allowed for sometime. When the rod was taken out, it was found not to attract iron. The material of the rod may be

(a) copper

(b) cobalt

(c) steel

(d) nickel

28. Two students make a solenoid each with same length but the number of turns. are in the ratio of 1 : 4 As they carry same current, the ratio of the magnetic field strength will be

(a) 1 : 2

(b) 1 : 4

(c) 3 : 2
(d) 4 : 1

29. The potential difference that can be produced using an AC generator be doubled by doubling the
(a) number of turns N only
(b) area of the coil A
(c) speed of rotation ω only
(d) magnetic field only

30. Power rating of an electric appliance indicates
(a) The rate of consumption of electrical energy
(b) Amount of heat evolved
(c) Brightness of the light
(d) Quality of the appliance

31. A circular coil of area A is rotated about its diameter with an angular velocity ω. The potential difference produce is(N – Number of turns)
(a) NAB
(b) NABω
(c) ABω
(d) Bω

32. Identify the incorrect statement:
Magnetic field lines due to a circular coil is
(a) circular near the wire
(b) straight along the axis
(c) leaving both the planes
(d) perpendicular to the plane

33. A moving charge experiences maximum force when the angle between its velocity and magnetic field is
(a) 0°
(b) 30°
(c) 60°
(d) 90°

34. Alloys are usually used in electrical heating devices because
(a) resistivity of an alloy is generally higher than that of constituent elements
(b) alloys do not oxidize readily at high temperature
(c) Both (a) and (b)
(d) Neither (a) nor (b)

35. Magnetic field lines caused by a solenoid
    (a) are curves
    (b) start at north and end at south
    (c) closed loops
    (d) uniform everywhere
36. A coil of insulated copper wire is connected to a galvanometer forming a loop and a magnet is
    A: held stationary
    B: moved away along its axis
    C: moved towards along its axis
    There will be induced current in
    (a) A only
    (b) A and B only
    (c) B and C only
    (d) A, B and C
37. A horizontal power line carries current from east to west. The direction of magnetic field at a point below the wire is directed
    (a) upward
    (b) downward
    (c) towards north
    (d) towards south
38. The region surrounding a magnet, in which the force of the magnet can be detected is said to have
    (a) magnetic field
    (b) electric field
    (c) magnetic poles
    (d) None of these
39. A coil of rectangular dimension is rotated in a magnetic field. The flux associated, changes due to the change in
    (a) number (N)
    (b) area (A)
    (c) strength of field (B)
    (d) angle between B and A
40. A conductor of length l carrying a current I placed in a perpendicular magnetic field experiences 5 N of force. If the length is doubled with

halved magnetic field. The force experienced with doubled current is

(a) 5 N
(b) 10 N
(c) 15 N
(d) 2.5 N

41. A straight conducting wire is placed parallel to and over a compass needle. The deflection in the needle

(a) becomes opposite when the direction of the current is reversed
(b) remains in the same direction even on reversing the direction of current
(c) keeps fluctuating on passage of current in any direction
(d) Is negligible on reversing the direction of current

42. Two long wires carrying current in the opposite direction perpendicular to the plane of the paper are at a distance of r from a point. The magnetic field at that point is proportional to

(a) r
(b) $\frac{1}{r}$
(c) $\frac{1}{r^2}$
(d) zero

43. A magnet having a pole strength m is cut along its length into two equal parts. The strenght of the pole of each of the magnets is

(a) $\frac{m}{2}$
(b) 2 m
(c) m
(d) 4 m

44. Regarding a transformer which of the following is incorrect?

(a) Principle is induction
(b) Varying potential is required

(c) Energy is produced or lost
(d) Performs based on the number of turns

45. At every point of a current carrying circular loop, the concentric circles representing the magnetic fields around it would become
(a) larger and larger as we move away from the wire
(b) so large at the centre of circular loop that they look like straight lines
(c) Both (a) and (b)
(d) Neither (a) nor (b)

46. In order to find the direction of induced current one uses
(a) Fleming's left-hand rule
(b) Fleming's right- hand rule
(c) Right-hand thumb rule
(d) Screw rule

47. MRI stands for
(a) Magnets Resonant Imaging
(b) Magnetic Resonance Imaging
(c) Magnetic Radar Imaging
(d) Magnets Radial Imagic

48. Which of the following instruments is used to measure magnetic field ?
(a) Thermometer
(b) Pyrometer
(c) Hygrometer
(d) Flux meter

49. Which of the following statements is not true?
(a) The pattern of the magnetic field around a conductor due to an electric current flowing through it depends on the shape of the conductor
(b) The magnetic field of a solenoid carrying a current is similar to that of a bar magnet
(c) Magnitude of magnetic field is directly proportional to the quantity of current flowing through the current

(d) Magnetic field produced by the passage of current through a straight wire is permanent

50. The direction of magnetic lines of force of a bar magnet is
(a) from south to north pole
(b) from north to south pole
(c) across the bar magnet
(d) from south to north pole inside the magnet and from north to south pole outside the magnet

51. The lines of force due to earth's horizontal magnetic field are
(a) parallel and straight
(b) concentric circles
(c) elliptical
(d) curved lines

52. An electric motor is a device
(a) that works on the principle described by Fleming's left hand rule
(b) that converts electrical energy to mechanical energy
(c) Both (a) and (b)
(d) Neither (a) nor (b)

53. Increase in number of turns of a coil in the solenoid will
(a) have no effect on the strength of magnetic field
(b) will add to the strength of the magnetic field
(c) will decrease the strength of the magnetic field
(d) will change the direction of the magnetic field

54. Which of the following statements cannot be related to an electric motor?
(a) A rectangular coil of insulated copper wire is placed between the two poles of a magnetic field such that two of its parallel sides are perpendicular to the direction of the magnetic field.
(b) The ends of the coil are connected to the two halves of a split ring.

(c) The inner insulated sides are attached to axle whereas the external conducting edges touch two conducting stationary bushes.

(d) The coil and the axle continuously rotate in one direction.

55. A student did the experiment to find the equivalent resistance of two given resistor R_1 & R_2. First when they are connected in series and next when they are connected in parallel. The two values of the equivalent resistance obtained by him were R_s and R_p respectively. He would find that :

(a) $R_s < R_p$

(b) $R_s > R_p$

(c) $R_s = R_p = \left(\frac{R_1 + R_2}{2}\right)$

(d) $R_s = R_p$ but not equal to $\left(\frac{R_1 + R_2}{2}\right)$

56. An electromagnet consists of a core of _____ wrapped around with a coil of _____ copper wire.

(a) soft iron, insulated

(b) aluminium, insulated

(c) soft iron, uncovered

(d) magnet, uncovered

57. Two bars of soft iron exactly alike are given. One of them is a magnet. Without using any thing more, how would you find which is a magnet :

(a) By bringing two bars near and noting which one is attracting. The attracting one is a magnet.

(b) By bringing two bars near and noting which one is repelling. One which repels is an ordinary iron.

(c) By rubbing one bar with the other and noting which becomes magnet. The bar which is magnetised is an ordinary iron.

(d) One bar is placed flat horizontal on the table and the other bar is held vertical with its one end on the middle of first bar. If there is attraction between the two, the vertical bar is magnet otherwise ordinary iron.

58. In domestic circuits, wires with red insulations are used as live wires, whereas
    (a) the wires with black insulations are used as neutral(or negative) wires
    (b) the wires with green insulations or steel wires are used as earth wires
    (c) the wires with black insulations are used for positive terminals
    (d) Only (a) and (b)

59. Parameters of electricity supply in India are
    (a) Potential Difference of 220 V, Frequency of 50 hertz and Current Rating of 5A/15A
    (b) Potential Difference of 150 V, Frequency of 40 hertz and Current Rating of 10 A
    (c) Potential Difference of 220 V, Frequency of 60 hertz and Current Rating of 15A
    (d) Potential Difference of 220 V, Frequency of 40 hertz and Current Rating of 5 A

Hints & SOLUTIONS

1. **(a)**
2. **(a)**
3. **(b)** Direction of conventional current is opposite to the direction of flow of current, i.e. from positive terminal to negative terminal.
4. **(c)**
5. **(c)** Fleming's left hand rule.
6. **(a)**
7. **(d)** Electric potential difference between two points on a current carrying conductor is defined as the work done to move a unit charge from one point to the other.
8. **(d)**
9. **(d)**
10. **(b)**
11. **(b)** Resistance of a wire is directly proportional to the length and inversely proportional to the area of cross-section.
12. **(c)**
13. **(d)**
14. **(b)**
15. **(d)** The amount of heat generated is directly proportional to the square of current, resistance of the conductor and the time for which current is passed. Quantity of heat generated in t seconds, $H = I^2 R t$. On substituting $V = IR$, $I = V/R$ or $R = V/I$, we get these equations.
16. **(c)**
17. **(b)**
18. **(a)** In series, $R = R_1 + R_2 + ----$
19. **(c)**
20. **(a)**
21. **(a)** The magnitude of the force experienced by a current-carrying conductor when placed in a magnetic field will be maximum if the directions of current and magnetic field are perpendicular to each other.
22. **(a)** In parallel, $1/R = 1/R_1 + 1/R_2 + ----$

23. **(a)**
24. **(a)**
25. **(c)**
26. **(b)** The voltage across each resistor of a parallel combination is the same and is also equal to the voltage across the whole combination. Total current is the sum of currents flowing in the individual resistors.
27. **(a)**
28. **(b)**
29. **(b)**
30. **(a)** Power rating of an appliance indicates the amount of energy consumed by it in one hour.
31. **(b)**
32. **(c)**
33. **(d)**
34. **(c)** Alloys are usually used in electrical heating devices because resistivity of an alloy is generally higher than that of constituent elements. Alloys do not oxidize readily at high temperature.
35. **(c)**
36. **(c)**
37. **(d)**
38. **(a)** Magnetic field is the region around a magnet where the magnetic force is experienced.
39. **(d)**
40. **(b)**
41. **(a)** The deflection in the needle becomes opposite when the mdirection of the current is reversed.
42. **(d) 43(a)**
44. **(c)**
45. **(c)** The concentric circles representing the magnetic fields become larger and larger.
46. **(b)**
47. **(b)**
48. **(d)**
49. **(d)** Electromagnetic effect is temporary.
50. **(d)**
51. **(b)**
52. **(c)** An electric motor is a device that converts electrical energy to mechanical energy.

53. **(b)** Each turn of a coil forms its own magnetic field.

54. **(d)** 'The coil and the axle continuously rotate in one direction' is not related, all other statements describe the construction.

55. **(b)**

56. **(a)** An electromagnet consists of a core of soft iron wrapped around with a coil of insulated copper wire.

57. **(d)**

58. **(d)** Wires with red insulations are conventionally used as live wires, whereas the wires with black insulations are used as neutral (or negative) wires and the wires with green insulations or steel wires are used as earth wires. It is not a rule.

59. **(a)** Parameters of electricity supply are different in different countries. In India they are:
Potential Difference of 220 V, Frequency of 50 hertz and Current Rating of 5A/15A.

Chapter 7

Sources of Energy

Energy is an essential requirement of our life. No activity in our daily life can be undertaken without the use of energy. Energy in one or the other form has been used by aman since long.

SOURCES OF ENERGY

Plants, wind, water, coal, petroleum, natural gas, gobar gas or bio-gas, etc.

Solar energy + Air ® Wind energy

Types of Sources of Energy

(i) Non-renewable or conventional sources of energy like coal, petroleum, natural gas, nuclear energy.

(ii) Renewable or non-conventional sources of energy like the wind, the sun, hydro power, ocean tidal energy, geothermal energy, biogas.

Requirements of Good Source of Energy?

A good source of energy would be one

(i) which would do a large amount of work per unit volume or mass,

(ii) be easily accessible,

(iii) be easy to store and transport, and

(iv) perhaps most importantly, be economical.

Fossil Fuels

Fossil fuels are hydrocarbon based natural resources that were formed over 300 hundred millions of years ago by the fossilization of prehistoric plants and animals. There are three major forms of fossil fuels: coal, oil and natural gas. We have learned to harness the energy released from these fossil fuels during combus-

tion in order to meet our energy needs. Fossil fuels are a common source of energy we use everyday. They are used to generate the electricity that runs our household appliances, fuel the motors of our cars, and heat our homes. Fossil fuels are currently essential for providing the energy needs of our everyday lives.

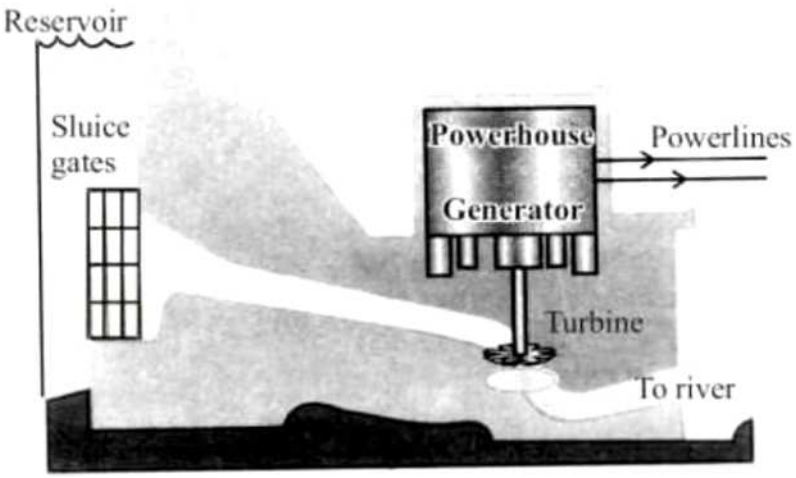
- The amount of heat energy produced by a fuel on burning is measured in terms of the calorific value of the fuel. A fuel having high calorific value is considered as a good fuel.

Thermal Power Plant

In thermal power plants, fuel is burnt to produce heat energy which is further converted into electrical energy. Generally fossil fuels are used in thermal power plants. Therefore, many thermal power plants are set up near coal or oil fields.

Hydropower Plants

In hydropower plants, the potential energy of falling water is converted into electricity. Since, there are very few water-falls which are suitable to be used as a source of potential energy, hydropower plants are associated with dams. A quarter of energy requirement in India is met by hydropower plants. In India, 25% of energy requirement is fulfilled by hydroelectric power plants.



A schematic view of a hydro power plant

High-rise dams are constructed on the river so as to obstruct the flow of water and thereby collect water in larger reservoirs. The water from the high level in the reservoir is made to fall on the turbine through pipes. In this way, the potential energy of water is converted into the electrical energy. Hydro power is a renewable source of energy, so we would not have to worry about hydro electricity sources getting used up the way fossil fuels would get finished.

BIOGAS

Biogas is a combustible mixture of gases produced by the decomposition of biomass, especially animal waste and sewage. Biogas can contain up to 75% methane (CH_4), 23% carbon dioxide and 2% other gases, including hydrogen and hydrogen sulphide.

Advantages of Biogas

Biogas plants are simple and the dung from 3 to 4 heads of cattle can supply biogas for cooking for about 6 hours every day. Biogas is an excellent clean fuel that burns without smoke. It leaves no ash on burning. The spent slurry from

a biogas plant is good manure. Biogas plants represent a safe and useful way of waste disposal. Use of biogas in rural areas leads to saving of fire wood and reduces deforestation.

Preparation of Biogas

Biogas is prepared by anaerobic fermentation of biomass. Biomass contains complex molecules like carbohydrates, fats, cellulose, etc. When these complex molecules are allowed to undergo fermentation process by action of bacteria in absence of air but in the presence of water than these complex molecules get decomposed into simpler molecules like CH_4, CO_2, H_2, H_2S which are collectively known as Biogas.

Biogas Plant

It is a place or a device in which biogas is prepared by anaerobic formation of biomass. These are two types of biogas plant –

(a) Fixed dome shaped

(b) Floating gas holder

Biomas is renewable source of energy if more and more plants are grown periodically.

WIND ENERGY

Moving air is called wind. When wind blows with a sufficient speed, it gets ability to do some work, it means wind possesses energy called **wind energy**. It means wind energy is another form of kinetic energy. Sun's rays fall directly over equatorial region and at an angle in the polar region. It means air in the equatorial region is hotter than the air in polar region. The temperature difference supports the air to move. This movement of air causes wind to blow.

Rotation and revolution of the earth also disturb the movement of air. Moreover local climatic conditions also affect the wind.

Uses of Wind Energy

(i) It is used to sail boats.
(ii) It is used to generate electricity.
(iii) It can be used to run wind mill which is further utilised
  (a) to grind wheat and grains.
  (b) to pump out water from the earth's crust.
(iv) It is used to fly gliders and moreover it is used for upward and downward movement of aeroplanes.

Wind Mill

It is a device which is used to convert wind energy into useful mechanical work.

Sequence of energy conversion in a wind mill.

Wind energy → Mechanical energy ® Electrical energy

Wind Farms

When large number of wind mills are installed over a large area to harness wind energy commercially, like to generate electricity commercially (large scale), they are called wind farms.

High wind energy level areas are available in Rajasthan, Gujarat, Tamil Nadu, coastal areas of Bay of Bengal, Maharashtra, etc.

Wind Power Plants in India

Wind energy is used to generate electricity on large scale in three places.
(i) Near Kanyakumari in Tamil Nadu.
(ii) Okha in Gujarat.
(iii) Lamba in Gujarat.

Our of these wind energy power plants, the one which is in Tamil Nadu is the biggest one. It produces 380 MW of electricity.

Advantages of Wind Energy

(i) It is renewable sources of energy.
(ii) The wind energy is free of cost.
(iii) It doesn't create pollution.

Disadvantages of Wind Energy (Wind Mill)

(i) It can not be used everywhere.
(ii) High cost of installation.
(iii) It has low efficiency.
(iv) It requires large area.

SOLAR ENERGY

The energy coming with the rays of the sun is called solar energy. Electromagnetic radiations from the sun consists of ultraviolet, visible and infra-red radiations. Visible and IR radiation reach the earth's surface. UV radiation is absorbed by the ozone layer in the earth's atmosphere.

Solar Cookers

Box type solar cookers can achieve temperatures of the order of 100-140°C. Frying and making chapattis are generally not possible in a box type solar cooker. These are possible in reflector type solar cookers in which temperature upto 200°C can be achieved.

A solar concentrator is a device that concentrates sunlight collected from a large area into a small region. Reflection type solar concentrators can be used for cooking, making steam to drive electrical generators, melting metals in solar furnaces, to dispose dead bod-