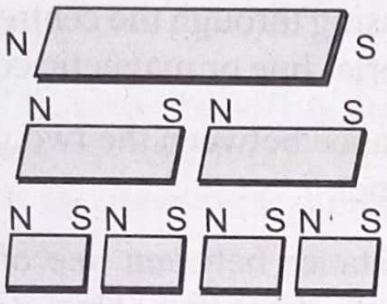
3. Similarly if the south pole of one magnet is brought near the south pole of the other magnet, they are found to repel each other.
4. But if the north pole of one magnet is brought near the south pole of another magnet, they are found to attract each other.

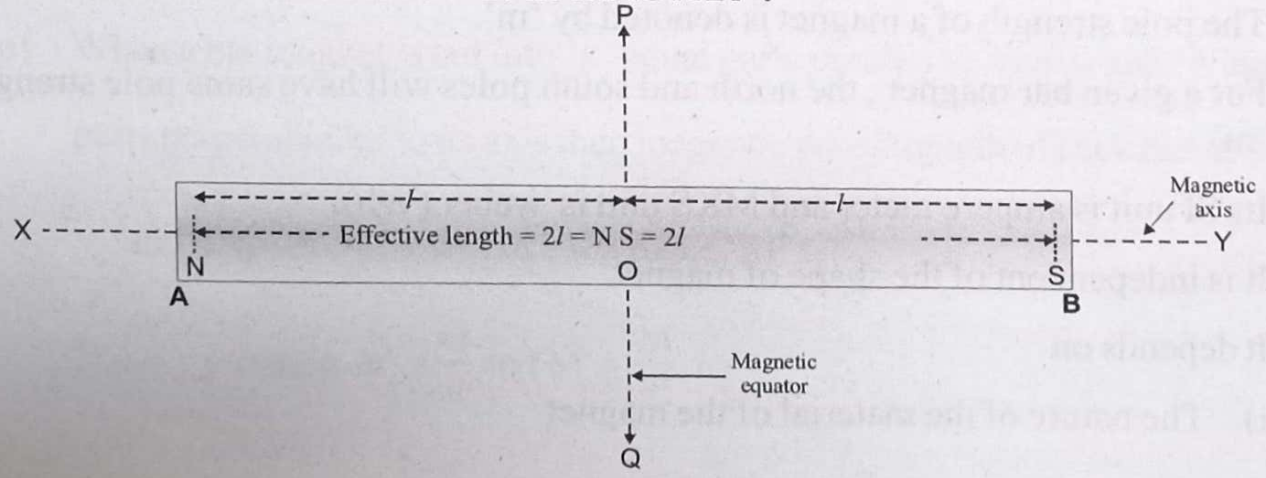
POLES EXIST IN PAIRS :



1. If a magnet is broken into two parts, each part is found to be a magnet (i.e. each part is found to have the attractive and the directive properties).
2. If these pieces are broken again & again, each part is still found to retain magnetism i.e. each part contains both the poles (N pole and S pole).
3. The new ends formed at the place where the magnet is cut, acquire polarities opposite to that at the other ends of the pieces.
4. However, the strength of magnetism in each part is reduced. Thus, magnetic, monopole (either N pole or S pole) does not exist separately.
5. If a magnet is cut into exactly two equal parts (either along its axis or along perpendicular to its axis), the magnetic strength of each part is half of the magnetic strength of the original magnet.

SYNOPSIS - 3

GENERAL DEFINITIONS OF BAR MAGNET :



Role of each end of a bar magnet is called its pole.

Geometric pole : The geometric end of a bar magnet is called its geometric pole.

Magnetic pole : The point situated slightly inside a bar magnet, where most of its magnetic power is concentrated is called its magnetic pole.

Magnetic axis : An imaginary line joining the magnetic north and south poles of a bar magnet is called its magnetic axis (or) axial line. (XY = magnetic axis)

Equatorial line : The line passing through the centre of magnet and perpendicular to the axial line is called equatorial line or magnetic equator.

Geometric length : The distance between the two geometric ends of a magnet is called geometric length of magnet.

Length of Magnet : The distance between one of the magnetic poles and the centre of magnet is called length of magnet. Thus, ON = OS = l is the length of magnet.

Effective length of Magnet : The distance between magnetic north and south poles of a bar magnet is called its effective length. Thus NS = $2l$ is the effective length.

NS $\rightarrow$ Magnetic length AB = Geometric length

The relation between magnetic length and geometric length is

MAGNETIC LENGTH = $\frac{5}{6}\times$ GEOMETRIC LENGTH

MAGNETIC POLE STRENGTH (m):

1. The ability of a pole of a magnet to attract or repel another magnetic pole is called its magnetic pole strength.
2. The pole strength of a magnet is denoted by 'm'.
3. For a given bar magnet , the north and south poles will have same pole strength 'm'.
4. Its SI unit is ampere meter and MKS unit is weber (Wb).
5. It is independent of the shape of magnet.
6. It depends on

   i) The nature of the material of the magnet

ii) Area of cross section

7. When a bar magnet of magnetic pole strength 'm' is cut into two equal halves

i) Along its axis, pole strength of each piece is $\frac{m}{2}$

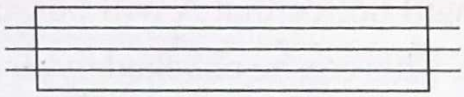
ii) Perpendicular to its length, pole strength of each piece remains same.

MAGNETIC MOMENT (M) :

Magnetic moment 'M' of a bar magnet is measured by the product of its pole strength (m) and its magnetic length ($2l$). Unit of magnetic moment is Ampere-square metre. ($A\text{-}m^2$). Its direction is along the axial line of the magnet from south pole to the north pole.

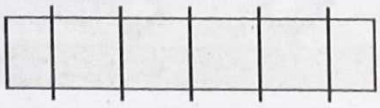
a) When a bar magnet is cut into 'n' equal parts parallel to its axis, then pole strength of each

piece, $m^1 = \frac{m}{n}$ and magnetic moment of each piece. $M^1 = \frac{M}{n}$



b) When a bar magnet is cut into 'n' equal parts perpendicular to its axis, then pole strength of

each piece, $m^1 = m$ and magnetic moment of each piece, $M^1 = \frac{M}{n}$



c) When a bar magnet is cut into 'x' equal parts parallel to its axis and 'y' equal parts perpendicular to its axis then magnetic pole strength of each piece, $m^1 = \frac{m}{x}$

and magnetic moment of each piece, $M^1 = \frac{M}{xy}$

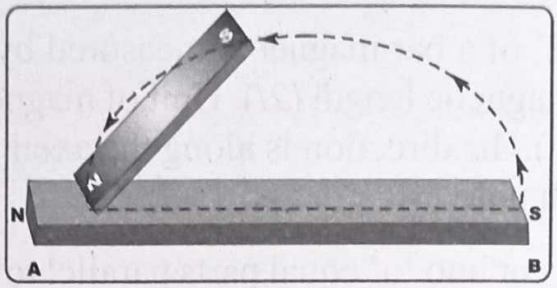
If $x = y = n$ then $m^1 = \frac{m}{n}$ and $M^1 = \frac{M}{n^2}$

SYNOPSIS - 4

METHODS OF MAGNETIZATION :

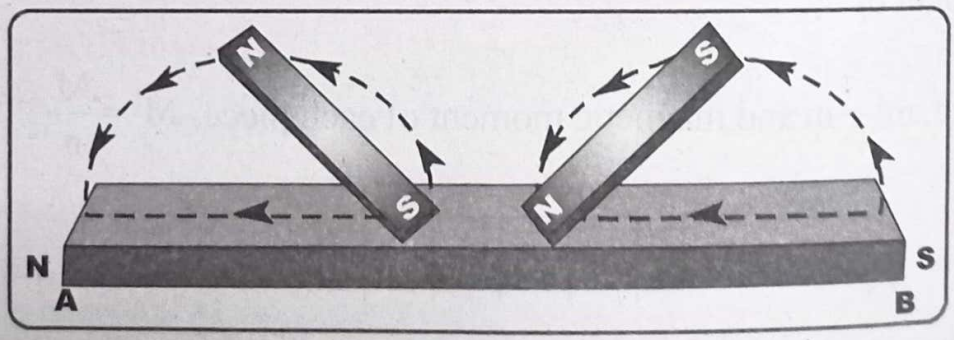
A given bar of a magnetic substance can be magnetized by any of the following methods:

SINGLE TOUCH METHOD :



1. Place the soft iron piece AB flat on a table and stroke it with a bar magnet from A to B with one end of a bar magnet as shown in figure. When the magnet reaches B it is lifted, and brought back to A to repeat the stroke.
2. After a few strokes you will notice that A will possess the same polarity as the pole being rubbed with it. This can be checked by a compass needle.

DOUBLE TOUCH METHOD :



1. It was found that using two bar magnets we could magnetize a steel bar more uniformly.
2. Place the steel bar flat on the table top, and place the opposite poles of two strong bar magnets inclined as shown. The magnets are moved apart and the stroke repeated from the centre.
3. B will get south polarity and A will get north polarity after magnetization.

DIVIDED DOUBLE TOUCH METHOD :

1. Keep the steel bar to be magnetized on the top of two permanent magnets.
2. Bring two permanent magnets with opposite poles and touch the middle of the steel bar and rub and move as shown in the figure. Repeat this several times.
3. The end of the steel bar at which the south pole of the magnet leaves becomes the north pole. The end of the steel bar at which the north pole of the magnet leaves becomes the south pole.

ELECTRICAL METHOD :

1. The best method of making a powerful magnet is by passing electric current. Wind a length of an insulated copper wire around a steel rod and connect it to a battery and a switch.

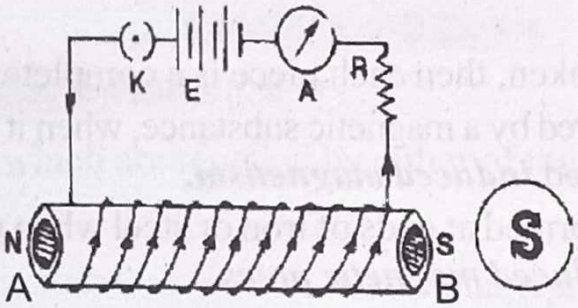
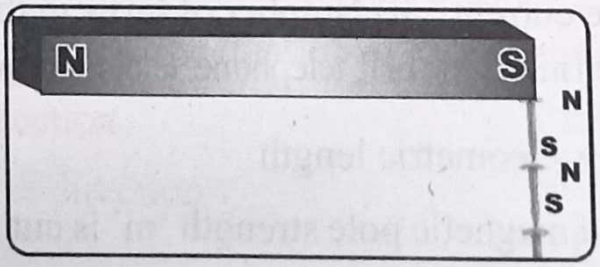


Fig : Electrical Method

2. After the current has passed through the coil for some time you will notice that the steel rod gets magnetized.
3. The polarity of the rod depends upon the direction of the current. If the bar is viewed from one end and the current is found to be flowing in a clockwise direction, then that end will become a south pole and if the current is flowing in the anticlockwise direction then that end will be a north pole.

MAGNETIC INDUCTION (OR INDUCED MAGNETISM) :



1. If you hold a bar magnet near or in contact with a soft iron nail as shown in figure, the nail becomes a magnet by induction. The nail retains its magnetism only as long as the magnet is held near it or in contact with it.

2. It will even pick up several other nails. But it loses its magnetism as soon as t magnet is removed. Magnetism produced in this manner due to the presence o magnet is called "Induced magnetism".
3. During magnetic induction, nearer end of the magnetic substance has opposi polarity and farther end has a similar polarity.

C.D.F. POINTS (RELATED TO PRACTICE SHEET -1)

1. A magnet attracts magnetic substance (like iron, steel; cobalt; nickel) towar itself.
2. When suspended freely, it points in the north south direction.
3. Like poles of a magnet repel each other. Unlike poles of a magnet attract eac other.
4. Repulsion is the surest test of magnetism.
5. When a bar magnet is rubbed over an unmagnetized piece of iron or steel, it changes int a magnet.
6. When a magnet is broken, then each piece is a complete magnet.
7. The magnetism acquired by a magnetic substance, when it is kept near or in contac with a magnet, is called ***induced magnetism.***
8. The magnetic poles formed at ends of iron or steel when placed near a strong ba magnet are called ***induced magnetic poles.***
9. Methods of Magnetization : A given bar of a magnetic substance can be magnetize by any of the following methods:
   i) Single touch ii) Double touch iii) Divided touch
   iv) Electrical and v) Induction.
10. The most convenient and efficient method to magnetize the specimen of any shape is electrical method. In an electrical method direct current is passed t magnetize specimen.
11. The strength of the magnetism produced in electrical method depends on two factors.
    i) The strength of the current ii) Number of turns in the coil.
12. Electromagnets are used in electric bell, telephone, telegraph, generator, electric motor etc
13. Magnetic length $= \frac{5}{6} \times$ Geometric length
14. When a bar magnet of magnetic pole strength 'm' is cut into two equal halves
    i) Along its axis, pole strength of each piece is $\frac{m}{2}$
    ii) Perpendicular to its length, pole strength of each piece remains same.

15. When a bar magnet is cut into 'n' equal parts parallel to its axis, then pole strength of each piece, $m^1 = \frac{m}{n}$ and magnetic moment of each piece. $M^1 = \frac{M}{n}$

16. When a bar magnet is cut into 'n' equal parts perpendicular to its axis, then pole strength of each piece, $m^1 = m$ and magnetic moment of each piece, $M^1 = \frac{M}{n}$

17. When a bar magnet is cut into 'x' equal parts parallel to its axis and 'y' equal parts perpendicular to its axis then magnetic pole strength of each piece, $m^1 = \frac{m}{x}$ and magnetic moment of each piece, $M^1 = \frac{M}{xy}$.

18. Due to the spin of electrons the magnetism will arise.

PRACTICE SHEET - 1

Conceptual Understanding Questions (C.U.Q) :

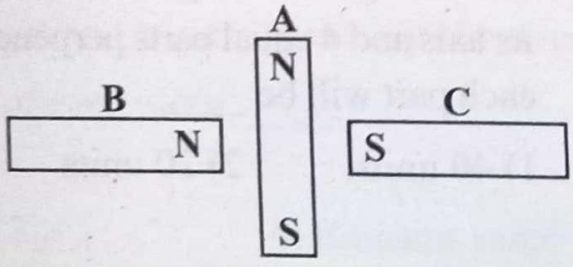
1. The substances which are repelled by either of the poles of a strong magnet are called
   1) Ferromagnetic substances 2) Diamagnetic substances
   3) Paramagnetic substances 4) None of the above

2. _____ is sure test of magnetism.
   1) Attraction 2) Repulsion 3) Induction 4)Pair Property

3. Magnetic compass works on the property of
   1) Attractive 2) Directive 3) Repulsive 4) Induction

4. Chemically natural magnet is
   1) FeO 2) Fe_2O_3 3) Fe_3O_4 4) None

5. In the figure given below the rotation of a magnet A will be
   1) Clockwise direction
   2) Anti-Clockwise direction
   3) Non rotation
   4) We can't say strictly



Single Correct Answer Type (S.C.A.T) :

6. The substances which are strongly attracted by a magnet and can be easily used for making magnets are known as
   1) Diamagnetic substances 2) Paramagnetic substances
   3) Ferromagnetic substances 4) None of the above
7. The substances which are feebly attracted by a magnet are known as
   1) Diamagnetic substances 2) Paramagnetic substances
   3) Ferromagnetic substances 4) None of the above
8. An imaginary straight line passing through magnetic north and south pole of a magnet is called:
   1) Magnetic meridian 2) Magnetic equator
   3) Magnetic axis 4) Equatorial meridian
9. The magnetism of a magnet is due to
   1) The earth 2) Cosmic rays
   3) The spin motion of electrons 4) Pressure of big magnet in side the earth
10. The magnetic moment of a magnet is 5 amp-m^2. If the pole strength is 25 amp-m, then what is its magnetic length?
    1) 10 cm 2) 20 cm 3) 30 cm 4) 40 cm
11. A bar magnet has magnetic moment of 100 units. If it cut into two halves of equal length along the axis, then each half will have a magnetic moment of ____
    1) 100 units 2) 75 units 3) 50 units 4) 25 units
12. A bar magnet has magnetic moment of 50 units. It is cut into 4 equal pieces perpendicular to its axis. Then the magnetic moment of each part will be ____
    1) 12.5 units 2) 25 units 3) 37.5 units 4) 50 units
13. A bar magnet of magnetic moment 160 units is cut into 2 equal parts parallel to its axis and 4 equal parts perpendicular to its axis. The new magnetic moment of each part will be ____
    1) 40 units 2) 20 units 3) 80 units 4) 120 units

14. The magnetic length of a bar magnet is 10 cm then geometric length is

1) 10 cm 2) 12 cm 3) 5 cm 4) 6 cm

15. A bar magnet consists of

1) Two poles of different nature and different strength

2) Same poles of equal magnitude

3) Opposite poles of equal magnitudes

4) Opposite poles of different magnitudes

16. The magnetic lines of force inside a bar magnet

1) are from North-pole to South- pole of the magnet

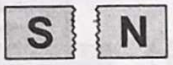
2) Do not exist

3) Depend upon the area of cross section of the barmagnet

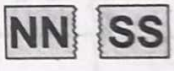
4) are from South–pole to North–pole of the magnet

17. A bar magnet is cut into two pieces as shown below. What will be the configuration of the poles of the two pieces ? 

1) 

2) 

3) 

4) 

18. Which one can be made the strongest electromagnet ?

1) Copper 2) Wood 3) Brass 4) Iron

19. Which one is Paramagnetic substance ?

1) Platinum 2) Manganese 3) Aluminium 4) All of them

20. Which one is repelled by either of the poles of strong magnet ?

1) Iron 2) Cobalt 3) Nickel 4) Copper

21. The magnets made from steel are _____ magnets

1) Temporary 2) Permanent 3) Both (1) and (2)4) None

22. When a bar magnet of magnetic pole strength 'm' is cut into two equal halves perpendicular to its length. Pole strength of each piece_____.

1) $\frac{m}{2}$ 2) $\frac{m}{4}$ 3) 2m 4) Remains same

23. The magnetic moment of a magnet is 15 amp-m^2. If pole strength is 30 amp m, then what is its magnetic length?

1) 30 cm 2) 40 cm 3) 50 cm 4) 60 cm

Multi Correct Answer Type (M.C.A.T) :

24. Select the correct statement (s)

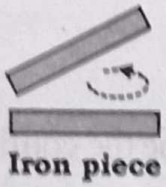
1) Copper is a Ferromagnetic substance

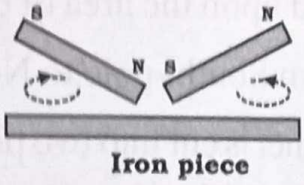
2) Cobalt is a Ferromagnetic substance

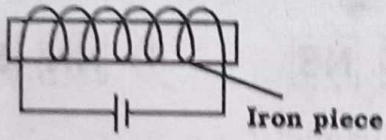
3) Iron is a Ferro magnetic substance

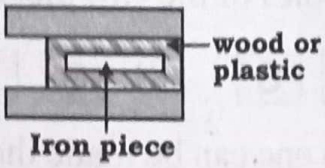
4) Stainless stell is a Ferromagnetic

25. Which of the following is the correct method to make a magnet?

1) 

2) 

3) 

4) 

26. Choose the correct one

1) Paramagnetic substances get weakly attracted to a magnet

2) Due to the spin of electrons the magnetism will arise

3) Magnetic lenght = 6/5 geometric length

4) Each end of a bar magnet posses less pole strength

Comprehension Type (C.T) :

Study the following table and answer the following questions:

P	*Q*	*R*
Diamagnetic	Paramagnetic	Ferromagnetic Substances

27. Particles from which group strongly attracted by magnets

1) P 2) Q 3) R 4) P and Q

28. Particles from which group repelled by the substances.

1) P 2) Q 3) R 4) Q Only R

29. Particles from which group are feebly attracted by substances

1) P 2) Q 3) R 4) P Only Q

Matrix Match Type (M.M.T) :

30.

Column-I		**Column-II**
a) Temporary magnet	( )	p) Directive property
b) Permanent magnet	( )	q) Converging lines
c) The natural magnet	( )	r) Electromagnet
d) Magnetic compass	( )	s) Magnet made up of steel
		t) Lode stone

PRACTICE SHEET : LEVEL - 2 & 3

1. Two similar poles one is twice as strong as other repel with a force of 64N, when separat by a distance of 12m. Find the pole strengths

   1) $10\sqrt{2}$Am, $10\sqrt{2}$Am 2) $20\sqrt{2}$Am, $20\sqrt{2}$Am

   3) $10\sqrt{2}$Am, $20\sqrt{2}$Am 4) $8\sqrt{6}$Am, $16\sqrt{6}$Am

2. There are four light-weight-rod samples A, B, C, D separately suspended by threads. A b magnet is slowly brought near each sample and the following observations are noted

   (i) A is feebly repelled (ii) B is feebly attracted

   (iii) C is strongly attracted (iv) D remains unaffected

   Which one of the following is true?

   1) B is of a paramagnetic material 2) C is of a diamagnetic material

   3) D is of a feeromagnetic material 4) A is of a non-magnetic material

3. Two magnets have their length in the ratio 2 : 3 and their pole strengths in the ratio 3 : 4. The ratio of their magnetic moment is

   1) 2 : 1 2) 4 : 1 3) 1 : 2 4) 1 : 4

4. A straight strip has magnetic moment M. If bent as a semicircle, the magnetic moment of th strip will be

   1) $\frac{2M}{\pi}$ 2) $\frac{2\pi}{M}$ 3) $\frac{2\pi}{3M}$ 4) $\frac{2\pi^2}{M}$

5. A southpole of pole strength 4 Am is placed exactly at the mid point on the line joinin between two north poles of pole strengths 2 Am. Calculate the net force on the south pol

   1) $4\pi \times 10^{-7}$ N 2) $2\pi \times 10^{-7}$ N 3) $4\pi \times 10^{-7}$ N 4) Zero

6. Two magnetic poles, one of which 5 times as strong as the other, experience a force of 12 dyne when placed 6cm apart in air. Find the strength of each pole

   1) 3 A-m, 15 A-m 2) 6 A-m, 30 A-m 3) 30 A-m, 150 A-m 4) 15 A-m, 150 A-m

7. Two similar poles repel each other will a force 164N when placed 1m apart. If the distanc between them is decreased by 50cm, then calculate the force between them

   1) 456 N 2) 556 N 3) 656 N 4) 756 N

8. The magneto-static force between two magnetic poles is F/2. When their strengths are halved and separation is reduced to half of the initial value, find the new magnetic force between them

   1) F 2) F/2 3) F/3 4) F/4