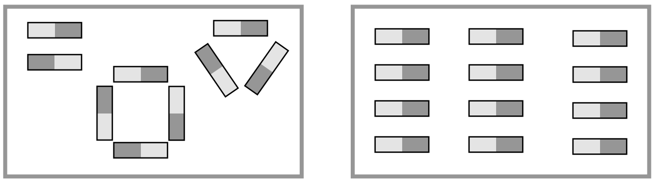
Chapter 22

Magnetism

The molecular theory of magnetism was given by Weber and modified later by Ewing. According to this theory.

Every molecule of a substance is a complete magnet in itself. However, in an **magnetic** substance the molecular magnets are randomly oriented to give net zero magnetic moment. On magnetising, the molecular magnets are realigned in a specific direction leading to a net magnetic moment.

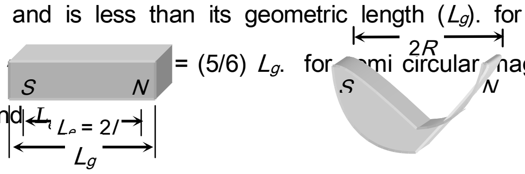


(A) Unmagnetised **(B)** Magnetised

Fig. 22.1

Bar Magnet

A bar magnet consist of two equal and opposite magnetic pole separated by a small distance. Poles are not exactly at the ends. The shortest distance between two poles is called effective length (L_e) and is less than its geometric length (L_g). for bar magnet L_e = (5/6) L_g. for semi circular magnet $L_g = \pi R$ and $L_e = 2R$



(A) Bar magnet **(B)** Semicircular magnet

Fig. 22.2

(1) **Directive properties** : When a magnet suspended freely it stays in the earth's *N*-*S* direction (in magnetic meridian).

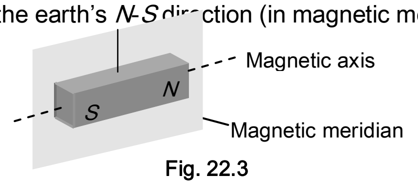


Fig. 22.3

(2) **Monopole concept** : If a magnet is Broken into number of pieces, each piece becomes a magnet. This in turn implies that monopoles do not exist. (*i.e.*, ultimate individual unit of magnetism in any magnet is called dipole).

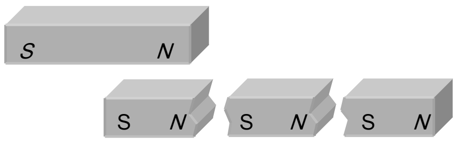


Fig. 22.4

(3) For two rods as shown, if both the rods attract in figure (A) and doesn't attract in figure (B) then, *Q* is a magnetic and *P* is simple iron rod. Repulsion is sure test of magnetism.

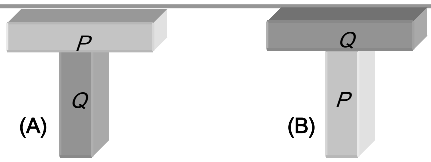


Fig. 22.5

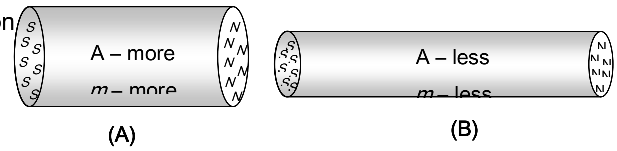
(4) **Pole strength (m) :** The strength of a magnetic pole to attract magnetic materials towards itself is known as pole strength.

(i) It is a scalar quantity.

(ii) Pole strength of N and S pole of a magnet is conventionally represented by $+m$ and $-m$ respectively.

(iii) It's SI unit is *amp* × *m* or *N*/*Tesla* and dimensions are $[LA]$.

(iv) Pole strength of the magnet depends on the nature of material of magnet and area of cross section. It doesn't depends upon



(A) (B)

Fig. 22.6

(5) **Magnetic moment or magnetic dipole moment ($\vec{M}$) :** It represents the strength of magnet. Mathematically it is defined as the product of the strength of either pole and effective length. *i.e.* $\vec{M} = m(2\vec{l})$

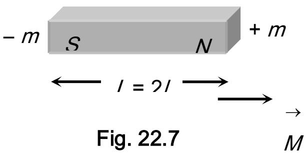


Fig. 22.7

(i) It is a vector quantity directed from south to north.

(ii) It's S.I. unit *amp*×*m*² or *N*-*m* / *Tesla* and dimensions $[AL^2]$

(6) **Cutting of a rectangular bar magnet :** Suppose we have a rectangular bar magnet having length, breadth and mass are L, b and w respectively if it is cut in n equal parts along the length as well as perpendicular to the length simultaneously as shown in the figure then

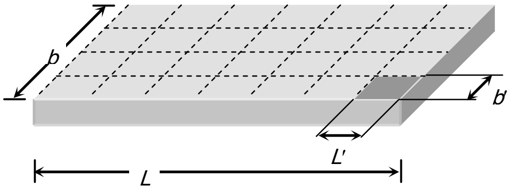


Fig. 22.8

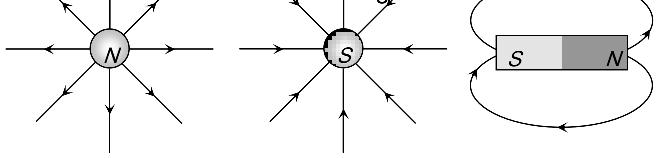
Length of each part $L' = \frac{L}{\sqrt{n}}$, breadth of each part $b' = \frac{b}{\sqrt{n}}$, Mass of each part $w' = \frac{w}{n}$, pole strength of each part $m' = \frac{m}{\sqrt{n}}$, Magnetic moment of each part $M' = m'L' = \frac{m}{\sqrt{n}} \times \frac{L}{\sqrt{n}} = \frac{M}{n}$

If initially moment of inertia of bar magnet about the axes passing from centre and perpendicular to it's length is $I = w\left(\frac{L^2+b^2}{12}\right)$ then moment of inertia of each part $I' = \frac{I}{n^2}$

(7) **Cutting of a thin bar magnet :** For thin magnet $b = 0$ so $L' = \frac{L}{n}$, $w' = \frac{w}{n}$, $m' = \frac{m}{n}$, $I' = \frac{I}{n^3}$

Various Terms Related to Magnetism

(1) **Magnetic field and magnetic lines of force :** Space around a magnetic pole or magnet or current carrying wire within which it's effect can be experienced is defined as magnetic field. Magnetic field can be represented with the help of a set of lines or curves called magnetic lines of force.



(A) Isolated north pole (B) Isolated south pole (C) Magnetic dipole

Fig. 22.9

(2) **Magnetic flux (ϕ) and flux density (B)**

(i) The number of magnetic lines of force passing normally through a surface is defined as magnetic flux (ϕ). It's S.I. unit is *weber* (*wb*) and CGS unit is *Maxwell*.

Remeber 1 *wb* = 10^8 *Maxwell*.

(ii) When a piece of a magnetic substance is placed in an external magnetic field the substance becomes magnetised. The number of magnetic lines of induction inside a magnetised substance crossing unit area normal to their direction is called magnetic induction or magnetic flux density $(\vec{B})$. It is a vector quantity.

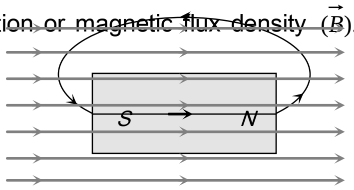
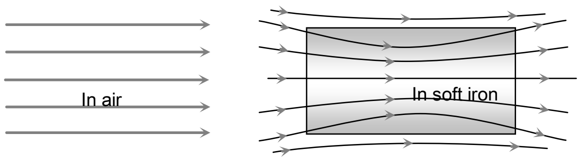


Fig. 22.10

It's SI unit is *Tesla* which is equal to $\frac{wb}{m^2} = \frac{N}{amp \times m} = \frac{J}{amp \times m^2} = \frac{volt \times \sec}{m^2}$

and CGS unit is *Gauss*. Remember 1 *Tesla* = 10^4 *Gauss*.

(3) **Magnetic permeability :** It is the degree or extent to which magnetic lines of force can enter a substance and is denoted by μ. Or characteristic of a medium which allows magnetic flux to pass through it is called it's permeability. *e.g.* permeability of soft iron is 1000 times greater than that of air.



(A) (B)

Fig. 22.11

Also μ = $\mu_0\ \mu_r$; where μ_0 = absolute permeability of air or free space = $4\pi \times 10^{-7}\ tesla \times m / amp.$

and μ_r = Relative permeability of the medium = $\frac{B}{B_0} = \frac{\text{flux density in material}}{\text{flux density in vacuum}}$.

(4) **Intensity of magnetising field $(\vec{H})$ (magnetising field) :** It is the degree or extent to which a magnetic field can magnetise a substance. Also $H = \frac{B}{\mu}$.

It's SI unit is

$A/m. = \frac{N}{m^2 \times Tesla} = \frac{N}{wb} = \frac{J}{m^3 \times Tesla} = \frac{J}{m \times wb}$ It's CGS unit is *Oersted*. Also 1 *Oersted* = 80 *A*/*m*

(5) **Intensity of magnetisation (*I*) :** It is the degree to which a substance is magnetised when placed in a magnetic field.

It can also be defined as the pole strength per unit cross sectional area of the substance or the induced dipole moment per unit volume.

Hence *I* = $\frac{m}{A} = \frac{M}{V}$. It is a vector quantity, it's S.I. unit is *Amp*/*m*.

(6) **Magnetic susceptibility (χ_m) :** It is the property of the substance which shows how easily a substance can be magnetised. It can also be defined as the ratio of intensity of magnetisation (*I*) in a substance to the magnetic intensity (*H*) applied to the substance, *i.e.* $\chi_m = \frac{I}{H}$. It is a scalar quantity with no units and dimensions.

(7) **Relation between permeability and susceptibility :** Total magnetic flux density *B* in a material is the sum of magnetic flux density in vacuum B_0 produced by magnetising force and magnetic flux density due to magnetisation of material B_m. *i.e.* $B = B_0 + B_m \Rightarrow B = \mu_0 H + \mu_0 I = \mu_0 (H + I) = \mu_0 H(1 + \chi_m)$. Also $\mu_r = (1 + \chi_m)$

Force and Field

(1) **Coulombs law in magnetism** : The force between two magnetic poles of strength m_1 and m_2 lying at a distance r is

given by $F = k.\frac{m_1 m_2}{r^2}$. In S.I. units $k = \frac{\mu_0}{4\pi} = 10^{-7} wb/Amp \times m$,

In CGS units $k = 1$

(2) **Magnetic field**

(i) Magnetic field due to an imaginary magnetic pole (Pole strength *m*) : Is given by $B = \frac{F}{m_0}$ also $B = \frac{\mu_0}{4\pi}.\frac{m}{d^2}$

(ii) Magnetic field due to a bar magnet : At a distance *r* from the centre of magnet

(a) On axial position

$B_a = \frac{\mu_0}{4\pi}\frac{2Mr}{(r^2 - l^2)^2}$; If *l* << *r* then $B_a = \frac{\mu_0}{4\pi}\frac{2M}{r^3}$

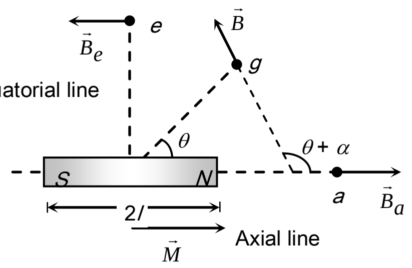


Fig. 22.12

(b) On equatorial position : $B_e = \frac{\mu_0}{4\pi}\frac{M}{(r^2 + l^2)^{3/2}}$; If *l* << *r* ; then $B_e = \frac{\mu_0}{4\pi}\frac{M}{r^3}$

(c) General position : In general position for a short bar magnet $B_g = \frac{\mu_0}{4\pi}\frac{M}{r^3}\sqrt{(3\cos^2\theta + 1)}$

(3) **Bar magnet in magnetic field** : When a bar magnet is left free in an uniform magnetic field, if align it self in the directional field.

(i) Torque : $\tau = MB\sin\theta \Rightarrow \vec{\tau} = \vec{M} \times \vec{B}$

(ii) Work : $W = MB(1 - \cos\theta)$

(iii) Potential energy : $U = -MB\cos\theta = -\vec{M}.\vec{B}$; (θ = Angle made by the dipole with the field)

(4) **Gauss's law in magnetism** : Net magnetic flux through any closed surface is always zero *i.e.* $\oint \vec{B}.\vec{ds} = 0$

Earth's Magnetic Field (Terrestrial Magnetism)

As per the most established theory it is due to the rotation of the earth where by the various charged ions present in the molten state in the core of the earth rotate and constitute a current.

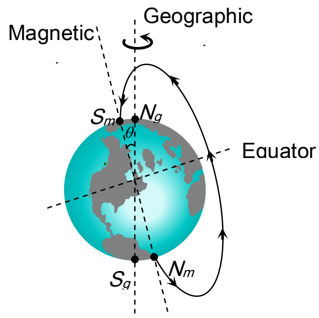


Fig. 22.13

(1) The magnetic field of earth is similar to one which would be obtained if a huge magnet is assumed to be buried deep inside the earth at it's centre.

(2) The axis of rotation of earth is called geographic axis and the points where it cuts the surface of earth are called geographical poles (N_g, S_g). The circle on the earth's surface perpendicular to the geographical axis is called equator.

(3) A vertical plane passing through the geographical axis is called geographical meridian.

(4) The axis of the huge magnet assumed to be lying inside the earth is called magnetic axis of the earth. The points where the magnetic axis cuts the surface of earth are called magnetic poles. The circle on the earth's surface perpendicular to the magnetic axis is called magnetic equator.

(5) Magnetic axis and Geographical axis don't coincide but they make an angle of 17.5° with each other.

(6) Magnetic equator divides the earth into two hemispheres. The hemisphere containing south polarity of

earth's magnetism is called northern hemisphere while the other, the southern hemisphere.

(7) The magnetic field of earth is not constant but changes irregularly from place to place on the surface of the earth and even at a given place it varies with time too.

(8) Direction of earth's magnetic field is from *S* (geographical south) to *N* (geographical north).

Elements of Earth's Magnetic Field

The magnitude and direction of the magnetic field of the earth at a place are completely given by certain. quantities known as magnetic elements.

(1) **Magnetic Declination (θ) :** It is the angle between geographic and the magnetic meridian planes.

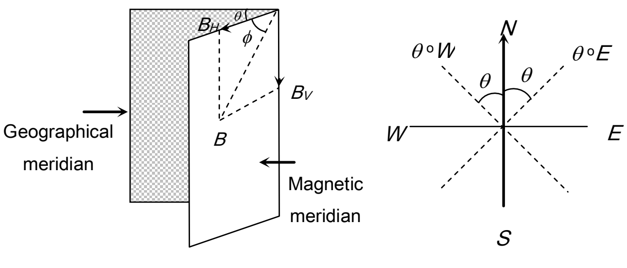


Fig. 22.14

Declination at a place is expressed at $\theta^o E$ or $\theta^o W$ depending upon whether the north pole of the compass needle lies to the east or to the west of the geographical axis.

(2) **Angle of inclination or Dip (ϕ) :** It is the angle between the direction of intensity of total magnetic field of earth and a horizontal line in the magnetic meridian.

(3) **Horizontal component of earth's magnetic field (B_H) :** Earth's magnetic field is horizontal only at the magnetic equator. At any other place, the total intensity can be resolved into horizontal component (B_H) and vertical component (B_V).

Also $B_H = B\cos\phi$ ...... (i) and $B_V = B\sin\phi$ ...... (ii)

By squaring and adding equation (i) and (ii)

$$B = \sqrt{B_{H^2} + B_{V^2}}$$

Dividing equation (ii) by equation (i) $\tan\phi = \frac{B_V}{B_H}$

Magnetic Maps and Neutral Points

(1) **Magnetic maps :** Magnetic maps (*i.e.* Declination, dip and horizontal component) over the earth vary in magnitude from place to place. It is found that many places have the same value of magnetic elements. The lines are drawn joining all place on the earth having same value of a magnetic element. These lines form magnetic map.

(i) Isogonic lines: These are the lines on the magnetic map joining the places of equal declination.

(ii) Agonic line: The line which passes through places having zero declination is called agonic line.

(iii) Isoclinic lines : These are the lines joining the points of equal dip or inclination.

(iv) Aclinic line : The line joining places of zero dip is called aclinic line (or magnetic equator)

(v) Isodynamic lines : The lines joining the points or places having the same value of horizontal component of earth's magnetic field are called isodynamic lines.

(2) **Neutral points :** A neutral point is a point at which the resultant magnetic field is zero. In general the neutral point is obtained when horizontal component of earth's field is balanced by the field produced by the magnet.

Tangent Law

When a small magnet is suspended in two uniform magnetic fields B and B_H which are at right angles to each other, the magnet comes to rest at an angle θ with respect to B_H.

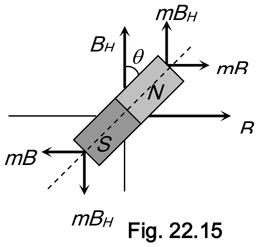


Fig. 22.15

In equilibrium

$$MB_H \sin\theta = MB\sin(90^o - \theta)$$

$\Rightarrow B = B_H \tan\theta.$ This is called tangent law.

Tangent Galvanometer

It consists of three circular coils of insulated copper wire wound on a vertical circular frame made of nonmagnetic material as ebonite or wood. A small magnetic compass needle is pivoted at the centre of the vertical circular frame. When the coil of the tangent galvanometer is kept in magnetic meridian and current passes through any of the coil then the needle at the centre gets deflected and comes to an equilibrium position under the action of two perpendicular field : one due to horizontal component of earth and the other due to field (*B*) set up by the coil due to current.

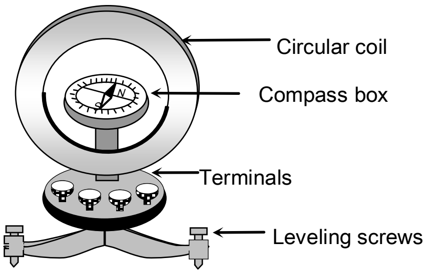


Fig. 22.16

In equilibrium $\boldsymbol{B} = \boldsymbol{B_H} \tan\theta$ where $B = \frac{\mu_0 ni}{2r}$; *n* = number of turns, *r* = radius of coil, *i* = the current to be measured, θ = angle made by needle from the direction of B_H in equilibrium.

Hence $\frac{\mu_0 Ni}{2r} = B_H \tan\theta \Rightarrow i = k\tan\theta$ where $k = \frac{2rB_H}{\mu_0 N}$ is called reduction factor.

Deflection Magnetometer

It's working is based on the principle of tangent law. It consists of a small compass needle, pivoted at the centre of a circular box. The box is kept in a wooden frame having two meter scale fitted on it's two arms. Reading of a scale at any point directly gives the distance of that point from the centre of compass needle.

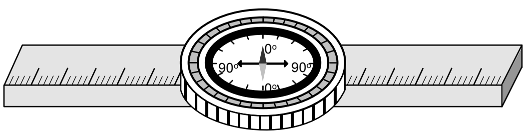


Fig. 22.17

(1) **Tan *A* position :** In this position the magnetometer is set perpendicular to magnetic meridian. So that, magnetic field due to magnet, is in axial position and perpendicular to earth's field. Hence $B_H \tan\theta = \frac{\mu_0}{4\pi}.\frac{2Mr}{(r^2 - l^2)^2}$ or $B_H \tan\theta = \frac{\mu_0}{4\pi}.\frac{2M}{r^3}$

(2) **Tan *B* position :** The arms of magnetometer are set in magnetic meridian, so that the magnetic field due to magnet is at it's equatorial position. Hence $B_H \tan\theta = \frac{\mu_0}{4\pi}.\frac{M}{(r^2 + l^2)^{3/2}}$ or $B_H \tan\theta = \frac{\mu_0}{4\pi}.\frac{M}{r^3}$

(3) **Comparison of magnetic moments :** According to deflection method $\frac{M_1}{M_2} = \frac{\tan\theta_1}{\tan\theta_2}$

According to null deflection method $\frac{M_1}{M_2} = \left(\frac{d_1}{d_2}\right)^3$

Vibration Magnetometer

Vibration magnetometer is used for comparison of magnetic moments and magnetic fields. This device works on the principle, that whenever a freely suspended magnet in a uniform magnetic field, is disturbed from it's equilibrium position, it starts vibrating about the mean position.

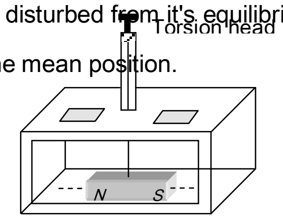


Fig. 22.18

Time period of oscillation of experimental bar magnet (magnetic moment *M*) in earth's magnetic field (B_H) is given by the formula. $T = 2\pi\sqrt{\frac{I}{MB_H}}$; where, $I =$ moment of inertia of short bar magnet $= \frac{wL^2}{12}$ (*w* = mass of bar magnet)

(1) **Determination of magnetic moment of a magnet :** The experimental (given) magnet is put into vibration magnetometer and it's time period *T* is determined. Now $T = 2\pi\sqrt{\frac{I}{MB_H}} \Rightarrow M = \frac{4\pi^2 I}{B_H.T^2}$

(2) **Comparison of horizontal components of earth's magnetic field at two places**

$T = 2\pi\sqrt{\dfrac{I}{MB_H}}$; since *I* and *M* of the magnet are constant,

So $T^2 \propto \dfrac{1}{B_H} \Rightarrow \dfrac{(B_H)_1}{(B_H)_2} = \dfrac{T_2^2}{T_1^2}$

(3) **Comparison of magnetic moment of two magnets of same size and mass**

$T = 2\pi\sqrt{\dfrac{I}{M.B_H}}$; Here *I* and B_H are constants.

So $M \propto \dfrac{1}{T^2} \Rightarrow \dfrac{M_1}{M_2} = \dfrac{T_2^2}{T_1^2}$

(4) **Comparison of magnetic moments by sum and difference method**

Sum position

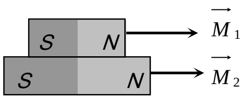


Fig. 22.19

Net magnetic moment $M_s = M_1 + M_2$

Net moment of inertia $I_s = I_1 + I_2$

Time period of oscillation of this pair in earth's magnetic field (B_H)

$$T_s = 2\pi\sqrt{\frac{I_s}{M_s\,B_H}} = 2\pi\sqrt{\frac{I_1 + I_2}{(M_1 + M_2)B_H}} \qquad \text{....(i)}$$

Frequency $\nu_s = \dfrac{1}{2\pi}\sqrt{\dfrac{(M_1 + M_2)B_H}{I_s}}$

Difference position

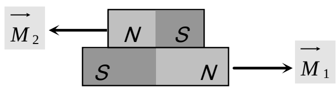


Fig. 22.20

Net magnetic moment

$M_d = M_1 + M_2$

Net moment of inertia $I_d = I_1 + I_2$

and $T_d = 2\pi\sqrt{\dfrac{I_d}{M_d\,B_H}} = 2\pi\sqrt{\dfrac{I_1 + I_2}{(M_1 - M_2)B_H}}$ ....(ii)

and $\nu_d = \dfrac{1}{2\pi}\sqrt{\dfrac{(M_1 + M_2)B_H}{(I_1 + I_2)}}$. From equation (i) and (ii) we get

$$\frac{T_s}{T_d} = \sqrt{\frac{M_1 - M_2}{M_1 + M_2}} \Rightarrow \frac{M_1}{M_2} = \frac{T_d^2 + T_s^2}{T_d^2 - T_s^2} = \frac{\nu_s^2 + \nu_d^2}{\nu_s^2 - \nu_d^2}$$

(5) **To find the ratio of magnetic field :** Suppose it is required to find the ratio $\dfrac{B}{B_H}$ where *B* is the field created by magnet and B_H is the horizontal component of earth's magnetic field.

To determine $\dfrac{B}{B_H}$ a primary (main) magnet is made to first oscillate in earth's magnetic field (B_H) alone and it's time period of oscillation (*T*) is noted.

$T = 2\pi\sqrt{\dfrac{I}{M\,B_H}}$

and frequency $\nu = \dfrac{1}{2\pi}\sqrt{\dfrac{M\,B_H}{I}}$

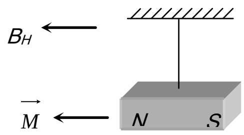


Fig. 22.21

Now a secondary magnet placed near the primary magnet so primary magnet oscillate in a new field with is the resultant of *B* and B_H and now time period, is noted again.

$T' = 2\pi\sqrt{\dfrac{I}{M(B + B_H)}}$

or $\nu' = \dfrac{1}{2\pi}\sqrt{\dfrac{M(B + B_H)}{I}}$

$\Rightarrow \dfrac{B}{B_H} = \left(\dfrac{\nu'}{\nu}\right)^2 - 1$

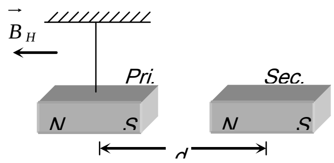


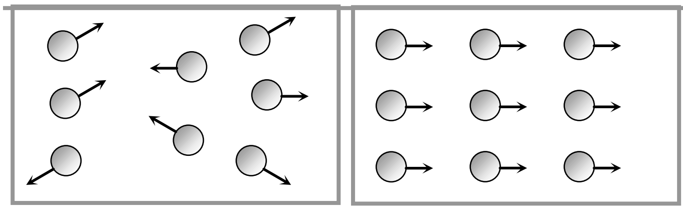
Fig. 22.22

Magnetic Materials

On the basis of mutual interactions or behaviour of various materials in an external magnetic field, the materials are divided in three main categories.

(1) **Diamagnetic materials :** Diamagnetism is the intrinsic property of every material and it is generated due to mutual interaction between the applied magnetic field and orbital motion of electrons.

(2) **Paramagnetic materials :** In these substances the inner orbits of atoms are incomplete. The electron spins are uncoupled, consequently on applying a magnetic field the magnetic moment generated due to spin motion align in the direction of magnetic field and induces magnetic moment in its direction due to which the material gets feebly magnetised. In these materials the electron number is odd.



(A) When no field is applied

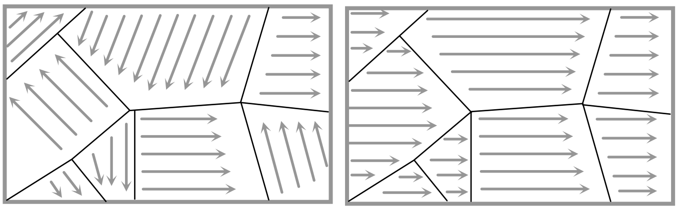
(B) On application of field $(\vec{B})$

Fig. 22.23

(3) **Ferromagnetic materials :** In some materials, the permanent atomic magnetic moments have strong tendency to align themselves even without any external field.

These materials are called ferromagnetic materials.

In every unmagnetised ferromagnetic material, the atoms form domains inside the material. Different domains, however, have different directions of magnetic moment and hence the materials remain unmagnetised. On applying an external magnetic field, these domains rotate and align in the direction of magnetic field.



(A) Unmagnetised

(B) Magnetised

Fig. 22.24

(4) **Curie Law :** The magnetic susceptibility of paramagnetic substances is inversely proportional to its absolute temperature *i.e.* $\chi \propto \frac{1}{T} \Rightarrow \chi \propto \frac{C}{T}$; where C = Curie constant, T = absolute temperature.

On increasing temperature, the magnetic susceptibility of paramagnetic materials decreases and vice versa.

The magnetic susceptibility of ferromagnetic substances does not change according to Curie law.

(5) **Curie temperature (T_c) :** The temperature above which a ferromagnetic material behaves like a paramagnetic material is defined as Curie temperature (T_c).

or

The minimum temperature at which a ferromagnetic substance is converted into paramagnetic substance is defined as Curie temperature. For various ferromagnetic materials its values are different, *e.g.* for *Ni*, $T_{C_{Ni}} = 358^o C$ for *Fe*, $T_{C_{Fe}} = 770^o C$

for *CO*, $T_{C_{CO}} = 1120^o C$

At this temperature the ferromagnetism of the substances suddenly vanishes.

(6) **Curie-weiss law :** At temperatures above Curie temperature the magnetic susceptibility of ferromagnetic materials is inversely proportional to ($T - T_c$)

i.e. $\chi \propto \frac{1}{T - T_c}$

$\Rightarrow \chi = \frac{C}{(T - T_c)}$

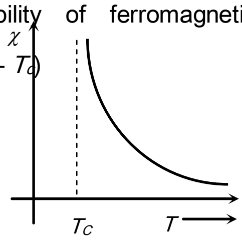


Fig. 22.25

Here T_c = Curie temperature

χ-T curve is shown (for Curie-Weiss Law)

Hysteresis Curve

For ferromagnetic materials, by removing external magnetic field *i.e.* H = 0. The magnetic moment of some domains remain aligned in the applied direction of previous magnetising field which results into a residual magnetism.

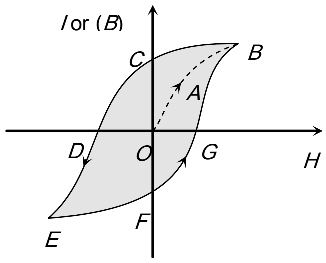


Fig. 22.26

The lack of retracibility as shown in figure is called hysteresis and the curve is known as hysteresis loop.

(1) **Retentivity :** When H is reduced, I reduces but is not zero when H = 0. The remainder value OC of magnetisation when H = 0 is called the residual magnetism or retentivity.

The property by virtue of which the magnetism (I) remains in a material even on the removal of magnetising field is called Retentivity or Residual magnetism.

(2) **Corecivity or corecive force** : When magnetic field H is reversed, the magnetisation decreases and for a particular value of H, denoted by H_c, it becomes zero *i.e.*, $H_c = OD$ when $I = 0$. This value of H is called the corecivity.

Magnetic hard substance (steel) → High corecvity

Magnetic soft substance (soft iron) → Low corecivity

(3) When field H is further increased in reverse direction, the intensity of magnetisation attains saturation value in reverse direction (*i.e.* point E)

(4) When H is decreased to zero and changed direction in steps, we get the part $EFGB$.

Thus complete cycle of magnetisation and demagnetisation is represented by $BCDEFGB$. This curve is known as hysteresis curve

Table 22.1 : Comparison between soft iron and steel

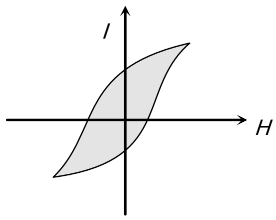
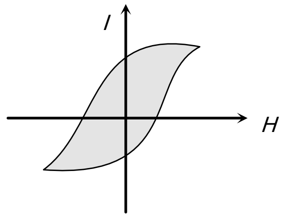
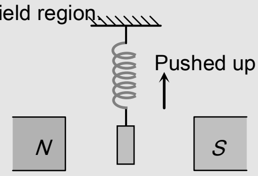
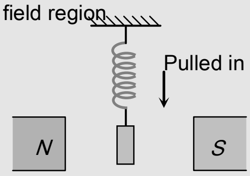
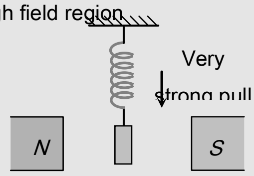
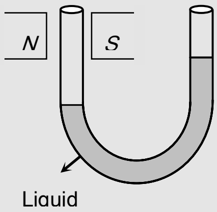
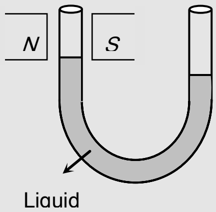
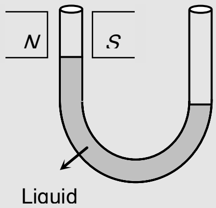
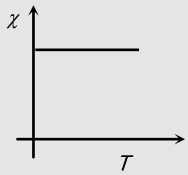
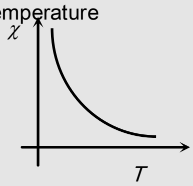
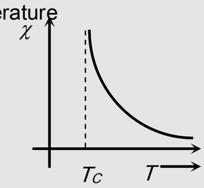
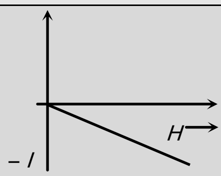
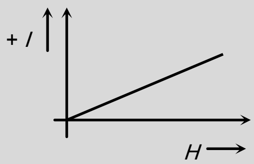
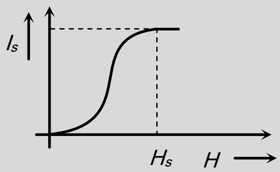
Soft iron	Steel
	
The area of hysteresis loop is less (low energy loss)	The area of hysteresis loop is large (high energy loss)
Less relativity and corecive force	More retentivity and corecive force
Magnetic permeability is high	Magnetic permeability is less
I and χ both are high	I and χ both are low
It magnetised and demagnetised easily	Magnetisation and demagnetisation is not easy
Used in dynamo, transformer, electromagnet tape recorder and tapes *etc.*	Used for making permanent magnet.

Table 22.2 : Comparative study of magnetic materials

Property	Diamagnetic substances	Paramagnetic substances	Ferromagnetic substances
Cause of magnetism	Orbital motion of electrons	Spin motion of electrons	Formation of domains
Explanation of magnetism	On the basis of orbital motion of electrons	On the basis of spin and orbital motion of electrons	On the basis of domains formed
Behaviour In a non-uniform magnetic field	These are repelled in an external magnetic field *i.e.* have a tendency to move from high to low field region 	These are feebly attracted in an external magnetic field *i.e.*, have a tendency to move from low to high field region 	These are strongly attracted in an external magnetic field *i.e.* they easily move from low to high field region 

State of magnetisation	These are weekly magnetised in a direction opposite to that of applied magnetic field	These get weekly magnetised in the direction of applied magnetic field	These get strongly magnetised in the direction of applied magnetic field
When the material in the form of liquid is filled in the *U*-tube and placed between pole pieces.	Liquid level in that limb gets depressed 	Liquid level in that limb rises up 	Liquid level in that limb rises up very much 
On placing the gaseous materials between pole pieces	The gas expands at right angles to the magnetic field.	The gas expands in the direction of magnetic field.	The gas rapidly expands in the direction of magnetic field
The value of magnetic induction B	$B < B_0$ (where B_0 is the magnetic induction in vacuum)	$B > B_0$	$B >> B_0$
Magnetic susceptibility χ	Low and negative $\|\chi\| \approx 1$	Low but positive $\chi \approx 1$	Positive and high $\chi \approx 10^2$
Dependence of χ on temperature	Does not depend on temperature (except *Bi* at low temperature) 	On cooling, these get converted to ferromagnetic materials at Curie temperature 	These get converted into paramagnetic materials at Curie temperature 
Relative permeability (μ_r)	$\mu_r < 1$	$\mu_r > 1$	$\mu_r >> 1$ $\mu_r = 10^2$
Intensity of magnetisation (I)	I is in a direction opposite to that of H and its value is very low	I is in the direction of H but value is low	I is in the direction of H and value is very high.
I-*H* curves			

Magnetic moment (*M*)	Very low (≈ 0)	Very low	Very high
Examples	*Cu, Ag, Au, Zn, Bi, Sb, NaCl,* H_2O air and diamond *etc.*	*Al, Mn, Pt, Na,* $CuCl_2$, O_2 and crown glass	*Fe, Co, Ni, Cd,* Fe_3O_4 *etc.*

Tips & Tricks

✍ Bohr magneton $\mu_B = \frac{eh}{4\pi m} = 9.27\times10^{-24}\ A/m^2$. It serves as natural unit of magnetic moment. Bohr magneton can be defined as the orbital magnetic moment of an electron circulating in inner most orbit.

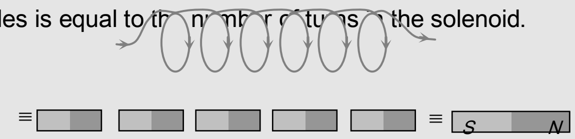
✍ Magnetic moment of straight current carrying wire is zero.

✍ Magnetic moment of toroid is zero

✍ Atoms which have paired electron have the magnetic moment zero.

✍ Magnetostriction : The length of an iron bar changes when it is magnetised, when an iron bar magnetised it's length increases due to alignment of spins parallel to the field. This increase is in the direction of magnetisation. This effect is known as magnetostriction.

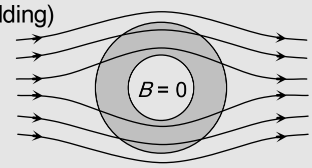
✍ A current carrying solenoid can be treated as the arrangement of small magnetic dipoles placed in line with each other as shown. The number of such small magnetic dipoles is equal to the number of turns in the solenoid.



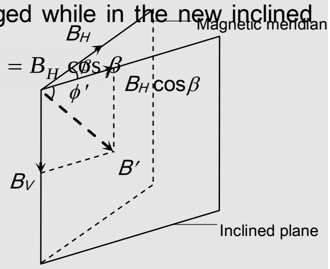
✍ When a magnetic dipole of moment *M* moves from unstable equilibrium to stable equilibrium position in a magnetic field B, the kinetic energy will decrease by 2 *MB*.

✍ Intensity of magnetisation (*I*) is produced in materials due to spin motion of electrons.

✍ For protecting a sensitive equipment from the external magnetic field it should be placed inside an iron cane. (magnetic shielding)



✍ **Apparent dip :** In a vertical plane inclined at an angle β to the magnetic meridian, vertical component of earth's magnetic field remains unchanged while in the new inclined plane horizontal component $B'_H = B_H \cos\beta$



$\phi' =$ apparent angle of dip

and $\tan\phi' = \frac{B_V}{B'_H} = \frac{B_V}{B_H \cos\beta}$

$\Rightarrow \tan\phi' = \frac{\tan\phi}{\cos\beta}$

✍ If at any place the angle of dip is θ and magnetic latitude is λ then $\tan\theta = 2\tan\lambda$

✍ At the poles and equator of earth the values of total intensity are 0.66 and 0.33 *Oersted respectively.*

✍ Remember time period of oscillation in difference position is greater than that in sum position $T_d > T_s$.

✍ If a rectangular bar magnet is cut in n equal parts then time period of each part will be $\frac{1}{\sqrt{n}}$ times that of complete magnet (i.e. $T' = \frac{T}{\sqrt{n}}$) while for short magnet $T' = \frac{T}{n}$. If nothing is said then bar magnet is treated as short magnet.

✍ Suppose a magnetic needle is vibrating in earth's magnetic field. With temperature rise *M* decreases hence time period (*T*) increases but at 770°*C* (Curie temperature) it stops vibrating.

✍ An iron cored coil and a bulb are connected in series with an ac generator. If an iron rod is introduced inside a coil, then the intensity of bulb will decrease, because some energy lost in magnetising the rod.

✍ Hysteresis energy loss = Area bound by the hysteresis loop = *VAnt Joule*; Where , *V* = Volume of ferromagnetic sample, *A* = Area of *B* – *H* loop *P*, *n* = Frequency of alternating magnetic field and *t* = Time

Ordinary Thinking

Objective Questions

Magnet and it's Properties

1. An iron rod of length *L* and magnetic moment *M* is bent in the form of a semicircle. Now its magnetic moment will be
   [CPMT 1984; MP Board 1986; NCERT 1975; MP PET/PMT 1988; EAMCET (Med.) 1995; Manipal MEE 1995;RPMT 1996; BHU 1995; MP PET 2002]
   (a) M (b) $\frac{2M}{\pi}$
   (c) $\frac{M}{\pi}$ (d) $M\pi$

2. Unit of magnetic flux density (or magnetic induction) is
   [DPMT 1988;CPMT 1984, 78, 90; MP PMT 1992; MH CET 2004]
   (a) *Tesla* (b) *Weber/metre*^{2}
   (c) *Newton/ampere-metre* (d) All of the above

3. Magnetic intensity for an axial point due to a short bar magnet of magnetic moment *M* is given by
   [MP PET 1984; CPMT 1974; Pb. PMT 1999]
   (a) $\frac{\mu_0}{4\pi}\times\frac{M}{d^3}$ (b) $\frac{\mu_0}{4\pi}\times\frac{M}{d^2}$
   (c) $\frac{\mu_0}{2\pi}\times\frac{M}{d^3}$ (d) $\frac{\mu_0}{2\pi}\times\frac{M}{d^2}$

4. A magnet is placed in iron powder and then taken out, then maximum iron powder is at
   (a) Some away from north pole
   (b) Some away from south pole
   (c) The middle of the magnet
   (d) The end of the magnet

5. A magnet of magnetic moment *M* and pole strength *m* is divided in two equal parts, then magnetic moment of each part will be **[MP Board 1985; MP PET 1984, 2000; NCERT 1974; AFMC 1996; MP PMT 2002; MH CET (Med.) 2001; CPMT 1983, 84; KCET 1994, 2001]**
   (a) M (b) $M/2$
   (c) $M/4$ (d) $2M$

6. Points *A* and *B* are situated along the extended axis of 2 *cm* long bar magnet at a distance *x* and 2*x cm* respectively. From the pole nearer to the points, the ratio of the magnetic field at A and B will be **[EAMCET 1984; CPMT 1986]**
   (a) 4 : 1 exactly (b) 4 : 1 approx.
   (c) 8 : 1 exactly (d) 8 : 1 approx.

7. If a magnet of pole strength *m* is divided into four parts such that the length and width of each part is half that of initial one, then the pole strength of each part will be
   (a) $m/4$ (b) $m/2$
   (c) $m/8$ (d) $4m$

8. The distance of two points on the axis of a magnet from its centre is 10 *cm* and 20 *cm* respectively. The ratio of magnetic intensity at these points is 12.5 : 1. The length of the magnet will be
   (a) 5 *cm* (b) 25 *cm*
   (c) 10 *cm* (d) 20 *cm*

9. Ratio of magnetic intensities for an axial point and a point on broad side-on position at equal distance *d* from the centre of magnet will be **or** The magnetic field at a

distance *d* from a short bar magnet in longitudinal and transverse positions are in the ratio **[CPMT 1978, 82; KCET 1998]**

(a) 1 : 1 (b) 2 : 3

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

10. The magnetism of magnet is due to [JIPMER 1997]

(a) The spin motion of electron
(b) Earth
(c) Pressure of big magnet inside the earth
(d) Cosmic rays

11. The pole strength of a bar magnet is 48 *ampere-metre* and the distance between its poles is 25 *cm*. The moment of the couple by which it can be placed at an angle of 30° with the uniform magnetic intensity of flux density 0.15 *Newton /ampere-metre* will be

(a) 12 *Newton × metre* (b) 18 *Newton × metre*
(c) 0.9 *Newton × metre* (d) None of the above

12. The magnetic field at a point *x* on the axis of a small bar magnet is equal to the field at a point *y* on the equator of the same magnet. The ratio of the distances of *x* and *y* from the centre of the magnet is [MP PMT 1990]

(a) 2^{-3} (b) $2^{-1/3}$
(c) 2^3 (d) $2^{1/3}$

13. A magnet of magnetic moment 20 C.G.S. units is freely suspended in a uniform magnetic field of intensity 0.3 C.G.S. units. The amount of work done in deflecting it by an angle of 30° in C.G.S. units is

(a) 6 (b) $3\sqrt{3}$
(c) $3(2-\sqrt{3})$ (d) 3

14. A bar magnet having centre O has a length of 4 *cm*. Point P_1 is in the broad side-on and P_2 is in the end side-on position with OP_1 = OP_2 = 10 *metres*. The ratio of magnetic intensities *H* at P_1 and P_2 is

(a) $H_1 : H_2 = 16 : 100$ (b) $H_1 : H_2 = 1 : 2$
(c) $H_1 : H_2 = 2 : 1$ (d) $H_1 : H_2 = 100 : 16$

15. The magnetic field due to a short magnet at a point on its axis at distance *X cm* from the middle point of the magnet is 200 *Gauss*. The magnetic field at a point on the neutral axis at a distance *X cm* from the middle of the magnet is

[CPMT 1971, 88; MP PET 1985]

(a) 100 *Gauss* (b) 400 *Gauss*
(c) 50 *Gauss* (d) 200 *Gauss*

16. Which of the following, the most suitable material for making permanent magnet is

(a) Steel (b) Soft iron
(c) Copper (d) Nickel

17. In the case of bar magnet, lines of magnetic induction

[CPMT 1975; CBSE PMT 1990]

(a) Start from the north pole and end at the south pole
(b) Run continuously through the bar and outside
(c) Emerge in circular paths from the middle of the bar
(d) Are produced only at the north pole like rays of light from a bulb

18. A sensitive magnetic instrument can be shielded very effectively from outside magnetic fields by placing it inside a box of

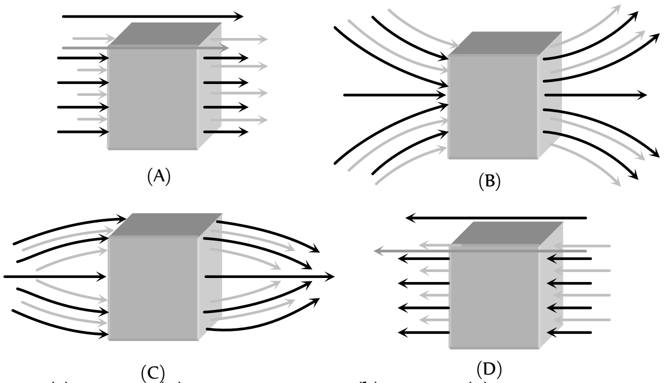
(a) Teak wood
(b) Plastic material
(c) Soft iron of high permeability
(d) A metal of high conductivity

19. The field due to a magnet at a distance *R* from the centre of the magnet is proportional to [MP PET 1996]

(a) R^2 (b) R^3
(c) $1/R^2$ (d) $1/R^3$

20. A uniform magnetic field, parallel to the plane of the paper existed in space initially directed from left to right. When a bar of soft iron is placed in the field parallel to it, the lines of force passing through it will be represented by

[CPMT 1986, 88]

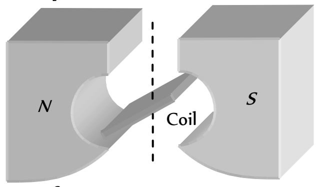


(a) Figure (A) (b) Figure (B)
(c) Figure (C) (d) Figure (D)

[MP PET 1991]

21. The figure below shows the north and south poles of a permanent magnet in which *n* turn coil of area of cross-section *A* is resting, such that for a current *i* passed through the coil, the plane of the coil makes an angle θ with respect to the direction of magnetic field B. If the plane of the magnetic field and the coil are horizontal and vertical respectively, the torque on the coil will be

[MP PET 1990] [CPMT 1986, 88; DPMT 2002]



(a) $\tau = niAB\cos\theta$
(b) $\tau = niAB\sin\theta$
(c) $\tau = niAB$
(d) None of the above, since the magnetic field is radial

22. Points *A* and *B* are situated perpendicular to the axis of a 2*cm* long bar magnet at large distances *X* and 3*X* from its centre on opposite sides. The ratio of the magnetic fields at *A* and *B* will be approximately equal to [CPMT 1988]

(a) 1 : 9 (b) 2 : 9
(c) 27 : 1 (d) 9 : 1

23. Two short magnets with their axes horizontal and perpendicular to the magnetic meridian are placed with their centres 40 *cm* east and 50 *cm* west of magnetic needle. If the needle remains undeflected, the ratio of their magnetic moments $M_1 : M_2$ is [MP PET 1990]

(a) 4 : 5 (b) 16 : 25
(c) 64 : 125 (d) $2:\sqrt{5}$

[CPMT 1974]

24. If a bar magnet of magnetic moment *M* is freely suspended in a uniform magnetic field of strength *B*, the work done in rotating the magnet through an angle θ is

[AFMC 1997; MNR 1998; RPET 1999; MP PMT 1989, 96, 99; MP PET 1984, 89, 2000; UPSEAT 1999, 2000, 05]

(a) $MB(1-\sin\theta)$ (b) $MB\sin\theta$
(c) $MB\cos\theta$ (d) $MB(1-\cos\theta)$

25. Two small bar magnets are placed in a line with like poles facing each other at a certain distance *d* apart. If the length of each magnet is negligible as compared to *d*, the force between them will be inversely proportional to

[CPMT 1971; NCERT 1971; MP PMT 1992]

(a) d (b) d^2

(c) $\frac{1}{d^2}$ (d) d^4

26. A magnet of magnetic moment *M* is situated with its axis along the direction of a magnetic field of strength B. The work done in rotating it by an angle of 180 will be

[MP PMT 1985; MP PET 1997]

(a) $-MB$ (b) $+MB$

(c) 0 (d) $+2MB$

27. A long magnet is cut in two parts in such a way that the ratio of their lengths is 2 : 1. The ratio of pole strengths of both the section is [CPMT 1986]

(a) Equal (b) In the ratio of 2 : 1

(c) In the ratio of 1 : 2 (d) In the ratio of 4 : 1

28. A bar magnet of length 10 *cm* and having the pole strength equal to 10 *weber* is kept in a magnetic field having magnetic induction (*B*) equal to $4\pi \times 10^{-3}$ *Tesla*. It makes an angle of 30 with the direction of magnetic induction. The value of the torque acting on the magnet is

[MP PMT 1993]

(a) $2\pi \times 10^{-7}\ N \times m$ (b) $2\pi \times 10^{-5}\ N \times m$

(c) $0.5 N \times m$ (d) $0.5 \times 10^2\ N \times m$

$(\mu_0 = 4\pi \times 10^{-7}\ weber\ /\ amp \times m)$

29. Magnetic field intensity is defined as [MP PET 1993]

(a) Magnetic moment per unit volume

(b) Magnetic induction force acting on a unit magnetic pole

(c) Number of lines of force crossing per unit area

(d) Number of lines of force crossing per unit volume

30. If the magnetic flux is expressed in *weber*, then magnetic induction can be expressed in

[CPMT 1974, 77, 83, 86, 87; MP PET 1989]

(a) *Weber/m* (b) *Weber/m*

(c) *Weber-m* (d) *Weber-m*

31. A magnetic needle is kept in a non-uniform magnetic field. It experiences [MP PMT 1987; IIT 1982; Kerala PET 2002; AMU 1999; AIEEE 2005]

(a) A force and a torque

(b) A force but not a torque

(c) A torque but not a force

(d) Neither a torque nor a force

32. The magnetic induction in air at a distance *d* from an isolated point pole of strength *m* unit will be [MNR 1987; CPMT 1991; MP PET 1995; AMU 1999; J & K CET 2005]

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

(c) md (d) md^2

33. A magnetic needle lying parallel to a magnetic field requires *W* units of work to turn it through 60°. The torque required to maintain the needle in this position will be

[AIEEE 2003; UPSEAT 2000; BHU 2004; Pb PET 2004]

(a) $\sqrt{3}\,W$ (b) W

(c) $\frac{\sqrt{3}}{2}W$ (d) $2W$

34. A long magnetic needle of length $2L$, magnetic moment *M* and pole strength *m* units is broken into two pieces at the middle. The magnetic moment and pole strength of each piece will be

(a) $\frac{M}{2}, \frac{m}{2}$ (b) $M, \frac{m}{2}$

(c) $\frac{M}{2}, m$ (d) M, m

35. Two identical thin bar magnets each of length *l* and pole strength *m* are placed at right angle to each other with north pole of one touching south pole of the other. Magnetic moment of the system is

(a) ml (b) $2ml$

(c) $\sqrt{2}ml$ (d) $\frac{1}{2}ml$

36. Magnetic induction is a [AFMC 1986]

(a) Scalar quantity (b) Vector quantity

(c) Both (a) and (b) (d) None of the above

37. What happens to the force between magnetic poles when their pole strength and the distance between them are both doubled[CPMT 1978, 80, 84, 8

(a) Force increases to two times the previous value

(b) No change

(c) Force decreases to half the previous value

(d) Force increases to four times the previous value

38. Force between two unit pole strength placed at a distance of one metre is [CPMT 1987]

(a) 1 *N* (b) $\frac{10^{-7}}{4\pi} N$

(c) $10^{-7}\ N$ (d) $4\pi \times 10^{-7} N$

39. A small bar magnet of moment *M* is placed in a uniform field *H*. If magnet makes an angle of 30° with field, the torque acting on the magnet is [CPMT 1989]

(a) MH (b) $\frac{MH}{2}$

(c) $\frac{MH}{3}$ (d) $\frac{MH}{4}$

40. If a hole is made at the centre of a bar magnet, then its magnetic moment will

(a) Increase (b) Decrease

(c) Not change (d) None of these

41. The small magnets each of magnetic moment 10 *A-m* are placed end-on position 0.1*m* apart from their centres. The force acting between them is [MNR 1994]

(a) $0.6 \times 10^7\ N$ (b) $0.06 \times 10^7\ N$

(c) $0.6N$ (d) $0.06N$

42. Magnetic lines of force [MP PET 1994]

(a) Always intersect

(b) Are always closed

(c) Tend to crowd far away from the poles of magnet

(d) Do not pass through vacuum

43. Rate of change of torque τ with deflection θ is maximum for a magnet suspended freely in a uniform magnetic field of induction *B*, when **[MP PET 1994]**

(a) $\theta = 0°$ (b) $\theta = 45°$

(c) $\theta = 60°$ (d) $\theta = 90°$

44. A magnet of magnetic moment *M* is rotated through 360° in a magnetic field *H*, the work done will be **[KCET 1998; MP PMT 1994; Roorkee 2000]**

(a) *MH* (b) 2*MH*

(c) $2\pi MH$ (d) Zero

45. The direction of line of magnetic field of bar magnet is **[AFMC 1995]**

(a) From south pole to north pole

(b) From north pole to south pole

(c) Across the bar magnet

(d) From south pole to north pole inside the magnet and from north pole to south pole outside the magnet

46. The work done in turning a magnet of magnetic moment '*M* by an angle of 90° from the meridian is '*n*' times the corresponding work done to turn it through an angle of 60°, where '*n*' is given by**[CBSE PMT 1995; MP PET 2003]**

(a) 1/2 (b) 2

(c) 1/4 (d) 1

47. Force between two identical bar magnets whose centres are *r metre* apart is 4.8 *N*, when their axes are in the same line. If separation is increased to 2*r*, the force between them is reduced to

(a) 2.4*N* (b) 1.2*N*

(c) 0.6*N* (d) 0.3*N*

48. A bar magnet of magnetic moment 10^{4} *J/T* is free to rotate in a horizontal plane. The work done in rotating the magnet slowly from a direction parallel to a horizontal magnetic field of 4×10^{-5} *T* to a direction 60° from the field will be **[MP PET 1995]**

(a) 0.2 *J* (b) 2.0 *J*

(c) 4.18 *J* (d) 2×10^{2} *J*

49. Magnetic lines of force due to a bar magnet do not intersect because

(a) A point always has a single net magnetic field

(b) The lines have similar charges and so repel each other

(c) The lines always diverge from a single point

(d) The lines need magnetic lenses to be made to intersect

50. The unit of magnetic moment is **[MP PET 1996; AMU 2000; MP PMT 1995, 2002]**

(a) *Wb/m* (b) $Wb.m^2$

(c) *A.m* (d) $A.m^2$

51. The dipole moment of a short bar magnet is 1.25 *A-m*. The magnetic field on its axis at a distance of 0.5 *metre* from the centre of the magnet is

(a) $1.0\times10^{-4}\ Newton/amp-meter$

(b) $4\times10^{-2}\ Newton/amp-metre$

(c) $2\times10^{-6}\ Newton/amp-metre$

(d) $6.64\times10^{-8}\ Newton/amp-metre$

52. A permanent magnet **[MP PET 1996]**

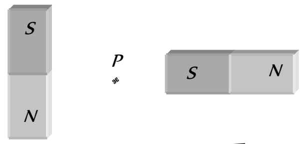
(a) Attracts all substances

(b) Attracts only magnetic substances

(c) Attracts magnetic substances and repels all non-magnetic substances

(d) Attracts non-magnetic substances and repels magnetic substances

53. Two equal bar magnets are kept as shown in the figure. The direction of resultant magnetic field, indicated by arrow head at the point *P* is (approximately)



(a) ⟶ (b) ↗

(c) ↘ (d) ↑

54. The S.I. unit of magnetic permeability is **[MP PET 1997]**

(a) Am^{-1}

(b) Am

(c) $Henry\,m^{-1}$

(d) No unit, it is a dimensionless number

55. A short bar magnet placed with its axis at 30° with a uniform external magnetic field of 0.16 *Tesla* experiences a torque of magnitude 0.032 *Joule*. The magnetic moment of the bar magnet will be **[AIIMS 1995]** **[MP PMT 1997; UPSEAT 2004]**

(a) 0.23 *Joule/Tesla* (b) 0.40 *Joule/Tesla*

(c) 0.80*Joule/Tesla* (d) Zero

56. The magnetic field to a small magnetic dipole of magnetic moment *M*, at distance *r* from the centre on the equatorial line is given by (in M.K.S. system) **[MP PMT/PET 1998]**

(a) $\frac{\mu_0}{4\pi}\times\frac{M}{r^2}$ (b) $\frac{\mu_0}{4\pi}\times\frac{M}{r^3}$

[MP PMT 1995]

(c) $\frac{\mu_0}{4\pi}\times\frac{2M}{r^2}$ (d) $\frac{\mu_0}{4\pi}\times\frac{2M}{r^3}$

57. The incorrect statement regarding the lines of force of the magnetic field *B* is **[MP PET 1999]**

(a) Magnetic intensity is a measure of lines of force passing through unit area held normal to it

(b) Magnetic lines of force form a close curve

(c) Inside a magnet, its magnetic lines of force move from north pole of a magnet towards its south pole

(d) Due to a magnet magnetic lines of force never cut each other

58. A straight wire carrying current *i* is turned into a circular loop. If the magnitude of magnetic moment associated with it in M.K.S. unit is *M*, the length of wire will be **[MP PET 1999]**

(a) $4\pi iM$ (b) $\sqrt{\frac{4\pi M}{i}}$

(c) $\sqrt{\frac{4\pi i}{M}}$ (d) $\frac{M\pi}{4i}$

59. A bar magnet of magnetic moment $\vec{M}$ is placed in a magnetic field of induction $\vec{B}$. The torque exerted on it is

[EAMCET (Engg.) 1995; CBSE PMT 1999; BHU 2003; CPMT 2004; MP PMT 2001, 05]

(a) $\vec{M}.\vec{B}$ (b) $-\vec{M}.\vec{B}$

(c) $\vec{M}\times\vec{B}$ (d) $\vec{B}\times\vec{M}$

60. For protecting a sensitive equipment from the external magnetic field, it should be

[KCET 1993; CBSE PMT 1998]

(a) Placed inside an aluminium cane
(b) Placed inside an iron cane
(c) Wrapped with insulation around it when passing current through it
(d) Surrounded with fine copper sheet

61. If a piece of metal was thought to be magnet, which one of the following observations would offer conclusive evidence

[KCET 1994]

(a) It attracts a known magnet
(b) It repels a known magnet
(c) Neither (a) nor (b)
(d) It attracts a steel screw driver

62. The magnet can be completely demagnetized by

[KCET 1994]

(a) Breaking the magnet into small pieces
(b) Heating it slightly
(c) Droping it into ice cold water
(d) A reverse field of appropriate strength

63. A current loop placed in a magnetic field behaves like a

[AFMC 1994]

(a) Magnetic dipole (b) Magnetic substance
(c) Magnetic pole (d) All are true

64. A magnet when placed perpendicular to a uniform field of strength $10^{-4}\,Wb/m^2$ experiences a maximum couple of moment $4\times10^{-5}\,N/m.$. What is its magnetic moment

[Bihar MEE 1995]

(a) $0.4A\times m^2$ (b) $0.2A\times m^2$
(c) $0.16A\times m^2$ (d) $0.04A\times m^2$
(e) $0.06A\times m^2$

65. *Weber/m* is equal to [CPMT 1985; AFMC 1997]

(a) *Volt* (b) *Henry*
(c) *Tesla* (d) All of these

66. Two magnets, each of magnetic moment '*M* are placed so as to form a cross at right angles to each other. The magnetic moment of the system will be

[AFMC 1999; Pb PET 2001]

(a) 2 *M* (b) $\sqrt{2}\,M$
(c) 0.5 *M* (d) *M*

67. Two like magnetic poles of strength 10 and 40 SI units are separated by a distance 30 *cm*. The intensity of magnetic field is zero on the line joining them [JIPMER 1999]

(a) At a point 10 *cm* from the stronger pole
(b) At a point 20 *cm* from the stronger pole
(c) At the mid-point
(d) At infinity

68. If a magnet of length 10 *cm* and pole strength 40 *A-m* is placed at an angle of 45° in an uniform induction field of intensity 2×10^{-4} *T*, the couple acting on it is

[Pb. PMT 1999; MH CET (Med.) 1999]

(a) 0.5656×10^{-4} *N-m* (b) 0.5656×10^{-3} *N-m*
(c) 0.656×10^{-4} *N-m* (d) 0.656×10^{-5} *N-m*

69. The intensity of magnetic field is *H* and moment of magnet is *M*. The maximum potential energy is

[Pb. PMT 1999; MH CET (Med.) 1999]

(a) *MH* (b) 2 *MH*
(c) 3 *MH* (d) 4 *MH*

70. A bar magnet of magnetic moment 200 *A-m* is suspended in a magnetic field of intensity 0.25 *N/A-m*. The couple required to deflect it through 30° is

[AFMC 1999; Pb. PET 2000]

(a) 50 *N-m* (b) 25 *N-m*
(c) 20 *N-m* (d) 15 *N-m*

71. Two similar bar magnets *P* and *Q*, each of magnetic moment *M*, are taken, If *P* is cut along its axial line and *Q* is cut along its equatorial line, all the four pieces obtained have [EAMCET (Engg.) 2000]

(a) Equal pole strength (b) Magnetic moment $\frac{M}{4}$

(c) Magnetic moment $\frac{M}{2}$ (d) Magnetic moment *M*

72. A magnet of magnetic moment $50\,\hat{i}\;A\text{-}m^2$ is placed along the *x*-axis in a magnetic field $\vec{B}=(0.5\,\hat{i}+3.0\hat{j})T$. The torque acting on the magnet is

[MP PMT 2000]

(a) 175 $\hat{k}\;N\text{-}m$ (b) 150 $\hat{k}\;N\text{-}m$

(c) 75 $\hat{k}\;N\text{-}m$ (d) $25\sqrt{37}\,\hat{k}\;N\text{-}m$

73. A bar magnet is held perpendicular to a uniform magnetic field. If the couple acting on the magnet is to be halved by rotating it, then the angle by which it is to be rotated is

[CBSE PMT 2000]

(a) 30° (b) 45°
(c) 60° (d) 90°

74. There is no couple acting when two bar magnets are placed coaxially separated by a distance because

[EAMCET (Engg.) 2000]

(a) There are no forces on the poles
(b) The forces are parallel and their lines of action do not coincide
(c) The forces are perpendicular to each other
(d) The forces act along the same line

75. A bar magnet of magnetic moment 3.0 *A-m* is placed in a uniform magnetic induction field of 2×10^{-5} *T*. If each pole of the

magnet experiences a force of 6×10^{-4} N, the length of the magnet is [EAMCET (Med.) 2000]

(a) 0.5 m (b) 0.3 m

(c) 0.2 m (d) 0.1 m

76. A bar magnet when placed at an angle of 30° to the direction of magnetic field induction of 5×10^{-2} T, experiences a moment of couple 25×10^{-6} N-m. If the length of the magnet is 5 cm its pole strength is

[EAMCET (Med.) 2000]

(a) 2×10^{-2} A-m (b) 5×10^{-2} A-m

(c) 2 A-m (d) 5 A-m

77. Two lines of force due to a bar magnet [MP PMT 2002]

(a) Intersect at the neutral point

(b) Intersect near the poles of the magnet

(c) Intersect on the equatorial axis of the magnet

(d) Do not intersect at all

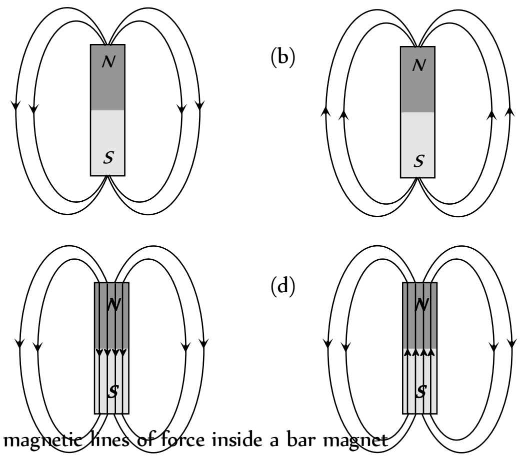
78. The ultimate individual unit of magnetism in any magnet is called [MP PET 2002; J & K CET 2004]

(a) North pole (b) South pole

(c) Dipole (d) Quadrupole

79. The magnetic field lines due to a bar magnet are correctly shown in [IIT-JEE (Screening) 2002]

(a) (b) (c) (d)



80. The magnetic lines of force inside a bar magnet

[AIEEE 2003]

(a) Are from south-pole to north-pole of the magnet

(b) Are from north-pole to south-pole of the magnet

(c) Do not exist

(d) Depend upon the area of cross-section of the bar magnet

81. If a magnet is hanged with its magnetic axis then it stops in

[AFMC 2003]

(a) Magnetic meridian (b) Geometric meridian

(c) Angle of dip (d) None of these

82. The work done in rotating a magnet of magnetic moment 2 A-m in a magnetic field of 5×10^{-3} T from the direction along the magnetic field to opposite direction to the magnetic field, is

(a) Zero (b) 2×10^{-2} J

(c) 10^{-2} J (d) 10 J

83. The torque on a bar magnet due to the earth's magnetic field is maximum when the axis of the magnet is

[MP PMT 2004]

(a) Perpendicular to the field of the earth

(b) Parallel to the vertical component of the earth's field

(c) At an angle of 33° with respect to the N-S direction

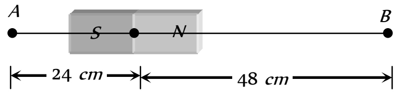
(d) Along the North-South (N-S) direction

84. Magnetic dipole moment is a [AFMC 2004]

(a) Scalar quantity (b) Vector quantity

(c) Constant quantity (d) None of these

85. A bar magnet of length 3 cm has points A and B along its axis at distances of 24 cm and 48 cm on the opposite sides. Ratio of magnetic fields at these points will be [DPMT 2004]



(a) 8 (b) $1/2\sqrt{2}$

(c) 3 (d) 4

86. A magnet of magnetic moment $2\ J\,T^{-1}$ is aligned in the direction of magnetic field of 0.1 T. What is the net work done to bring the magnet normal to the magnetic field

[DCE 2004]

(a) 0.1 J (b) 0.2 J

(c) 1 J (d) 2 J

87. The magnetic moment of a magnet of length 10 cm and pole strength 4.0 Am will be [DPMT 2003]

(a) $0.4\ Am^2$ (b) $1.6\ Am^2$

(c) $20\ Am^2$ (d) $8.0\ Am^2$

88. The effective length of a magnet is 31.4 cm and its pole strength is 0.5 Am. The magnetic moment, if it is bent in the form of a semicircle will be [DPMT 2003]

(a) $0.1\ Am^2$ (b) $0.01\ Am^2$

(c) $0.2\ Am^2$ (d) $1.2\ Am^2$

89. The magnetic potential at a point on the axial line of a bar magnet of dipole moment M is V. What is the magnetic potential due to a bar magnet of dipole moment $\frac{M}{4}$ at the same point

(a) $4V$ (b) $2V$

(c) $\frac{V}{2}$ (d) $\frac{V}{4}$

90. A small bar magnet has a magnetic moment 1.2 A-m. The magnetic field at a distance 0.1 m on its axis will be : ($\mu_0 = 4\pi \times 10^{-7}$ T-m/A) [MP PET 2003]

(a) 1.2×10^{-4} T (b) 2.4×10^{-4} T

(c) 2.4×10^{4} T (d) 1.2×10^{4} T

91. Two identical short bar magnets, each having magnetic moment of 10 Am, are arranged such that their axial lines are perpendicular to each other and their centres be along the same straight line in a horizontal plane. If the distance between their centres is 0.2 m, the resultant magnetic induction at a point midway between them is

$(\mu_0 = 4\pi \times 10^{-7} Hm^{-1})$ [EAMCET 2005]

(a) $\sqrt{2} \times 10^{-7}$ *Tesla* (b) $\sqrt{5} \times 10^{-7}$ *Tesla*

(c) $\sqrt{2} \times 10^{-3}$ *Tesla* (d) $\sqrt{5} \times 10^{-3}$ *Tesla*

92. A magnet of length 0.1 *m* and pole strength $10^{-4} A.m.$ is kept in a magnetic field of $30\, Wb/m^2$ at an angle 30°. The couple acting on it is .... $\times 10^{-4}\, Nm$. [MP PET 2005]

(a) 7.5 (b) 3.0

(c) 1.5 (d) 6.0

Earth Magnetism

1. A very small magnet is placed in the magnetic meridian with its south pole pointing north. The null point is obtained 20 *cm* away from the centre of the magnet. If the earth's magnetic field (horizontal component) at this point be 0.3 *gauss*, the magnetic moment of the magnet is

[CPMT 1987; MNR 1978]

(a) $8.0 \times 10^2\, e.m.u.$ (b) $1.2 \times 10^3\, e.m.u.$

(c) $2.4 \times 10^3\, e.m.u.$ (d) $3.6 \times 10^3\, e.m.u.$

2. Intensity of magnetic field due to earth at a point inside a hollow steel box is [MP PET 1995]

(a) Less than outside (b) More than outside

(c) Same (d) Zero

3. Earth's magnetic field always has a horizontal component except at or Horizontal component of earth's magnetic field remains zero at

(a) Equator (b) Magnetic poles

(c) A latitude of 60° (d) An altitude of 60°

4. A dip needle in a plane perpendicular to magnetic meridian will remain [NCERT 1975; MP PMT 1984; MP PET 1995]

(a) Vertical

(b) Horizontal

(c) In any direction

(d) At an angle of dip to the horizontal

5. At magnetic poles of earth, angle of dip is

[CPMT 1977, 91; NCERT 1981; MP PET 1997; Pb PET 2002]

(a) Zero (b) 45°

(c) 90° (d) 180°

6. The correct relation is

[CPMT 1986; MP PET 1981; AFMC 1996]

(a) $\boldsymbol{B} = \dfrac{B_V}{B_H}$ (b) $\boldsymbol{B} = B_V \times B_H$

(c) $|\boldsymbol{B}| = \sqrt{B_H^2 + B_V^2}$ (d) $\boldsymbol{B} = B_H + B_V$

(Where B_H = Horizontal component of earth's magnetic field; B_V = Vertical component of earth's magnetic field and B = Total intensity of earth's magnetic field)

7. At a certain place, the horizontal component of earth's magnetic field is $\sqrt{3}$ times the vertical component. The angle of dip at that place is [MP PMT 1984, 85; AFMC 2000]

(a) 60° (b) 45°

(c) 90° (d) 30°

8. The vertical component of earth's magnetic field is zero at or The earth's magnetic field always has a vertical component except at the

[NCERT 1980, 88; CPMT 1983; MP PMT 1996]

(a) Magnetic poles (b) Geographical poles

(c) Every place (d) Magnetic equator

9. The angle between the magnetic meridian and geographical meridian is called

[MNR 1990; UPSEAT 1999, 2000; MP PMT 2000]

(a) Angle of dip (b) Angle of declination

(c) Magnetic moment (d) Power of magnetic field

10. The lines of forces due to earth's horizontal component of magnetic field are

[CPMT 1985; MP PMT 1980; AIIMS 1998]

(a) Parallel straight lines (b) Concentric circles

(c) Elliptical (d) Parabolic

11. At a place, if the earth's horizontal and vertical components of magnetic fields are equal, then the angle of dip will be

[SCRA 1994; DCE 2001; MP PMT 2002]

(a) 30° (b) 90°

(c) 45° (d) 0°

[CPMT 1971, 81, 83]

12. If the angles of dip at two places are 30° and 45° respectively, then the ratio of horizontal components of earth's magnetic field at the two places will be [MP PET 1989]

(a) $\sqrt{3} : \sqrt{2}$ (b) $1 : \sqrt{2}$

(c) $1 : \sqrt{3}$ (d) $1 : 2$

13. At a place the earth's horizontal component of magnetic field is $0.36 \times 10^{-4}\, weber/m^2$. If the angle of dip at that place is 60°, then the vertical component of earth's field at that place in *weber/m* will be approximately [MP PMT 1985]

(a) 0.12×10^{-4} (b) 0.24×10^{-4}

(c) 0.40×10^{-4} (d) 0.62×10^{-4}

14. The angle of dip at a place is 40.6° and the intensity of the vertical component of the earth's magnetic field $V = 6 \times 10^{-5}$ *Tesla*. The total intensity of the earth's magnetic field (*I*) at this place is

(a) $7 \times 10^{-5}\, tesla$ (b) $6 \times 10^{-5}\, tesla$

(c) $5 \times 10^{-5}\, tesla$ (d) $9.2 \times 10^{-5}\, tesla$

15. The angle of dip is the angle [CPMT 1978]

(a) Between the vertical component of earth's magnetic field and magnetic meridian

(b) Between the vertical component of earth's magnetic field and geographical meridian

(c) Between the earth's magnetic field direction and horizontal direction

(d) Between the magnetic meridian and the geographical meridian

16. At a certain place the angle of dip is 30° and the horizontal component of earth's magnetic field is 0.50 *Oersted*. The earth's total magnetic field is [CPMT 1990]

(a) $\sqrt{3}$ (b) 1

(c) $\frac{1}{\sqrt{3}}$ (d) $\frac{1}{2}$

17. The angle of dip at the magnetic equator is

[MP PET 1984; MP PMT 1987; CBSE PMT 1989, 90; MP Board 1980; CPMT 1977, 87, 90; Manipal MEE 1995]

(a) 0° (b) 45°

(c) 30° (d) 90°

18. The line on the earth's surface joining the points where the field is horizontal is

[MNR 1985; UPSEAT 1999; Pb PET 2004]

(a) Magnetic meridian (b) Magnetic axis

(c) Magnetic line (d) Magnetic equator

(e) Isogonic line

19. The angle between the earth's magnetic and the earth's geographical axes is [MNR 1979]

(a) Zero (b) 17°

(c) 23° (d) None of these

20. The lines joining the places of the same horizontal intensity are known as [MNR 1984]

(a) Isogonic lines (b) Aclinic lines

(c) Isoclinic lines (d) Agonic lines

(e) Isodynamic lines

21. Ratio between total intensity of magnetic field at equator to poles is

(a) 1 : 1 (b) 1 : 2

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

22. A line passing through places having zero value of magnetic dip is called [CPMT 1987]

(a) Isoclinic line (b) Agonic line

(c) Isogonic line (d) Aclinic line

23. At a place, the horizontal and vertical intensities of earth's magnetic field is 0.30 *Gauss* and 0.173 *Gauss* respectively. The angle of dip at this place is [MP PMT 1986]

(a) 30° (b) 90°

(c) 60° (d) 45°

24. The angle of dip at a place is 60°. At this place the total intensity of earth's magnetic field is 0.64 units. The horizontal intensity of earth's magnetic field at this place is

[MP PET 1984]

(a) 1.28 units (b) 0.64 units

(c) 0.16 units (d) 0.32 units

25. The magnetic compass is not useful for navigation near the magnetic poles because [BIT Ranchi 1982]

(a) The magnetic field near the poles is zero

(b) The magnetic field near the poles is almost vertical

(c) At low temperature, the compass needle looses its magnetic properties

(d) Neither of the above

26. The angle of dip at a place on the earth gives

[MP PET 1994]

(a) The horizontal component of the earth's magnetic field

(b) The location of the geographic meridian

(c) The vertical component of the earth's field

(d) The direction of the earth's magnetic field

27. At the magnetic north pole of the earth, the value of horizontal component of earth's magnetic field and angle of dip are, respectively [MP PMT 1994]

(a) Zero, maximum (b) Maximum, minimum

(c) Maximum, maximum (d) Minimum, minimum

28. At a place, the magnitudes of the horizontal component and total intensity of the magnetic field of the earth are 0.3 and 0.6 *Oersted* respectively. The value of the angle of dip at this place will be

(a) 60° (b) 45°

(c) 30° (d) 0°

29. A dip circle is at right angle to the magnetic meridian. What will be the apparent dip [AFMC 1995]

(a) 0° (b) 30°

(c) 60° (d) 90°

30. A bar magnet is placed north-south with its north pole due north. The points of zero magnetic field will be in which direction from the centre of the magnet

[MNR 1995; MP PMT 1995; UPSEAT 2000]

(a) North and south

(b) East and west

(c) North-east and south-west

(d) North-west and south-east [IIT 1970; CPMT 1981]

31. In two separate experiments the neutral points due to two small magnets are at a distance of r and $2r$ in broad side-on position. The ratio of their magnetic moments will be

(a) 4 : 1 (b) 1 : 2

(c) 2 : 1 (d) 1 : 8

32. The magnetic field due to the earth is closely equivalent to that due to [BIT Ranchi 1982]

(a) A large magnet of length equal to the diameter of the earth

(b) A magnetic dipole placed at the centre of the earth

(c) A large coil carrying current

(d) Neither of the above

33. The earth's magnetic field at a certain place has a horizontal component 0.3 *Gauss* and the total strength 0.5 *Gauss*. The angle of dip is [MP PMT 1995]

(a) $\tan^{-1}\frac{3}{4}$ (b) $\sin^{-1}\frac{3}{4}$

(c) $\tan^{-1}\frac{4}{3}$ (d) $\sin^{-1}\frac{3}{5}$

34. The value of the horizontal component of the earth's magnetic field and angle of dip are $1.8\times10^{-5}\,Weber/m^2$ and 30° respectively at some place. The total intensity of earth's magnetic field at that place will be [MP PET 1996]

(a) $2.08\times10^{-5}\,Weber/m^2$ (b) $3.67\times10^{-5}\,Weber/m^2$

(c) $3.18\times10^{-5}Weber/m^2$ (d) $5.0\times10^{-5}Weber/m^2$

35. When the *N*-pole of a bar magnet points towards the south and *S*-pole towards the north, the null points are at the [MP PMT 1996]

(a) Magnetic axis
(b) Magnetic centre
(c) Perpendicular divider of magnetic axis
(d) *N* and *S* poles

36. Lines which represent places of constant angle of dip are called

(a) Isobaric lines (b) Isogonic lines
(c) Isoclinic lines (d) Isodynamic lines

37. The vertical component of the earth's magnetic field is zero at a place where the angle of dip is [MP PMT/PET 1998]

(a) 0° (b) 45°
(c) 60° (d) 90°

38. At a certain place, the horizontal component B_0 and the vertical component V_0 of the earth's magnetic field are equal in magnitude. The total intensity at the place will be [MP PMT 1999, 2003]

(a) B_0 (b) B_0^2
(c) $2B_0$ (d) $\sqrt{2}B_0$

39. A compass needle will show which one of the following directions at the earth's magnetic pole [KCET 1993, 94]

(a) Vertical (b) No particular direction
(c) Bent at 45° to the vertical (d) Horizontal

40. The north pole of the earth's magnet is near the geographical

(a) South (b) East
(c) West (d) North

41. The magnetic field of earth is due to [JIPMER 1997]

(a) Motion and distribution of some material in and outside the earth
(b) Interaction of cosmic rays with the current of earth
(c) A magnetic dipole buried at the centre of the earth
(d) Induction effect of the sun

42. A short magnet of moment 6.75 *Am* produces a neutral point on its axis. If horizontal component of earth's magnetic field is $5\times10^{-5}Wb/m^2$, then the distance of the neutral point should be

(a) 10 *cm* (b) 20 *cm*
(c) 30 *cm* (d) 40 *cm*

43. Due to the earth's magnetic field, charged cosmic ray particles

(a) Require greater kinetic energy to reach the equator than the poles
(b) Require less kinetic energy to reach the equator than the poles
(c) Can never reach the equator
(d) Can never reach the poles

44. Two bar magnets with magnetic moments 2 *M* and *M* are fastened together at right angles to each other at their centres to form a crossed system, which can rotate freely about a vertical axis through the centre. The crossed system sets in earth's magnetic field with magnet having magnetic moment 2*M* making and angle θ with the magnetic meridian such that [AFMC 1999]

(a) $\theta=\tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$ (b) $\theta=\tan^{-1}\left(\sqrt{3}\right)$
(c) $\theta=\tan^{-1}\left(\frac{1}{2}\right)$ (d) $\theta=\tan^{-1}\left(\frac{3}{4}\right)$

45. Angle of dip is 90° at [AIIMS 1999]

(a) Poles (b) Equator
(c) Both (a) and (b) (d) None of these

46. At a certain place the horizontal component of the earth's magnetic field is B_0 and the angle of dip is 45°. The total intensity of the field at that place will be [MP PET 2000; Pb PET 2003]

(a) B_0 (b) $\sqrt{2}\,B_0$
(c) $2\,B_0$ (d) B_0^2

47. The value of angle of dip is zero at the magnetic equator because on it [MP PET 2001]

(a) *V* and *H* are equal
(b) The value of *V* and *H* is zero
(c) The value of *V* is zero
(d) The value of *H* is zero

48. Which of the following relation is correct in magnetism [KCET (Engg./Med.) 2001]

(a) $I^2=V^2+H^2$ (b) $I=V+H$
(c) $V=I^2+H^2$ (d) $V^2=I+H$

49. The direction of the null points is on the equatorial line of a bar magnet, when the north pole of the magnet is pointing [KCET 1994] [AFMC 1999; Pb. PMT 2000; CPMT 2001; MH CET 2003]

(a) North (b) South
(c) East (d) West

50. Magnetic meridian is a [Orissa JEE 2002]

(a) Point (b) Horizontal plane
(c) Vertical plane (d) Line along *N-S*

51. The angle of dip at a certain place is 30°. If the horizontal component of the earth's magnetic field is *H*, the intensity of the total magnetic field is [SCRA 1994] [UPSEAT 1993, 2000; MP PMT 2002]

(a) $\frac{H}{2}$ [CBSE PMT 1997] (b) $\frac{2H}{\sqrt{3}}$
(c) $H\sqrt{2}$ (d) $H\sqrt{3}$

52. The horizontal component of the earth's magnetic field is 0.22 *Gauss* and total magnetic field is 0.4 *Gauss*. The angle of dip. is

(a) $\tan^{-1}(1)$ (b) $\tan^{-1}(\infty)$
(c) $\tan^{-1}(1.518)$ (d) $\tan^{-1}(\pi)$

53. A bar magnet is situated on a table along east-west direction in the magnetic field of earth. The number of neutral points, where the magnetic field is zero, are [MP PMT 2004]

(a) 2 (b) 0
(c) 1 (d) 4

54. At which place, earth's magnetism become horizontal

[AFMC 2004]

(a) Magnetic pole (b) Geographical pole

(c) Magnetic meridian (d) Magnetic equator

55. Isogonic lines on magnetic map will have [AFMC 2004]

(a) Zero angle of dip

(b) Zero angle of declination

(c) Same angle of declination

(d) Same angle of dip

56. A current carrying coil is placed with its axis perpendicular to *N-S* direction. Let horizontal component of earth's magnetic field be H_0 and magnetic field inside the loop is *H*. If a magnet is suspended inside the loop, it makes angle θ with *H*. Then θ =

(a) $\tan^{-1}\left(\frac{H_0}{H}\right)$ (b) $\tan^{-1}\left(\frac{H}{H_0}\right)$

(c) $\text{cosec}^{-1}\left(\frac{H}{H_0}\right)$ (d) $\cot^{-1}\left(\frac{H_0}{H}\right)$

57. Let *V* and *H* be the vertical and horizontal components of earth's magnetic field at any point on earth. Near the north pole

(a) $V >> H$ (b) $V << H$

(c) $V = H$ (d) $V = H = 0$

58. At the magnetic poles of the earth, a compass needle will be

[DCE 2003]

(a) Vertical

(b) Bent slightly

(c) Horizontal

(d) Inclined at 45° to the horizontal

59. If magnetic lines of force are drawn by keeping magnet vertical, then number of neutral points will be

[MP PMT 1985; CPMT 1985]

(a) One (b) Two

(c) Four (d) Five

Magnetic Equipments

1. Time period of a freely suspended magnet does not depend upon [NCERT 1980; CPMT 1986; MP PET 1997]

(a) Length of the magnet

(b) Pole strength of the magnet

(c) Horizontal component of earth's magnetic field

(d) Length of the suspension thread

2. Magnetic moments of two bar magnets may be compared with the help of [MP PET/PMT 1988]

(a) Deflection magnetometer

(b) Vibration magnetometer

(c) Both of the above

(d) None of the above

3. The time period of oscillation of a freely suspended bar magnet with usual notations is given by

[CPMT 1973, 76, 87; MP PET 1994, 96]

(a) $T = 2\pi\sqrt{\frac{I}{MB_H}}$ (b) $T = 2\pi\sqrt{\frac{MB_H}{I}}$

(c) $T = \sqrt{\frac{I}{MB_H}}$ (d) $T = 2\pi\sqrt{\frac{B_H}{MI}}$

4. In sum and difference method in vibration magnetometer, the time period is more if

[MP PMT 1989; MP PET/PMT 1988]

(a) Similar poles of both magnets are on same sides

(b) Opposite poles of both magnets are on same sides

(c) Both magnets are perpendicular to each other

(d) Nothing can be said [Orissa PMT 2004]

5. At a certain place a magnet makes 30 oscillations per minute. At another place where the magnetic field is double, its time period will be

[MP PMT 1989; MP PET/PMT 1988]

(a) 4 *sec* (b) 2 *sec*

(c) $\frac{1}{2}$ sec (d) $\sqrt{2}$ sec

6. Vibration magnetometer is used for comparing [UPSEAT 2004]

[MP PET/PMT 1988]

(a) Magnetic fields (b) Earth's field

(c) Magnetic moments (d) All of the above

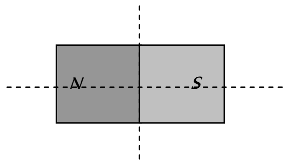
7. Two magnets of same size and mass make respectively 10 and 15 *oscillations per minute* at certain place. The ratio of their magnetic moments is

[Bihar PET 1984; MP PET/PMT 1988; MP PET 1992]

(a) 4 : 9 (b) 9 : 4

(c) 2 : 3 (d) 3 : 2

8. Time period for a magnet is *T*. If it is divided in four equal parts along its axis and perpendicular to its axis as shown then time period for each part will be



(a) $4T$ (b) $T/4$

(c) $T/2$ (d) T

9. Keeping dissimilar poles of two magnets of equal pole strength and length same side, their time period will be

[DPMT 2001]

(a) Zero (b) One second

(c) Infinity (d) Any value

10. Time period in vibration magnetometer will be infinity at

(a) Magnetic equator (b) Magnetic poles

(c) Equator (d) At all places

11. Twists of suspension fibre should be removed in vibration magnetometer so that

(a) Time period be less

(b) Time period be more

(c) Magnet may vibrate freely

(d) Cannot be said with certainty

12. The period of oscillation of a magnet in vibration magnetometer is 2 sec. The period of oscillation of a magnet whose magnetic moment is four times that of the first magnet is[CPMT 1975, 77, 79, 89, 90; MP PMT 1986]

(a) 1 *sec* (b) 4 *sec*

(c) 8 *sec* (d) 0.5 *sec*

13. Moment of inertia of a magnetic needle is 40 *gm-cm* has time period 3 *seconds* in earth's horizontal field = 3.6×10^{-5} *weber/m*. Its magnetic moment will be

(a) $0.5\,A\times m^2$ (b) $5\,A\times m^2$

(c) $0.250\,A\times m^2$ (d) $5\times10^2\,A\times m^2$

14. Vibration magnetometer before use, should be set

(a) In magnetic meridian

(b) In geographical meridian

(c) Perpendicular to magnetic meridian

(d) In any position

15. If a brass bar is placed on a vibrating magnet, then its time period

(a) Decreases

(b) Increases

(c) Remains unchanged

(d) First increases then decreases

16. A magnetic needle is made to vibrate in uniform field *H*, then its time period is *T*. If it vibrates in the field of intensity 4*H*, its time period will be

[MP Board 1988; MP PMT 1992; MH CET (Med.) 1999]

(a) $2T$ (b) $T/2$

(c) $2/T$ (d) T

17. Two bar magnets of the same mass, length and breadth but magnetic moments *M* and 2*M* respectively, when placed in same position, time period is 3 *sec*. What will be the time period when they are placed in different position

[NCERT 1977; DPMT 1999]

(a) $\sqrt{3}$ sec (b) $3\sqrt{3}$ sec

(c) 3 sec (d) 6 sec

18. To compare magnetic moments of two magnets by vibration magnetometer, 'sum and difference method' is better because

(a) Determination of moment of inertia is not needed which minimises the errors

(b) Less observations are required

(c) Comparatively less calculations

(d) All the above

19. A magnet is suspended in such a way that it oscillates in the horizontal plane. It makes 20 *oscillations per minute* at a place where dip angle is 30° and 15 *oscillations per minute* at a place where dip angle is 60°. The ratio of total earth's magnetic field at the two places is

[MP PMT 1991; BHU 1997]

(a) $3\sqrt{3}:8$ (b) $16:9\sqrt{3}$

(c) $4:9$ (d) $2\sqrt{3}:9$

20. The time period of oscillation of a magnet in a vibration magnetometer is 1.5 *seconds*. The time period of oscillation of another magnet similar in size, shape and mass but having one-fourth magnetic moment than that of first magnet, oscillating at same place will be

[MP PMT 1991; MP PMT 2002]

(a) 0.75 *sec* (b) 1.5 *sec*

(c) 3 *sec* (d) 6 *sec*

21. A bar magnet *A* of magnetic moment M_A is found to oscillate at a frequency twice that of magnet *B* of magnetic moment M_B when placed in a vibrating *magneto-meter*. We may say that

(a) $M_A = 2M_B$ (b) $M_A = 8M_B$

(c) $M_A = 4M_B$ (d) $M_B = 8M_A$

22. Two magnets *A* and *B* are identical in mass, length and breadth but have different magnetic moments. In a vibration magnetometer, if the time period of *B* is twice the time period of *A*. The ratio of the magnetic moments M_A/M_B of the magnets will be [MP PET 1990; MP PMT 19

(a) $1/2$ (b) 2

(c) 4 (d) $1/4$

23. A magnet of magnetic moment *M* oscillating freely in earth's horizontal magnetic field makes *n* oscillations per minute. If the magnetic moment is quadrupled and the earth's field is doubled, the number of oscillations made per minute would be

(a) $\frac{n}{2\sqrt{2}}$ (b) $\frac{n}{\sqrt{2}}$

(c) $2\sqrt{2}n$ (d) $\sqrt{2}n$

24. A magnetic needle suspended horizontally by an unspun silk fibre, oscillates in the horizontal plane because of the restoring force originating mainly from [CPMT 1980, 89]

(a) The torsion of the silk fibre

(b) The force of gravity

(c) The horizontal component of earth's magnetic field

(d) All the above factors

25. At two places *A* and *B* using vibration magnetometer, a magnet vibrates in a horizontal plane and its respective periodic time are 2 *sec* and 3 *sec* and at these places the earth's horizontal components are H_A and H_B respectively. Then the ratio between H_A and H_B will be

[MP PMT 1985, 89]

(a) 9 : 4 (b) 3 : 2

(c) 4 : 9 (d) 2 : 3

26. The time period of a bar magnet suspended horizontally in the earth's magnetic field and allowed to oscillate

[MP PET 1992]

(a) Is directly proportional to the square root of its mass

(b) Is directly proportional to its pole strength

(c) Is inversely proportional to its magnetic moment

(d) Decreases if the length increases but pole strength remains same

27. Magnets *A* and *B* are geometrically similar but the magnetic moment of *A* is twice that of *B*. If T_1 and T_2 be the time periods of the oscillation when their like poles and unlike poles are kept together respectively, then $\frac{T_1}{T_2}$ will be

[SCRA 1998]

(a) $\frac{1}{3}$ (b) $\frac{1}{2}$

(c) $\frac{1}{\sqrt{3}}$ (d) $\sqrt{3}$

28. A small bar magnet *A* oscillates in a horizontal plane with a period *T* at a place where the angle of dip is 60°. When the same needle is made to oscillate in a vertical plane coinciding with the magnetic meridian, its period will be

[MP PMT 1992]

(a) $\frac{T}{\sqrt{2}}$ (b) T

(c) $\sqrt{2}T$ (d) $2T$

29. Vibration magnetometer works on the principle of [MP PET 1993]

(a) Torque acting on the bar magnet
(b) Force acting on the bar magnet
(c) Both the force and the torque acting on the bar magnet
(d) None of these

30. Tangent galvanometer is used to measure [MP PET 1993]

(a) Steady currents
(b) Current impulses
(c) Magnetic moments of bar magnets
(d) Earth's magnetic field

31. A tangent galvanometer has a coil with 50 turns and radius equal to 4 *cm*. A current of 0.1 *A* is passing through it. The plane of the coil is set parallel to the earth's magnetic meridian. If the value of the earth's horizontal component of the magnetic field is 7×10^{-5} *tesla* and $\mu_0 = 4\pi\times10^{-7} weber / amp \times m$, then the deflection in the galvanometer needle will be [MP PMT 1993]

(a) 45° (b) 48.2°
(c) 50.7° (d) 52.7°

32. A bar magnet has a magnetic moment equal to $5\times10^{-5} weber \times m$. It is suspended in a magnetic field which has a magnetic induction (*B*) equal to $8\pi\times10^{-4} tesla$ The magnet vibrates with a period of vibration equal to 15 *sec*. The moment of inertia of the magnet is

[MP PMT 1993; CBSE PMT 2001]

(a) $22.5 kg\times m^2$ (b) $11.25\times kg\times m^2$

(c) $5.62\times kg\times m^2$ (d) $7.16\times10^{-7} kg - m^2$

33. The time period of a freely suspended magnet is 4 *seconds*. If it is broken in length into two equal parts and one part is suspended in the same way, then its time period will be

[NCERT 1984; CPMT 1991; MP PMT 1994; MH CET 2004]

(a) 4 *sec* (b) 2 *sec*

(c) 0.5 *sec* (d) 0.25 *sec*

34. Which of the following statement is true about magnetic moments of atoms of different elements [CPMT 1977]

(a) All have a magnetic moment
(b) None has a magnetic moment
(c) All acquire a magnetic moment under external magnetic field and in same direction as the field
(d) None of the above statements are accurate

35. The number of turns and radius of cross-section of the coil of a tangent galvanometer are doubled. The reduction factor *K* will be [NCERT 1983; MP PMT 2002]

(a) *K* (b) 2*K*

(c) 4*K* (d) *K*/4

36. A magnetic needle suspended by a silk thread is vibrating in the earth's magnetic field. If the temperature of the needle is increased by 500°*C*, then [MNR 1994]

(a) The time period decreases
(b) The time period remains unchanged
(c) The time period increases
(d) The needle stops vibrating

37. The sensitivity of a tangent galvanometer is increased if [AFMC 1995]

(a) Number of turn decreases (b) Number of turn increases
(c) Field increases (d) None of the above

38. Two tangent galvanometers having coils of the same radius are connected in series. A current flowing in them produces deflections of 60° and 45° respectively. The ratio of the number of turns in the coils is

[MP PET 1995; MP PMT 1999]

(a) 4/3 (b) $(\sqrt{3}+1)/1$

(c) $(\sqrt{3}+1)/(\sqrt{3}-1)$ (d) $\sqrt{3}/1$

39. Using a bar magnet *P*, a vibration magnetometer has time period 2*seconds*. When a bar *Q* (identical to *P* in mass and size) is placed on top of *P*, the time period is unchanged. Which of the following statements is true [MP PMT 1995]

(a) *Q* is of non-magnetic material
(b) *Q* is a bar magnet identical to *P*, and its north pole placed on top of *P*'s north pole
(c) *Q* is of unmagnetized ferromagnetic material
(d) Nothing can be said about *Q*'s properties

40. The strength of the magnetic field in which the magnet of a vibration magnetometer is oscillating is increased 4 times its original value. The frequency of oscillation would then become

(a) Twice its original value
(b) Four times its original value
(c) Half its original value
(d) One-fourth its original value

41. A certain amount of current when flowing in a properly set tangent galvanometer, produces a deflection of 45°. If the current be reduced by a factor of $\sqrt{3}$, the deflection would

[MP PMT 1996; DPMT 2005]

(a) Decrease by 30° (b) Decrease by 15°
(c) Increase by 15° (d) Increase by 30°

42. Two normal uniform magnetic field contain a magnetic needle making an angle 60° with *F*. Then the ratio of $\frac{F}{H}$ is

[CPMT 1987; DPMT 2001]

(a) 1 : 2 (b) 2 : 1

(c) $\sqrt{3}:1$ (d) $1:\sqrt{3}$

43. A short magnetic needle is pivoted in a uniform magnetic field of strength 1 *T*. When another magnetic field of strength $\sqrt{3}\,T$ is applied to the needle in a perpendicular direction, the needle deflects through an angle θ, where θ is

[KCET 1999]

(a) 30° (b) 45°
(c) 90° (d) 60°

44. Two magnets are held together in a vibration magnetometer and are allowed to oscillate in the earth's magnetic field with like poles together, 12 oscillations per minute are made but for unlike poles together only 4 oscillations per minute are executed. The ratio of their magnetic moments is

[MP PMT 1996; CPMT 2002]

(a) 3 : 1 (b) 1 : 3

(c) 3 : 5 (d) 5 : 4

45. To measure which of the following, is a tangent galvanometer used [MP PET 1997; CBSE PMT 2001]

(a) Charge (b) Angle

(c) Current (d) Magnetic intensity

46. When $\sqrt{3}$ *ampere* current is passed in a tangent galvanometer, there is a deflection of 30° in it. The deflection obtained when 3 *amperes* current is passed, is

[MP PMT 1997]

(a) 30° (b) 45°

(c) 60° (d) 75°

47. The period of oscillations of a magnetic needle in a magnetic field is 1.0 *sec*. If the length of the needle is halved by cutting it, the time period will be [MP PMT/PET 1998]

(a) 1.0 *sec* (b) 0.5 *sec*

(c) 0.25 *sec* (d) 2.0 *sec*

48. The time period of a freely suspended magnet is 2 *sec*. If it is broken in length into two equal parts and one part is suspended in the same way, then its time period will be

[MP PMT 1999]

(a) 4 *sec* (b) 2 *sec*

(c) $\sqrt{2}$ sec (d) 1 *sec*

49. The bob of a simple pendulum is replaced by a magnet. The oscillations are set along the length of the magnet. A copper coil is added so that one pole of the magnet passes in and out of the coil. The coil is short-circuited. Then which one of the following happens

[KCET 1994]

(a) Period decreases

(b) Period does not change

(c) Oscillations are damped

(d) Amplitude increases

50. The period of oscillation of a vibration magnetometer depends on which of the following factors [KCET 1994]

(a) *I* and *M* only (b) *M* and *H* only

(c) *I* and *H* only (d) *I*, M and *H* only

where *I* is the moment of inertia of the magnet about the axis of suspension, *M* is the magnetic moment of the magnet and *H* is the external magnetic field

51. The time period of oscillation of a bar magnet suspended horizontally along the magnetic meridian is T_0. If this magnet is replaced by another magnet of the same size and pole strength but with double the mass, the new time period will be

(a) $\frac{T_0}{2}$ (b) $\frac{T_0}{\sqrt{2}}$

(c) $\sqrt{2}T_0$ (d) $2T_0$

52. Two short magnets having magnetic moments in the ratio 27 : 8, when placed on opposite sides of a deflection magnetometer, produce no deflection. If the distance of the weaker magnet is 0.12 *m* from the centre of deflection magnetometer, the distance of the stronger magnet from the centre is

(a) 0.06 *m* (b) 0.08 *m*

(c) 0.12 *m* (d) 0.18 *m*

53. The magnet of a vibration magnetometer is heated so as to reduce its magnetic moment by 19%. By doing this the periodic time of the magnetometer will [MP PMT 2000, 01]

(a) Increase by 19% (b) Decrease by 19%

(c) Increase by 11% (d) Decrease by 21%

54. A magnet makes 40 oscillations per minute at a place having magnetic field intensity of 0.1×10^{-5} *T*. At another place, it takes 2.5 *sec* to complete one vibration. The value of earth's horizontal field at that place is

[AIIMS 2000; CPMT 2000; Pb PET 2002]

(a) 0.25×10^{-6} *T* (b) 0.36×10^{-6} *T*

(c) 0.66×10^{-8} *T* (d) 1.2×10^{-6} *T*

55. A tangent galvanometer has a coil of 25 turns and radius of 15 *cm*. The horizontal component of the earth's magnetic field is 3×10^{-5} *T*. The current required to produce a deflection of 45° in it, is

[MP PMT 2000]

(a) 0.29 *A* (b) 1.2 *A*

(c) 3.6×10^{-5} *A* (d) 0.14 *A*

56. The time period of a vibration magnetometer is T_0. Its magnet is replaced by another magnet whose moment of inertia is 3 times and magnetic moment is 1/3 of the initial magnet. The time period now will be [MP PMT 2000]

(a) $3T_0$ (b) T_0

(c) $T_0 / \sqrt{3}$ (d) $T_0/3$

57. The error in measuring the current with a tangent galvanometer is minimum when the deflection is about

[MP PET 2001]

(a) 0° (b) 30°

(c) 45° (d) 60°

58. Before using the tangent galvanometer, its coil is set in

[MP PMT 2001; CPMT 2005]

(a) Magnetic meridian (or vertically north south)

(b) Perpendicular to magnetic meridian

(c) At angle of 45° to magnetic meridian

(d) It does not require any setting

59. The time period of a thin bar magnet in earth's magnetic field is *T*. If the magnet is cut into two equal parts perpendicular to its length, the time period of each part in the same field will be

(a) $\frac{T}{2}$ (b) *T*

(c) $\sqrt{2}\,T$ (d) 2*T*

60. A magnet freely suspended in a vibration magnetometer makes 10 oscillations per minute at a place *A* and 20 oscillations per minute at a place *B*. If the horizontal component of earth's magnetic field at *A* is $36 \times 10^{-6} T$, then its value at *B* is [SCRA 1994; JIPMER 2001, 02]

(a) 36×10^{-6} *T* (b) 72×10^{-6} *T*

(c) 144×10^{-6} *T* (d) 288×10^{-6} *T*

61. When 2 *amperes* current is passed through a tangent galvanometer, it gives a deflection of 30°. For 60° deflection, the current must be [EAMCET (Med.) 2000]

(a) 1 *amp* (b) $2\sqrt{3}$ *amp*

(c) 4 *amp* (d) 6 *amp*

62. Which of the following statement is not the true

[KCET (Engg./Med.) 2001]

(a) While taking reading of tangent galvanometer, the plane of the coil must be set at right angles to the earth's magnetic meridian

(b) A short magnet is used in a tangent galvanometer since a long magnet would be heavy and may not easily move

(c) Measurements with the tangent galvanometer will be more accurate when the deflection is around 45°

(d) A tangent galvanometer can not be used in the polar region

63. The period of oscillations of a magnet is 2 *sec*. When it is remagnetised so that the pole strength is 4 times its period will be

(a) 4 *sec* (b) 2 *sec*

(c) 1 *sec* (d) 1/2 *sec*

64. When two magnetic moments are compared using equal distance method the deflections produced are 45° and 30°. If the length of magnets are in the ratio 1 : 2, the ratio of their pole strengths is

(a) 3 : 1 (b) 3 : 2

(c) $\sqrt{3} : 1$ (d) $2\sqrt{3} : 1$

65. The magnetic needle of a tangent galvanometer is deflected at an angle 30° due to a magnet. The horizontal component of earth's magnetic field 0.34×10^{-4} *T* is along the plane of the coil. The magnetic intensity is

[AIIMS 2000, 2002; BHU 2000; AFMC 2000; KCET (Engg./Med.) 1999]

(a) 1.96×10^{-4} *T* (b) 1.96×10^{-5} *T*

(c) 1.96×10^{4} *T* (d) 1.96×10^{5} *T*

66. In a tangent galvanometer a current of 0.1 *A* produces a deflection of 30°. The current required to produce a deflection of 60° is

(a) 0.2 A (b) 0.3 A

(c) 0.4 A (c) 0.5 A

67. A bar magnet is oscillating in the Earth's magnetic field with a period *T*. What happens to its period and motion if its mass is quadrupled [CBSE PMT 2003]

(a) Motion remains S.H.M. with time period = $2T$

(b) Motion remains S.H.M. with time period = $4T$

(c) Motion remains S.H.M. and period remains nearly constant

(d) Motion remains S.H.M. with time period $= \frac{T}{2}$

68. A thin rectangular magnet suspended freely has a period of oscillation equal to *T*. Now it is broken into two equal halves (each having half of the original length) and one piece is made to oscillate freely in the same field. If its period of oscillation is T', then ratio $\frac{T'}{T}$ is [AIEEE 2003]

(a) $\frac{1}{4}$ (b) $\frac{1}{2\sqrt{2}}$

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

69. A bar magnet is oscillating in the earth's magnetic field with time period *T*. If its mass is increased four times then its time period will be [J & K CET 2004]

(a) 4 *T* (b) 2 *T*

(c) *T* (d) *T*/2

70. The length of a magnet is large compared to its width and breadth. The time period of its oscillation in a vibration magnetometer is 2 *s*. The magnet is cut along its length into three equal parts and three parts are then placed on each other with their like poles together. The time period of this combination will be

(a) 2 *s* (b) 2/3 *s*

(c) $2\sqrt{3}\, s$ (d) $2/\sqrt{3}\, s$

71. A magnet oscillating in a horizontal plane has a time period of 2 *second* at a place where the angle of dip is 30° and 3 *seconds* at another place where the angle of dip is 60°. The ratio of resultant magnetic fields at the two places is [Kerala PMT 2002]

[Pb. PET 2001]

(a) $\frac{4\sqrt{3}}{7}$ (b) $\frac{4}{9\sqrt{3}}$

[JIPMER 2002]

(c) $\frac{9}{4\sqrt{3}}$ (d) $\frac{9}{\sqrt{3}}$

72. Two identical bar magnets are placed on above the other such that they are mutually perpendicular and bisect each other. The time period of this combination in a horizontal magnetic field is *T*. The time period of each magnet in the same field is

(a) $\sqrt{2}\, T$ (b) $2^{\frac{1}{4}} T$

(c) $2^{-\frac{1}{4}} T$ (d) $2^{-\frac{1}{2}} T$

73. The radius of the coil of a Tangent galvanometer. which has 10 turns is 0.1*m*. The current required to produce a deflection of 60° $(B_H = 4 \times 10^{-5} T)$ is [MP PET 2005] [MP PET 2003]

(a) 3 *A* (b) 1.1 *A*

(c) 2.1 *A* (d) 1.5 *A*

Magnetic Materials

1. Magnets cannot be made from which of the following substances

(a) Iron (b) Nickel

(c) Copper (d) All of the above

2. The magnetic moment of atomic neon is

[NCERT 1984]

(a) Zero (b) $\mu B / 2$

(c) μB (d) $3\mu B / 2$

3. Which of the following is most suitable for the core of electromagnets [AIIMS 1980; NCERT 1980; AFMC 1988; CBSE PMT 1990]

(a) Soft iron (b) Steel

(c) Copper-nickel alloy (d) Air

4. Demagnetisation of magnets can be done by

[DPMT 1984; CBSE PMT 1988]

(a) Rough handling

(b) Heating

(c) Magnetising in the opposite direction

(d) All the above

5. A ferromagnetic material is heated above its curie temperature. Which one is a correct statement [MP PET 1995]
   (a) Ferromagnetic domains are perfectly arranged
   (b) Ferromagnetic domains becomes random
   (c) Ferromagnetic domains are not influenced
   (d) Ferromagnetic material changes itself into diamagnetic material

6. If a diamagnetic substance is brought near north or south pole of a bar magnet, it is [EAMCET (Engg.) 1995; CBSE PMT 1999; AFMC 2003]
   (a) Attracted by the poles
   (b) Repelled by the poles
   (c) Repelled by the north pole and attracted by the south pole
   (d) Attracted by the north pole and repelled by the south pole

7. The material of permanent magnet has [KCET 1994, 2003; AFMC 2004]
   (a) High retentivity, low coercivity
   (b) Low retentivity, high coercivity
   (c) Low retentivity, low coercivity
   (d) High retentivity, high coercivity

8. The permanent magnet is made from which one of the following substances [Bihar MEE 1995]
   (a) Diamagnetic (b) Paramagnetic
   (c) Ferromagnetic (d) Electromagnetic

9. Temperature above which a ferromagnetic substance becomes paramagnetic is called [SCRA 1994; J & K CET 2004]
   (a) Critical temperature (b) Boyle's temperature
   (c) Debye's temperature (d) Curie temperature

10. When a magnetic substance is heated, then it [AIIMS 1999]
    (a) Becomes a strong magnet
    (b) Losses its magnetism
    (c) Does not effect the magnetism
    (d) Either (a) or (c)

11. The only property possessed by ferromagnetic substance is [KCET 1999]
    (a) Hysteresis
    (b) Susceptibility
    (c) Directional property
    (d) Attracting magnetic substances

12. Substances in which the magnetic moment of a single atom is not zero, is known as [AFMC 1999]
    (a) Diamagnetism (b) Ferromagnetism
    (c) Paramagnetism (d) Ferrimagnetism

13. Diamagnetic substances are [AFMC 1999]
    (a) Feebly attracted by magnets
    (b) Strongly attracted by magnets
    (c) Feebly repelled by magnets
    (d) Strongly repelled by magnets

14. The magnetic susceptibility is [RPMT 1999]
    (a) $\chi = \frac{I}{H}$ (b) $\chi = \frac{B}{H}$
    (c) $\chi = \frac{M}{V}$ (d) $\chi = \frac{M}{H}$

15. Which of the following statements are true about the magnetic susceptibility χ_m of paramagnetic substance [Roorkee 1999]
    (a) Value of χ_m is inversely proportional to the absolute temperature of the sample
    (b) χ_m is positive at all temperature
    (c) χ_m is negative at all temperature
    (d) χ_m does not depend on the temperature of the sample

16. Relative permeability of iron is 5500, then its magnetic susceptibility will be [KCET 2000; Kerala PMT 2004]
    (a) 5500×10^{7} (b) 5500×10^{-7}
    (c) 5501 (d) 5499

17. An example of a diamagnetic substance is [KCET 2000]
    (a) Aluminium (b) Copper
    (c) Iron (d) Nickel

18. The use of study of hysteresis curve for a given material is to estimate the [KCET (Engg./Med.) 2000]
    (a) Voltage loss (b) Hysteresis loss
    (c) Current loss (d) All of these

19. Magnetic permeability is maximum for [AIIMS 2000; MH CET 2003; DPMT 2003]
    (a) Diamagnetic substance (b) Paramagnetic substance
    (c) Ferromagnetic substance (d) All of these

20. If a diamagnetic solution is poured into a *U*-tube and one arm of this *U*-tube placed between the poles of a strong magnet with the meniscus in a line with the field, then the level of the solution will
    (a) Rise (b) Fall
    (c) Oscillate slowly (d) Remain as such

21. The relative permeability is represented by μ_r and the susceptibility is denoted by χ for a magnetic substance. Then for a paramagnetic substance [KCET (Engg./Med.) 2001]
    (a) $\mu_r < 1, \chi < 0$ (b) $\mu_r < 1, \chi > 0$
    (c) $\mu_r > 1, \chi < 0$ (d) $\mu_r > 1, \chi > 0$

22. Which of the following is true [BHU 2001]
    (a) Diamagnetism is temperature dependent
    (b) Paramagnetism is temperature dependent
    (c) Paramagnetism is temperature independent
    (d) None of these

23. The magnetic susceptibility does not depend upon the temperature in [CBSE PMT 2001]
    (a) Ferrite substances (b) Ferromagnetic substances
    (c) Diamagnetic substances (d) Paramagnetic substances

24. Identify the paramagnetic substance [KCET 2001]
    (a) Iron (b) Aluminium
    (c) Nickel (d) Hydrogen

25. If a magnetic substance is kept in a magnetic field, then which of the following is thrown out [DCE 1999, 2001]

(a) Paramagnetic (b) Ferromagnetic

(c) Diamagnetic (d) Antiferromagnetic

26. If the angular momentum of an electron is $\vec{J}$ then the magnitude of the magnetic moment will be [MP PET 2002]

(a) $\frac{eJ}{m}$ (b) $\frac{eJ}{2m}$

(c) $eJ\,2m$ (d) $\frac{2m}{eJ}$

27. The magnetic susceptibility is negative for [AIEEE 2002]

(a) Paramagnetic materials

(b) Diamagnetic materials

(c) Ferromagnetic materials

(d) Paramagnetic and ferromagnetic materials

28. The universal property of all substances is [CPMT 2002]

(a) Diamagnetism (b) Ferromagnetism

(c) Paramagnetism (d) All of these

29. Which of the following statements is incorrect about hysteresis

(a) This effect is common to all ferromagnetic substances

(b) The hysteresis loop area is proportional to the thermal energy developed per unit volume of the material

(c) The hysteresis loop area is independent of the thermal energy developed per unit volume of the material

(d) The shape of the hysteresis loop is characteristic of the material

30. Curies law can be written as

[MH CET 2002; CBSE PMT 2003]

(a) $\chi \propto (T - T_c)$ (b) $\chi \propto \frac{1}{T - T_c}$

(c) $\chi \propto \frac{1}{T}$ (d) $\chi \propto T$

31. A superconductor exhibits perfect [KCET 2002]

(a) Ferrimagnetism (b) Ferromagnetism

(c) Paramagnetism (d) Diamagnetism

32. A small rod of bismuth is suspended freely between the poles of a strong electromagnet. It is found to arrange itself at right angles to the magnetic field. This observation establishes that bismuth is

(a) Diamagnetic (b) Paramagnetic

(c) Ferri-magnetic (d) Antiferro-magnetic

33. A diamagnetic material in a magnetic field moves

[Pb. PMT 1999; AIIMS 2000; MH CET 2000; CBSE PMT 2003]

(a) From weaker to the stronger parts of the field

(b) Perpendicular to the field

(c) From stronger to the weaker parts of the field

(d) In none of the above directions

34. Curie temperature is the temperature above which

[DCE 2002; AIEEE 2003]

(a) A paramagnetic material becomes ferromagnetic

(b) A ferromagnetic material becomes paramagnetic

(c) A paramagnetic material becomes diamagnetic

(d) A ferromagnetic material becomes diamagnetic

35. A frog can be deviated in a magnetic field produced by a current in a vertical solenoid placed below the frog. This is possible because the body of the frog behaves as

[AIIMS 2003]

(a) Paramagnetic (b) Diamagnetic

(c) Ferromagnetic (d) Antiferromagnetic

36. Which one of the following is a non-magnetic substance

[MP PET 2004]

(a) Iron (b) Nickel

(c) Cobalt (d) Brass

37. Liquid oxygen remains suspended between two pole faces of a magnet because it is [AIIMS 2004]

(a) Diamagnetic (b) Paramagnetic

(c) Ferromagnetic (d) Antiferromagnetic

38. Curie-Weiss law is obeyed by iron at a temperature ......

[KCET 2004]

(a) Below Curie temperature (b) Above Curie temperature

(c) At Curie temperature only (d) At all temperatures

39. The materials suitable for making electromagnets should have

[UPSEAT 2002]

(a) High retentivity and high coercivity

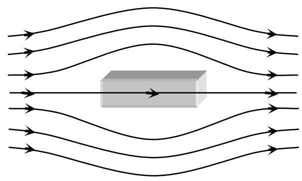
(b) Low retentivity and low coercivity

(c) High retentivity and low coercivity

(d) Low retentivity and high coercivity

40. The given figure represents a material which is

[Orissa PMT 2004]



(a) Paramagnetic (b) Diamagnetic

(c) Ferromagnetic (d) None of these

41. For an isotropic medium B, μ, H and M are related as (where B, μ_0, H and M have their usual meaning in the context of magnetic material [Pb. PMT 2004]

[Kerala 2002]

(a) $(B - M) = \mu_0 H$ (b) $M = \mu_0(H + M)$

(c) $H = \mu_0(H + M)$ (d) $B = \mu_0(H + M)$

42. The magnetic susceptibility of any paramagnetic material changes with absolute temperature T as

[UPSEAT 2004; DCE 2005]

(a) Directly proportional to T

(b) Remains constant

(c) Inversely proportional to T

(d) Exponentially decaying with T

43. When a piece of a ferromagnetic substance is put in a uniform magnetic field, the flux density inside it is four times the flux density away from the piece. The magnetic permeability of the material is

(a) 1 (b) 2

(c) 3 (d) 4

44. Which of the following is diamagnetism [DCE 2002]

(a) Aluminium (b) Quartz

(c) Nickel (d) Bismuth

45. If a ferromagnetic material is inserted in a current carrying solenoid, the magnetic field of solenoid **[DCE 2004]**

(a) Largely increases (b) Slightly increases

(c) Largely decreases (d) Slightly decreases

46. In the hysteresis cycle, the value of H needed to make the intensity of magnetisation zero is called **[DCE 2004]**

(a) Retentivity (b) Coercive force

(c) Lorentz force (d) None of the above

47. If the magnetic dipole moment of an atom of diamagnetic material, paramagnetic material and ferromagnetic material denoted by μ_d, μ_p, μ_f respectively then **[CBSE PMT 2005]**

(a) $\mu_d \neq 0$ and $\mu_f \neq 0$ (b) $\mu_p = 0$ and $\mu_f \neq 0$

(c) $\mu_d = 0$ and $\mu_p \neq 0$ (d) $\mu_d \neq 0$ and $\mu_p = 0$

48. Among the following properties describing diamagnetism identify the property that is wrongly stated **[KCET 2005]**

(a) Diamagnetic material do not have permanent magnetic moment

(b) Diamagnetism is explained in terms of electromagnetic induction

(c) Diamagnetic materials have a small positive susceptibility

(d) The magnetic moment of individual electrons neutralize each other

49. Susceptibility of ferromagnetic substance is **[Orissa JEE 2005]**

(a) > 1 (b) < 1

(c) 0 (d) 1

50. When a ferromagnetic material is heated to temperature above its Curie temperature, the material **[UPSEAT 2005]**

(a) Is permanently magnetized

(b) Remains ferromagnetic

(c) Behaves like a diamagnetic material

(d) Behaves like a paramagnetic material

Critical Thinking

Objective Questions

1. Two identical magnetic dipoles of magnetic moments 1.0 *A-m* each, placed at a separation of $2m$ with their axis perpendicular to each other. The resultant magnetic field at a point midway between the dipoles is **[Roorkee 1995]**

(a) $5 \times 10^{-7} T$ (b) $\sqrt{5} \times 10^{-7} T$

(c) $10^{-7} T$ (d) None of these

2. Two short magnets placed along the same axis with their like poles facing each other repel each other with a force which varies inversely as

(a) Square of the distance

(b) Cube of the distance

(c) Distance

(d) Fourth power of the distance

3. Two identical short bar magnets, each having magnetic moment M, are placed a distance of $2d$ apart with axes perpendicular to each other in a horizontal plane. The magnetic induction at a point midway between them is **[IIT-JEE (Screening) 2000]**

(a) $\frac{\mu_0}{4\pi}(\sqrt{2})\frac{M}{d^3}$ (b) $\frac{\mu_0}{4\pi}(\sqrt{3})\frac{M}{d^3}$

(c) $\left(\frac{2\mu_0}{\pi}\right)\frac{M}{d^3}$ (d) $\frac{\mu_0}{4\pi}(\sqrt{5})\frac{M}{d^3}$

4. If a magnet is suspended at an angle 30° to the magnetic meridian, it makes an angle of 45° with the horizontal. The real dip is

(a) $\tan^{-1}(\sqrt{3}/2)$ (b) $\tan^{-1}(\sqrt{3})$

(c) $\tan^{-1}(\sqrt{3/2})$ (d) $\tan^{-1}(2/\sqrt{3})$

5. A short bar magnet with its north pole facing north forms a neutral point at P in the horizontal plane. If the magnet is rotated by 90° in the horizontal plane, the net magnetic induction at P is (Horizontal component of earth's magnetic field = B_H)

(a) 0 (b) $2B_H$

(c) $\frac{\sqrt{5}}{2}B_H$ (d) $\sqrt{5}B_H$

6. The true value of angle of dip at a place is 60°, the apparent dip in a plane inclined at an angle of 30° with magnetic meridian is

(a) $\tan^{-1}\frac{1}{2}$ (b) $\tan^{-1}(2)$

(c) $\tan^{-1}\left(\frac{2}{3}\right)$ (d) None of these

7. A vibration magnetometer consists of two identical bar magnets placed one over the other such that they are perpendicular and bisect each other. The time period of oscillation in a horizontal magnetic field is $2^{5/4}$ *seconds*. One of the magnets is removed and if the other magnet oscillates in the same field, then the time period in seconds is

(a) $2^{1/4}$ (b) $2^{1/2}$

(c) 2 (d) $2^{3/4}$

8. In a vibration magnetometer, the time period of a bar magnet oscillating in horizontal component of earth's magnetic field is 2 *sec*. When a magnet is brought near and parallel to it, the time period reduces to 1 *sec*. The ratio H/F of the horizontal component H and the field F due to magnet will be **[MP PMT 1990; Pb PET 2000]**

(a) 3 (b) $1/3$

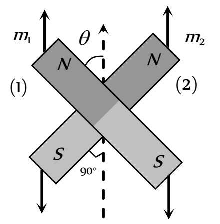
(c) $\sqrt{3}$ (d) $1/\sqrt{3}$

9. A cylindrical rod magnet has a length of 5 cm and a diameter of 1 cm. It has a uniform magnetisation of 5.30×10^3 Amp/m^3. What its magnetic dipole moment

(a) $1 \times 10^{-2} J/T$ (b) $2.08 \times 10^{-2} J/T$

(c) $3.08 \times 10^{-2}\ J/T$ (d) $1.52 \times 10^{-2}\ J/T$

10. Two magnets of equal mass are joined at right angles to each other as shown the magnet 1 has a magnetic moment 3 times that of magnet 2. This arrangement is pivoted so that it is free to rotate in the horizontal plane. In equilibrium what angle will the magnet 1 subtend with the magnetic meridian



(a) $\tan^{-1}\left(\frac{1}{2}\right)$

(b) $\tan^{-1}\left(\frac{1}{3}\right)$

(c) $\tan^{-1}(1)$

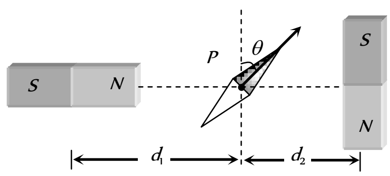
(d) 0°

11. The dipole moment of each molecule of a paramagnetic gas is 1.5×10^{-23} *amp* × *m*. The temperature of gas is $27^\circ C$ and the number of molecules per unit volume in it is 2×10^{26} m^{-3}. The maximum possible intensity of magnetisation in the gas will be

(a) 3×10^{3} *amp/m* (b) 4×10^{-3} *amp/m*

(c) 5×10^{5} *amp/m* (d) 6×10^{-4} *amp/m*

12. Two magnets *A* and *B* are identical and these are arranged as shown in the figure. Their length is negligible in comparison to the separation between them. A magnetic needle is placed between the magnets at point *P* which gets deflected through an angle θ under the influence of magnets. The ratio of distance d_1 and d_2 will be



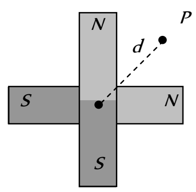
(a) $(2\tan\theta)^{1/3}$

(b) $(2\tan\theta)^{-1/3}$

(c) $(2\cot\theta)^{1/3}$

(d) $(2\cot\theta)^{-1/3}$

13. Two short magnets of equal dipole moments *M* are fastened perpendicularly at their centre (figure). The magnitude of the magnetic field at a distance *d* from the centre on the bisector of the right angle is



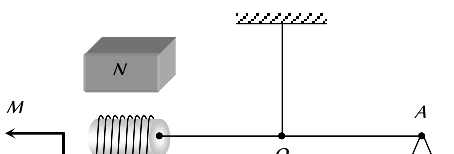
(a) $\frac{\mu_0}{4\pi}\frac{M}{d^3}$

(b) $\frac{\mu_0}{4\pi}\frac{M\sqrt{2}}{d^3}$

(c) $\frac{\mu_0}{4\pi}\frac{2\sqrt{2}M}{d^3}$

(d) $\frac{\mu_0}{4\pi}\frac{2M}{d^3}$

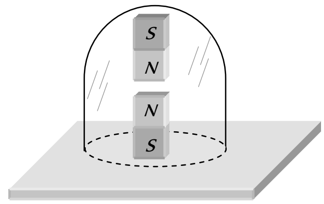
14. A small coil C with *N* = 200 turns is mounted on one end of a balance beam and introduced between the poles of an electromagnet as shown in figure. The cross sectional area of coil is A= 1.0 *cm*, length of arm OA of the balance beam is $l = 30\ cm$. When there is no current in the coil the balance is in equilibrium. On passing a current *I* = 22 mA through the coil the equilibrium is restored by putting the additional counter weight of mass $\Delta m = 60\ mg$ on the balance pan. Find the magnetic induction at the spot where coil is located.



(a) 0.4 *T* (b) 0.3 *T*

(c) 0.2 *T* (d) 0.1 *T*

15. Two identical bar magnets with a length 10 *cm* and weight 50 *gm-weight* are arranged freely with their like poles facing in a inverted vertical glass tube. The upper magnet hangs in the air above the lower one so that the distance between the nearest pole of the magnet is 3*mm*. Pole strength of the poles of each magnet will be



(a) 6.64 *amp* × *m*

(b) 2 *amp* × *m*

(c) 10.25 *amp* × *m*

(d) None of these

16. If ϕ_1 and ϕ_2 be the angles of dip observed in two vertical planes at right angles to each other and ϕ be the true angle of dip, then

(a) $\cos^2\phi = \cos^2\phi_1 + \cos^2\phi_2$

(b) $\sec^2\phi = \sec^2\phi_1 + \sec^2\phi_2$

(c) $\tan^2\phi = \tan^2\phi_1 + \tan^2\phi_2$

(d) $\cot^2\phi = \cot^2\phi_1 + \cot^2\phi_2$

17. Each atom of an iron bar $(5\,cm \times 1\,cm \times 1\,cm)$ has a magnetic moment $1.8 \times 10^{-23}\ Am^2$. Knowing that the density of iron is $7.78 \times 10^3\ kg^{-3}m$, atomic weight is 56 and Avogadro's number is 6.02×10^{23} the magnetic moment of bar in the state of magnetic saturation will be

(a) $4.75\ Am^2$ (b) $5.74\ Am^2$

(c) $7.54\ Am^2$ (d) $75.4\ Am^2$

18. An iron rod of volume $10^{-4}\ m^3$ and relative permeability 1000 is placed inside a long solenoid wound with 5 *turns/cm*. If a current of 0.5 *A* is passed through the solenoid, then the magnetic moment of the rod is

(a) $10\ Am^2$ (b) $15\ Am^2$

(c) $20\ Am^2$ (d) $25\ Am^2$

19. A bar magnet has coercivity $4 \times 10^3\ Am^{-1}$. It is desired to demagnetise it by inserting it inside a solenoid 12 *cm* long and having 60 turns. The current that should be sent through the solenoid is

(a) 2 *A* (b) 4 *A*

(c) 6 *A* (d) 8 *A*

20. A magnet is suspended in the magnetic meridian with an untwisted wire. The upper end of wire is rotated through 180° to deflect the magnet by 30° from magnetic meridian. When this magnet is replaced by another magnet, the upper end of wire is rotated through 270° to deflect the magnet 30° from magnetic meridian. The ratio of magnetic moments of magnets is

(a) 1 : 5 (b) 1 : 8

(c) 5 : 8 (d) 8 : 5

21. A dip needle vibrates in the vertical plane perpendicular to the magnetic meridian. The time period of vibration is found to be 2 *seconds*. The same needle is then allowed to vibrate in the horizontal plane and the time period is again found to be 2 *seconds*. Then the angle of dip is

(a) 0° (b) 30°

(c) 45° (d) 90°

22. The unit for molar susceptibility is

(a) *m* (b) *kg-m*

(c) *kg m* (d) No units

23. A short magnet oscillates with a time period 0.1 *s* at a place where horizontal magnetic field is $24\mu T$. A downward current of 18 *A* is established in a vertical wire 20 *cm* east of the magnet. The new time period of oscillator

(a) 0.1 *s* (b) 0.089 *s*

(c) 0.076 *s* (d) 0.057 *s*

24. A dip needle lies initially in the magnetic meridian when it shows an angle of dip θ at a place. The dip circle is rotated through an angle x in the horizontal plane and then it shows an angle of dip θ'. Then $\frac{\tan\theta'}{\tan\theta}$ is

(a) $\frac{1}{\cos x}$ (b) $\frac{1}{\sin x}$

(c) $\frac{1}{\tan x}$ (d) $\cos x$

25. A dip circle is adjusted so that its needle moves freely in the magnetic meridian. In this position, the angle of dip is 40°. Now the dip circle is rotated so that the plane in which the needle moves makes an angle of 30° with the magnetic meridian. In this position the needle will dip by an angle

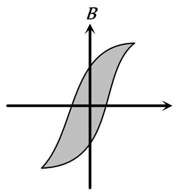
[DCE 2005]

(a) 40° (b) 30°

(c) More than 40° (d) Less than 40°

GQ Graphical Questions

1. For substances hysteresis (*B* - *H*) curves are given as shown in figure. For making temporary magnet which of the following is best.

(a)


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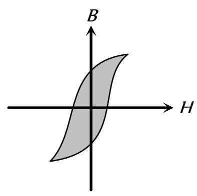

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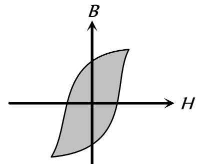
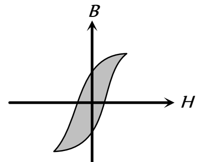
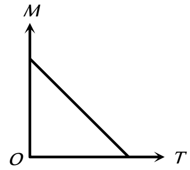


(d)


2. A curve between magnetic moment and temperature of magnet is

(a)


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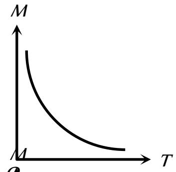

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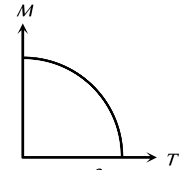
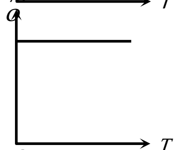
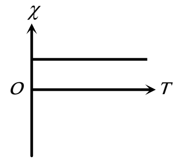
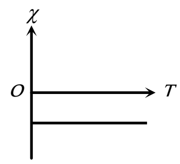
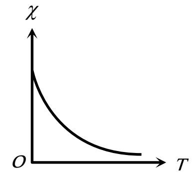


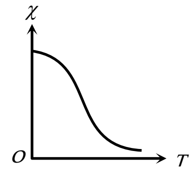
(d)


3. The variation of magnetic susceptibility (χ) with temperature for a diamagnetic substance is best represented by

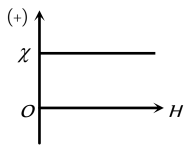
(a)


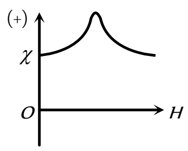
(b)


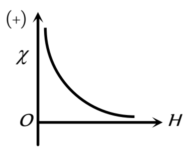
(c)


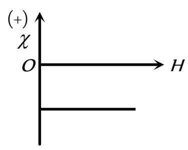
(d)


4. The variation of magnetic susceptibility (χ) with magnetising field for a paramagnetic substance is

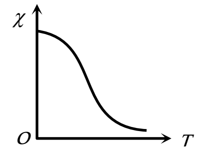
(a)


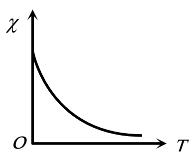
(b)


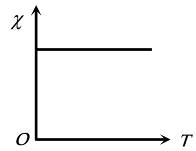
(c)


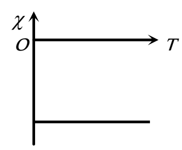
(d)


5. The variation of magnetic susceptibility (χ) with absolute temperature *T* for a ferromagnetic material is

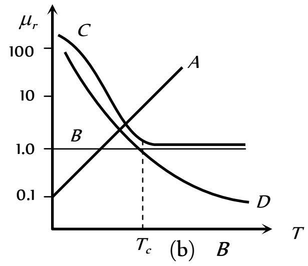
(a)


(b)


(c)


(d)


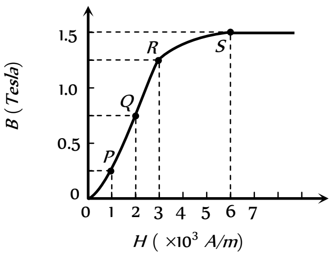
6. The relative permeability (μ_r) of a ferromagnetic substance varies with temperature *(T)* according to the curve



(a) *A* (b) *B*

(c) *C* (d) *D*

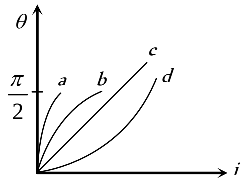
7. The basic magnetization curve for a ferromagnetic material is shown in figure. Then, the value of relative permeability is highest for the point



(a) *P* (b) *Q*

(c) *R* (d) *S*

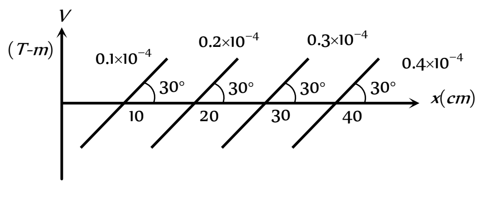
8. Which curve may best represent the current deflection in a tangent galvanometer



(a) *A* (b) *B*

(c) *C* (d) *D*

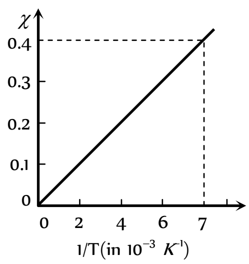
9. Some equipotential surfaces of the magnetic scalar potential are shown in the figure. Magnetic field at a point in the region is



(a) $10^{-4}\,T$ (b) $2\times10^{-4}\,T$

(c) $0.5\times10^{-4}\,T$ (d) None of these

10. The $\chi - 1/T$ graph for an alloy of paramagnetic nature is shown in Fig. The curie constant is, then

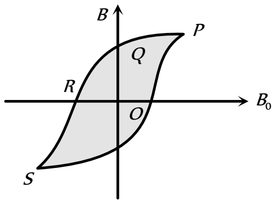


(a) 57 *K* (b) $2.8\times10^{-3}K$

(c) 570 *K* (d) $17.5\times10^{-3}K$

11. The figure illustrate how *B*, the flux density inside a sample of unmagnetised ferromagnetic material varies with B_0 the magnetic flux density in which the sample is kept. For the sample to be suitable for making a permanent magnet

[AMU 2001]



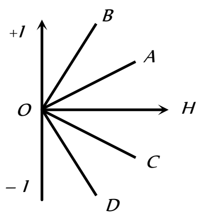
(a) *OQ* should be large, *OR* should be small

(b) *OQ* and *OR* should both be large

(c) *OQ* should be small and *OR* should be large

(d) *OQ* and *OR* should both be small

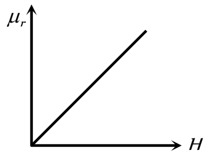
12. The variation of the intensity of magnetisation *(I)* with respect to the magnetising field *(H)* in a diamagnetic substance is described by the graph **[KCET 2002]**

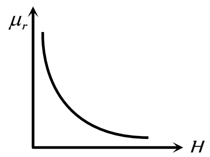


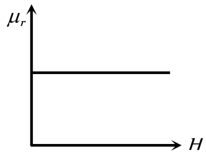
(a) *OD* (b) *OC*

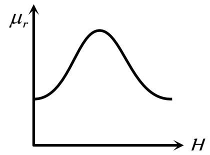
(c) *OB* (d) *OA*

13. For ferromagnetic material, the relative permeability (μ_r), versus magnetic intensity *(H)* has the following shape

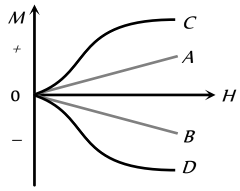
(a)


(b)


(c)


(d)


14. The most appropriate magnetization *M* versus magnetising field *H* curve for a paramagnetic substance is



(a) A (b) B

(c) C (d) D

Assertion & Reason

For AIIMS Aspirants

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. Assertion : We cannot think of magnetic field configuration with three poles.

Reason : A bar magnet does exert a torque on itself due to its own field. [AIIMS 2002]

2. Assertion : The poles of magnet cannot be separated by breaking into two pieces.

Reason : The magnetic moment will be reduced to half when a magnet is broken into two equal pieces.[SCRA 1994]

3. Assertion : Basic difference between an electric line and magnetic line of force is that former is discontinuous and the latter is continuous or endless.

Reason : No electric lines of forces exist inside a charged body but magnetic lines do exist inside a magnet.

4. Assertion : Magnetic moment of an atom is due to both, the orbital motion and spin motion of every electron.

Reason : A charged particle produces a magnetic field.

5. Assertion : When radius of circular loop carrying current is doubled, its magnetic moment becomes four times.

Reason : Magnetic moment depends on area of the loop.

6. Assertion : The earth's magnetic field is due to iron present in its core.

Reason : At a high temperature magnet losses its magnetic property or magnetism.

7. Assertion : A compass needle when placed on the magnetic north pole of the earth rotates in vertical direction.

Reason : The earth has only horizontal component of its magnetic field at the north poles.

8. Assertion : The tangent galvanometer can be made more sensitive by increasing the number of turns of its coil.

Reason : Current through galvanometer is proportional to the number of turns of coil.

9. Assertion : The ferromagnetic substance do not obey Curie's law.

Reason : At Curie point a ferromagnetic substance start behaving as a paramagnetic substance.

10. Assertion : The properties of paramagnetic and ferromagnetic substance are not effected by heating.

Reason : As temperature rises, the alignment of molecular magnets gradually decreases.

11. Assertion : Soft iron is used as transformer core.

Reason : Soft iron has narrow hysteresis loop.

12. Assertion : Magnetism is relativistic.

Reason : When we move along with the charge so that there is no motion relative to us, we find no magnetic field associated with the charge.

13. Assertion : The earth's magnetic field does not affect the working of a moving coil galvanometer.

Reason : Earth's magnetic field is very weak.

14. Assertion : A paramagnetic sample display greater magnetisation (for the same magnetising field) when cooled.

Reason : The magnetisation does not depend on temperature.

15. Assertion : Electromagnets are made of soft iron.

Reason : Coercivity of soft iron is small.

16. Assertion : To protect any instrument from external magnetic field, it is put inside an iron body.

Reason : Iron is a magnetic substance.

17. Assertion : When a magnet is brought near iron nails, only translatory force act on it.

Reason : The field due to a magnet is generally uniform.

18. Assertion : When a magnetic dipole is placed in a non uniform magnetic field, only a torque acts on the dipole.

Reason : Force would also acts on dipole if magnetic field were uniform.

19. Assertion : Reduction factor (K) of a tangent galvanometer helps in reducing deflection to current.

Reason : Reduction factor increases with increase of current.

20. Assertion : The susceptibility of diamagnetic materials does not depend upon temperature.

Reason : Every atom of a diamagnetic material is not a complete magnet in itself.

21. Assertion : The permeability of a ferromagnetic material is independent of the magnetic field.

Reason : Permeability of a material is a constant quantity.

22. Assertion : For a perfectly diamagnetic substance permeability is always one.

Reason : The ability of a material of permit the passage of magnetic lines of force through it is called magnetic permeability.

23. Assertion : Gauss theorem is not applicable in magnetism.

Reason : Mono magnetic pole does not exist.

24. Assertion : Magnetic moment of helium atom is zero.

Reason : All the electron are paired in helium atom orbitals.

25. Assertion : For making permanent magnets, steel is preferred over soft iron.

Reason : As retentivity of steel is smaller.

Answers

Magnet and It's Properties

1	b	2	d	3	c	4	d	5	b
6	d	7	b	8	c	9	c	10	a
11	c	12	d	13	c	14	b	15	a
16	a	17	b	18	c	19	d	20	b
21	a	22	c	23	c	24	d	25	d
26	d	27	a	28	a	29	b	30	a
31	a	32	b	33	a	34	c	35	c
36	b	37	b	38	c	39	b	40	c
41	c	42	b	43	a	44	d	45	d
46	b	47	d	48	a	49	a	50	d
51	c	52	b	53	b	54	c	55	b
56	b	57	c	58	b	59	c	60	b
61	b	62	d	63	a	64	a	65	c
66	b	67	b	68	b	69	a	70	b
71	c	72	b	73	c	74	d	75	d
76	a	77	d	78	c	79	d	80	a
81	a	82	b	83	a	84	b	85	a
86	b	87	a	88	a	89	d	90	b
91	d	92	c						

Earth Magnetism

1	b	2	d	3	b	4	a	5	c
6	c	7	d	8	d	9	b	10	a
11	c	12	a	13	d	14	d	15	c
16	c	17	a	18	d	19	b	20	e
21	b	22	d	23	a	24	d	25	b
26	d	27	a	28	a	29	d	30	b
31	d	32	a	33	c	34	a	35	a
36	c	37	a	38	d	39	a	40	a
41	a	42	c	43	c	44	c	45	a
46	b	47	c	48	a	49	a	50	c
51	b	52	c	53	b	54	d	55	c
56	a	57	a	58	b	59	a		

Magnetic Equipments

1	d	2	c	3	a	4	b	5	d
6	d	7	a	8	c	9	c	10	b
11	c	12	a	13	a	14	a	15	b
16	b	17	b	18	d	19	b	20	c
21	c	22	c	23	c	24	c	25	a
26	a	27	c	28	a	29	a	30	a
31	b	32	d	33	b	34	d	35	a
36	c	37	b	38	d	39	b	40	a
41	b	42	d	43	d	44	d	45	c
46	b	47	b	48	d	49	c	50	d
51	c	52	d	53	c	54	b	55	a
56	a	57	c	58	a	59	a	60	c
61	d	62	a	63	c	64	d	65	b
66	b	67	a	68	c	69	b	70	b
71	c	72	c	73	b				

Magnetic Materials

1	c	2	a	3	a	4	d	5	b
6	b	7	d	8	c	9	d	10	b
11	a	12	c	13	c	14	a	15	ab
16	d	17	b	18	b	19	c	20	b
21	d	22	b	23	c	24	b	25	c
26	b	27	b	28	a	29	c	30	c
31	d	32	a	33	c	34	b	35	b
36	d	37	b	38	b	39	c	40	b
41	d	42	c	43	d	44	d	45	a
46	b	47	c	48	c	49	a	50	d

Critical Thinking Questions

1	b	2	d	3	d	4	a	5	d
6	b	7	c	8	b	9	b	10	b
11	a	12	c	13	c	14	a	15	a
16	d	17	c	18	d	19	d	20	c
21	c	22	a	23	c	24	a	25	c

Graphical Questions

1	d	2	c	3	b	4	a	5	a
6	c	7	b	8	b	9	b	10	a
11	b	12	b	13	d	14	a		

Assertion and Reason

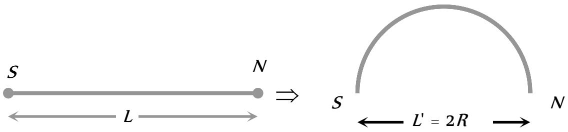
1	d	2	b	3	a	4	c	5	b
6	e	7	d	8	b	9	b	10	e
11	a	12	a	13	a	14	c	15	a
16	a	17	d	18	d	19	c	20	c
21	d	22	e	23	a	24	a	25	b

Answers and Solutions

Magnet and it's Properties

1. (b) On bending a rod it's pole strength remains unchanged where as its magnetic moment changes.

New magnetic moment $M' = m(2R) = m\left(\frac{2L}{\pi}\right) = \frac{2M}{\pi}$



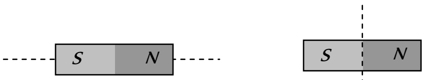
2. (d)

3. (c) $B_a = \frac{\mu_0}{4\pi}\frac{2M}{d^3} = \frac{\mu_0}{2\pi}\frac{M}{d^3}$

4. (d)

5. (b) If cut along the axis of magnet of length *l*, then new pole strength $m' = \frac{m}{2}$ and new length $l' = l$

$\therefore$ New magnetic moment $M' = \frac{m}{2} \times l = \frac{ml}{2} = \frac{M}{2}$



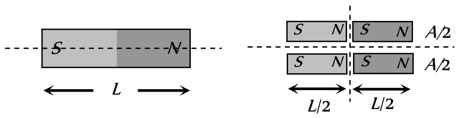
If cut perpendicular to the axis of magnet, then new pole strength $m' = m$ and new length, $l' = l/2$

$\therefore$ New magnetic moment $M' = m \times \frac{l}{2} = \frac{ml}{2} = \frac{M}{2}$

6. (d) For a magnet $B = \frac{\mu_0}{4\pi} \cdot \frac{2M}{x^3}$ (Nearly)

$\Rightarrow \frac{B_1}{B_2} = \left(\frac{x_1}{x_2}\right)^3 = \left(\frac{x}{2x}\right)^3 = \frac{1}{8}$ (Approx.)

7. (b) For each part $m' = \frac{m}{2}$



8. (c) $\frac{B_1}{B_2} = \frac{d_1}{d_2}\left(\frac{d_2^2 - l^2}{d_1^2 - l^2}\right)^2 \Rightarrow \frac{12.5}{1} = \frac{10}{20}\left(\frac{400 - l^2}{100 - l^2}\right)^2$

$\Rightarrow l = 5\ cm$

Hence length of magnet $= 2l = 10\ cm$

9. (c) $B_1 = \frac{2M}{d^3}.B_2 = \frac{M}{d^3};\ \therefore \frac{B_1}{B_2} = 2:1$

10. (a)

11. (c) $\tau = MB\sin\theta = 48 \times 25 \times 10^{-2} \times 0.15 \times \frac{1}{2} = 0.9\ N \times m$

12. (d) $B_1 = \frac{2M}{x^3}$ and $B_2 = \frac{M}{y^3}$

As $B_1 = B_2$

Hence $\frac{2M}{x^3} = \frac{M}{y^3}$ or $\frac{x^3}{y^3} = 2$ or $\frac{x}{y} = 2^{1/3}$

13. (c) Work done $W = MB_H(1 - \cos\theta)$

$= 20 \times 0.3(1 - \cos 30°) = 6\left(1 - \frac{\sqrt{3}}{2}\right) = 3(2 - \sqrt{3})$

14. (b) Magnetic intensity on end side-on position is twice than broad side on position.

15. (a) Along the axis of magnet $B_a = \frac{2M}{X^3} = 200\ guass$

$\Rightarrow B_a = \frac{M}{X^3} = 100\ guass$

16. (a)

17. (b)

18. (c)

19. (d) Provided length of magnet is <<the distance.

20. (b) Permeability of soft iron is maximum, so maximum lines of force tries to pass through the soft iron.

21. (a) Plane of coil is having angle θ with the magnetic field.

$\therefore \tau = MB\sin(90 - \theta)$ or $\tau = niAB\cos\theta$ [As $M = niA$]

22. (c) $B \propto \frac{1}{x^3} \Rightarrow \frac{B_1}{B_2} = \left(\frac{x_2}{x_1}\right)^3 = \left(\frac{3x}{x}\right)^3 = \frac{27}{1}$

23. (c) For null deflection $\frac{M_1}{M_2} = \left(\frac{d_1}{d_2}\right)^3 = \left(\frac{40}{50}\right)^3 = \frac{64}{125}$

24. (d)

25. (d) $F = \frac{\mu_0}{4\pi}\left(\frac{6MM'}{d^4}\right)$ in end-on position.

26. (d) Work done $MB(\cos\theta_1 - \cos\theta_2)$

$\theta_1 = 0^o$ and $\theta_2 = 180^o$

$\Rightarrow W = MB(\cos 0 - \cos 180) = 2MB$

27. (a) Pole strength doesn't depend upon the length.

28. (a) Torque $\tau = MB_H \sin\theta$

$= 0.1 \times 10^{-3} \times 4\pi \times 10^{-3} \times \sin 30^o = 10^{-7} \times 4\pi \times \frac{1}{2}$

$= 2\pi \times 10^{-7}\ N \times m$

29. (b) Number of lines of force passing through per unit area normally is intensity of magnetic field, hence option (c) is incorrect. The correct option is (b).

30. (a) Flux $= B \times A;\ \therefore B = \frac{Flux}{A} = Weber/m^2$

31. (a)

32. (b) $B = \frac{m}{d^2}$ in C.G.S. system.

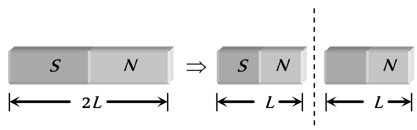
33. (a) $W = MB(\cos\theta_1 - \cos\theta_2) = MB(\cos 0^o - \cos 60^o)$

$= MB\left(1 - \frac{1}{2}\right) = \frac{MB}{2}$

and $\tau = MB\sin\theta = MB\sin 60^o = MB\frac{\sqrt{3}}{2}$

$\therefore \tau = \left(\frac{MB}{2}\right)\sqrt{3} \Rightarrow \tau = \sqrt{3}\ W$

34. (c)

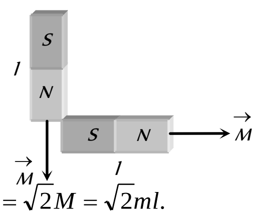


Pole strength of each part $= m$

Magnetic moment of each part

$= M' = m'L' = mL = \frac{M}{2}$

35. (c)



$M_{net} = \sqrt{2}M = \sqrt{2}ml.$

36. (b)

37. (b) $F \propto \frac{m_1 m_2}{r^2}$

38. (c) $F = 10^{-7} \times \frac{m^2}{r^2} = \frac{10^{-7}(1)^2}{(1)^2} = 10^{-7}\,N$

39. (b) $\tau = MH\sin\theta = MH\sin 30^o = \frac{MH}{2}$

40. (c)

41. (c) $F = \frac{\mu_0}{4\pi}\left(\frac{6MM'}{d^4}\right)$ in end-on position between two small magnets.

$\therefore F = 10^{-7}\left(\frac{6\times 10\times 10}{(0.1)^4}\right) = 0.6N$

42. (b)

43. (a) $\tau = MB_H\sin\theta$ or $\frac{d\tau}{d\theta} = MB_H\cos\theta$

This will be maximum. when $\theta = 0^o$.

44. (d) $W = MB(\cos\theta_1 - \cos\theta_2)$; $\theta_1 = 0^o$ and $\theta_2 = 360^o \Rightarrow W = 0$

45. (d)

46. (b) $W_1 = MB(\cos 0^o - \cos 90^o) = MB(1-0) = MB$

$W_2 = MB(\cos 0^o - \cos 60^o) = MB\left(1 - \frac{1}{2}\right) = \frac{MB}{2}$

$\therefore W_1 = 2W_2 \Rightarrow n = 2$

47. (d) In magnetic dipole, force $\propto \frac{1}{r^4}$

Hence new force $= \frac{4.8}{2^4} = \frac{4.8}{16} = 0.3\,N$

48. (a) Magnetic moment of bar $M = 10^4\,J/T$

$B = 4\times 10^{-5}\,T$

Hence work done $W = \vec{M}.\vec{B}$

$= 10^4 \times 4\times 10^{-5} \times \cos 60^o = 0.2\,J$

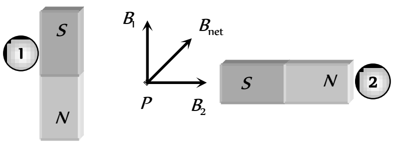
49. (a)

50. (d)

51. (c) $B = \frac{\mu_0}{4\pi}\frac{2M}{d^3} = 10^{-7}\times\frac{2\times 1.25}{(0.5)^3} = 2\times 10^{-6}\,N/A-m$

52. (b)

53. (b)



54. (c)

55. (b) $\tau = MB_H\sin\theta \Rightarrow 0.032 = M\times 0.16\times\sin 30^o$

$\Rightarrow M = 0.4\,J/tesla$

56. (b) $B_{equatorial} = \frac{\mu_0}{4\pi}\frac{M}{r^3}$

57. (c) Inside a magnet, magnetic lines of force move form south pole to north pole.

58. (b) Magnetic moment of circular loop carrying current

$M = IA = I(\pi R^2) = I\pi\left(\frac{L}{2\pi}\right)^2 = \frac{IL^2}{4\pi} \Rightarrow L = \sqrt{\frac{4\pi M}{I}}$

59. (c)

60. (b) Concept of magnetic screening.

61. (b) Repulsion is the sure test of magnetism.

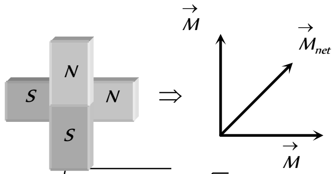
62. (d)

63. (a)

64. (a) $C_{max} = MB \Rightarrow 4\times 10^{-5} = M\times 10^{-4} \Rightarrow M = 0.4\,A\times m^2$

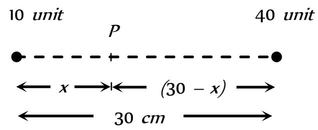
65. (c) Magnetic flux $\phi = BA \Rightarrow B = \frac{\phi}{A} = \frac{Weber}{m^2} = Tesla$

66. (b)



$\Rightarrow M_{net} = \sqrt{M^2 + M^2} = \sqrt{2}M$

67. (b) Suppose magnetic field is zero at point *P*. Which lies at a distance *x* from 10 unit pole. Hence at *P*



$\frac{\mu_0}{4\pi}.\frac{10}{x^2} = \frac{\mu_0}{4\pi}.\frac{40}{(30-x)^2} \Rightarrow x = 10cm$

So from stronger pole distance is 20 *cm*.

68. (b) $\tau = MB\sin\theta = (mL)B\sin\theta$

$= (40\times 10\times 10^{-2})\times 2\times 10^{-4}\times\sin 45°$

$= 0.565\times 10^{-3}\,N-m$

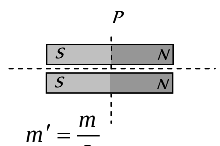
69. (a) Potential energy $U = -MB\cos\theta$

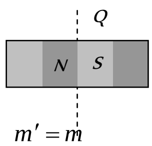
$\Rightarrow U_{max} = MH(\text{at}\,\theta = 180^o)$

70. (b) $\tau = MB\sin\theta$

$\tau = 200\times 0.25\times\sin 30° = 25\,N\times m.$

71. (c) If pole strength, magnetic moment and length of each part are m', M' and L' respectively then





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

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

$\Rightarrow M' = \frac{M}{2}$ $\Rightarrow M' = \frac{M}{2}$

72. (b) $\vec{\tau} = \vec{M}\times\vec{B} \Rightarrow \vec{\tau} = 50\hat{i}\times(0.5\hat{i} + 3\hat{j})$

$= 150(\hat{i}\times\hat{j}) = 150\hat{k}N\times m.$

73. (c) $\tau = MB\sin\theta \Rightarrow \tau \propto \sin\theta$

$\Rightarrow \frac{\tau_1}{\tau_2} = \frac{\sin\theta_1}{\sin\theta_2} \Rightarrow \frac{\tau}{\tau/2} = \frac{\sin 90}{\sin\theta_2}$

$\Rightarrow \sin\theta_2 = \frac{1}{2} \Rightarrow \theta_2 = 30^o$

$\Rightarrow$ angle of rotation $= 0Å - 30 = 60°$

74. (d)

75. (d) $F = mB \Rightarrow F = \frac{M}{L} \times B$

$\Rightarrow 6 \times 10^{-4} = \frac{3}{L} \times 2 \times 10^{-5} \Rightarrow L = 0.1\, m.$

76. (a) $\tau = MB\sin\theta \Rightarrow \tau = (mL)B\sin\theta$

$\Rightarrow 25 \times 10^{-6} = (m \times 5 \times 10^{-2}) \times 5 \times 10^{-2} \times \sin 30$

$\Rightarrow m = 2 \times 10^{-2}\, A - m.$

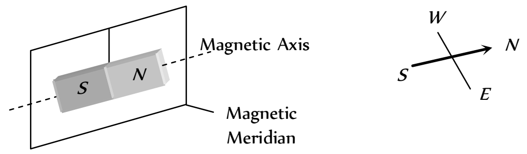
77. (d)

78. (c) Monopole do not exists.

79. (d)

80. (a)

81. (a)



82. (b) $W = MB(1 - \cos\theta)$; where $\theta = 180^o$

$\Rightarrow W = 2MB \Rightarrow W = 2 \times 2 \times 5 \times 10^{-3} = 2 \times 10^{-2}\, J$

83. (a) Torque on a bar magnet in earths magnetic field (B) is $\tau = MB_H \sin\theta$. τ will be maximum if sin θ = maximum *i.e.* θ = 90°. Hence axis of the magnet is perpendicular to the field of earth.

84. (b)

85. (a) Both points A and B lying on the axis of the magnet and on axial position

$B \propto \frac{1}{d^3} \Rightarrow \frac{B_A}{B_B} = \left(\frac{d_B}{d_A}\right)^3 = \left(\frac{48}{24}\right)^3 = \frac{8}{1}$

86. (b) $W = MB(1 - \cos\theta) = 2 \times 0.1 \times (1 - \cos 90^o) = 0.2\, J$

87. (a) $M = mL = 4 \times 10 \times 10^{-2} = 0.4\, A \times m^2$

88. (a) Similar to solution (1)

New magnetic moment

$M' = \frac{2M}{\pi} = \frac{2mL}{\pi} = \frac{2 \times 0.5 \times 31.4 \times 10^{-2}}{3.14} = 0.1\, amp \times m^2$

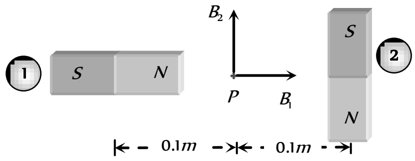
89. (d) Magnetic potential at a distance d from the bar magnet on it's axial line is given by

$V = \frac{\mu_0}{4\pi} \cdot \frac{M}{d^2} \Rightarrow V \propto M \Rightarrow \frac{V_1}{V_2} = \frac{M_1}{M_2}$

$\Rightarrow \frac{V}{V_2} = \frac{M}{M/4} \Rightarrow V_2 = \frac{V}{4}$

90. (b) $B = \frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3} \Rightarrow B = 10^{-7} \times \frac{2 \times 1.2}{(0.1)^3} = 2.4 \times 10^{-4}\, T$

91. (d)



From figure $B_{net} = \sqrt{B_a^2 + B_e^2}$

$= \sqrt{\left(\frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3}\right)^2 + \left(\frac{\mu_0}{4\pi} \cdot \frac{M}{d^3}\right)^2}$

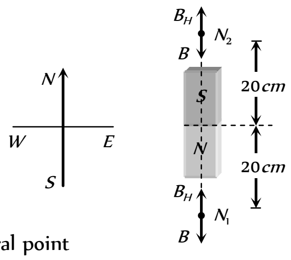
$= \sqrt{5} \cdot \frac{\mu_0}{4\pi} \cdot \frac{M}{d^3} = \sqrt{5} \times 10^{-7} \times \frac{10}{(0.1)^3} = \sqrt{5} \times 10^{-3}$ *Tesla.*

92. (c) $\tau = MB\sin\theta = m \times (2l) \times B\sin\theta$

$= 10^{-4} \times 0.1 \times 30 \sin 30° = 1.5 \times 10^{-4}\, Nm$

Earth Magnetism

1. (b)



At neutral point

$|B| = |B_H| \Rightarrow \frac{2M}{(20)^3} = 0.3 \Rightarrow M = 1.2 \times 10^3\, emu.$

2. (d) No magnetic lines of force passes through the steel box.

3. (b) At magnetic poles, the angle of dip is 90°. Hence the horizontal component $B_H = B\cos\theta = 0$.

4. (a)

5. (c)

6. (c)

7. (d) $B_H = \sqrt{3}\, B_V$, also $\tan\theta = \frac{B_V}{B_H} = \frac{1}{\sqrt{3}} \Rightarrow \theta = 30^o$

8. (d) At magnetic equator, the angle of dip is 0°. Hence the vertical component $V = I\sin\phi = 0$.

9. (b)

10. (a)

11. (c) $B_V = H_H \tan\phi$; If $B_V = B_H$, then $\tan\phi = 1$ or $\phi = 45^o$

12. (a) The horizontal components are $(B_H)_1 = B\cos\phi_1$ and $(B_H)_2 = B\cos\phi_2$

$\therefore \frac{(B_H)_1}{(B_H)_2} = \frac{\cos\phi_1}{\cos\phi_2} = \frac{\cos 30^o}{\cos 45^o} = \frac{\sqrt{3}}{2} \times \sqrt{2} = \frac{\sqrt{3}}{\sqrt{2}}$

13. (d) From the relation $B_H = B\cos\phi$ and $B_V = B\sin\phi$

$\frac{B_V}{B_H} = \tan\phi$ or $B_V = B_H \tan\phi$

$= 0.36 \times 10^{-4} \times \tan 60^o = 0.623 \times 10^{-4}\ Wb/m^2$

14. (d) From the relation $B_V = I\sin\phi$

$I = \frac{V}{\sin\phi} = \frac{6\times10^{-5}}{\sin 40.6^o} = \frac{6\times10^{-5}}{0.65} = 9.2\times10^{-5}$ *tesla*

15. (c)

16. (c) $B_H = B\cos\phi; \therefore B = \frac{B_H}{\cos\phi} = \frac{0.5}{\cos 30^o} = \frac{0.5}{\sqrt{3}/2} = \frac{1}{\sqrt{3}}$

17. (a)

18. (d)

19. (b)

20. (e)

21. (b)

22. (d)

23. (a) $\tan\phi = \frac{B_V}{B_H} = \frac{0.173}{0.30} = \frac{1.73}{3.0} = \frac{\sqrt{3}}{3} = \frac{1}{\sqrt{3}} \Rightarrow \phi = 30^o$

24. (d) $B_H = B\cos\phi = 0.64\times\cos 60^o = 0.64\times\frac{1}{2} = 0.32$ units

25. (b)

26. (d)

27. (a)

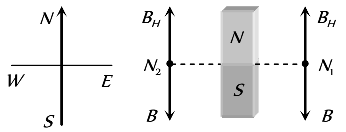
28. (a) $B_H = 0.3\ Oersted,\ I = 0.6\ Oersted$

We have $B_H = I\cos\phi \Rightarrow \cos\phi = \frac{B_H}{I} = \frac{0.3}{0.6} = \frac{1}{2}$

$\therefore \phi = 60^o$

29. (d)

30. (b)



31. (d) At broad side-on position $B = \frac{M}{d^3}$

$\therefore \frac{M_1}{d_1^3} = \frac{M_2}{d_2^3}\ or\ \frac{M_1}{r^3} = \frac{M_2}{8r^3}\ or\ \frac{M_1}{M_2} = \frac{r^3}{8r^3} = \frac{1}{8}$

32. (a)

33. (c) $B^2 = B_V^2 + B_H^2 \Rightarrow B_V = \sqrt{B^2 - B_H^2} = \sqrt{(0.5)^2 - (0.3)^2} = 0.4$

Now $\tan\phi = \frac{B_V}{B_H} = \frac{0.4}{0.3} = \frac{4}{3} \Rightarrow \phi = \tan^{-1}\left(\frac{4}{3}\right)$.

34. (a) Horizontal component $B_H = B\cos\phi$

Total intensity of earth magnetic field $B = \frac{B_H}{\cos\phi}$

$= \frac{1.8\times10^5}{\cos 30^o} = \frac{1.8\times10^{-5}}{\sqrt{3}/2} = 2.08\times10^{-5}\,Wb/m^2$

35. (a)

36. (c)

37. (a) The vertical component of earth's magnetic field is zero at equator where angle of dip is also zero.

38. (d) $B_0 = V_0$ also total intensity $B = \sqrt{B_0^2 + V_0^2} \Rightarrow B = \sqrt{2}B_0$

39. (a) At poles magnetic field is perpendicular to the surface of earth.

40. (a)

41. (a)

42. (c) At neutral point

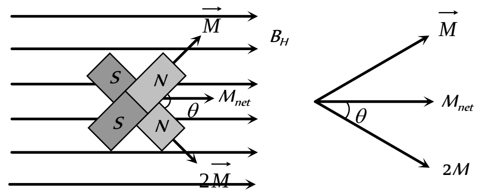
$\left|\begin{matrix}\text{Magnetic field due}\\ \text{to magnet}\end{matrix}\right| = \left|\begin{matrix}\text{Magnetic field due}\\ \text{to earth}\end{matrix}\right|$

$\frac{\mu_0}{4\pi}.\frac{2M}{d^3} = 5\times10^{-5} \Rightarrow 10^{-7}\times\frac{2\times6.75}{d^3} = 5\times10^{-5}$

$\Rightarrow d = 0.3\ m = 30\ cm$

43. (c) As they enter the magnetic field of the earth, they are deflected away from the equator.

44. (c)



$\Rightarrow \tan\theta = \frac{M}{2M} = \frac{1}{2} \Rightarrow \theta = \tan^{-1} = \frac{1}{2}$

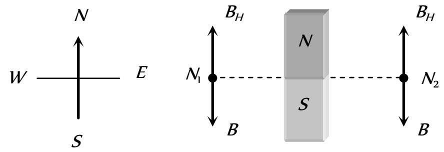
45. (a)

46. (b) $B_H = B\sin\phi \Rightarrow B = \frac{B_H}{\sin\phi} \Rightarrow B = \frac{B_o}{\sin 45^o} = \sqrt{2}B_0$

47. (c)

48. (a)

49. (a)



N_1 and N_2 are two null points. And

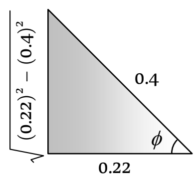
B_H = Horizontal component of earth's magnetic field

B = Magnetic field due to bar magnet.

50. (c)

51. (b) $B_H = B\cos\phi \Rightarrow B = \frac{B_H}{\cos\phi} \Rightarrow B = \frac{B_H}{\cos 30^o} = \frac{2B_H}{\sqrt{3}}$

52. (c) By using $B_H = B\cos\phi$



$\Rightarrow \cos\phi = \frac{B_H}{B} = \frac{0.22}{0.4}$

$\Rightarrow \tan\phi = \frac{\sqrt{(0.4)^2 - (0.22)^2}}{0.22}$

$\Rightarrow \phi = \tan^{-1}(1.518)$

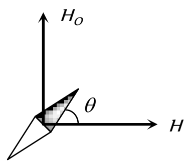
53. (b)

54. (d) At equator angle of dip is zero.

55. (c)

56. (a) In given case H and H_0 are perpendicular to each other.

From figure $\tan\theta = \frac{H_0}{H}$



$\Rightarrow \theta = \tan^{-1}\left(\frac{H_0}{H}\right)$

57. (a)
58. (b)
59. (a)

Magnetic Equipments

1. (d)
2. (c)
3. (a)

4. (b) In sum position : $T_S = 2\pi\sqrt{\frac{I_s}{(M_1+M_2)B_H}}$

In difference position : $T_d = 2\pi\sqrt{\frac{I_d}{(M_1-M_2)B_H}}$

It is clear that $T_d > T_s$

5. (d) $T = 2\pi\sqrt{\frac{I}{MB_H}}; \therefore \frac{T_1}{T_2} = \sqrt{\frac{(B_H)_2}{(B_H)_1}} \Rightarrow T_2 = T_1\sqrt{\frac{(B_H)_1}{(B_H)_2}}$

Here n=30 *oscillation / min* $= \frac{1}{2}$ *oscillation/sec*

$\therefore T_1 = \frac{1}{n_1} = 2\,\sec$

$\therefore T_2 = 2\sqrt{\frac{B_H}{2B_H}} = 2\times\frac{1}{\sqrt{2}} = \sqrt{2}\,\sec$

6. (d)

7. (a) $T = 2\pi\sqrt{\frac{1}{MB_H}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{M_2}{M_1}}$

$\Rightarrow \frac{M_1}{M_2} = \frac{T_2^2}{T_1^2} = \frac{(60/15)^2}{(60/10)^2} = \frac{4}{9}$

8. (c) When magnet of length l is cut into four equal parts. then $m' = \frac{m}{2}$ and $l' = \frac{l}{2}$; $\therefore M' = \frac{m}{2}\times\frac{l}{2} = \frac{ml}{4} = \frac{M}{4}$

New moment of inertia $I' = \frac{wl^2}{12} = \frac{\frac{w}{4}.\left(\frac{1}{2}\right)^2}{12} = \frac{1}{16}.\frac{wl^2}{12}$

Here w is the mass of magnet.

$\therefore I' = \frac{1}{16}I$; Time period of each part $T' = 2\pi\sqrt{\frac{I'}{M'B_H}}$

$= 2\pi\sqrt{\frac{I/16}{(M/4)B_H}} = 2\pi\sqrt{\frac{I}{4MB_H}} = \frac{T}{2}$

9. (c) $T = 2\pi\sqrt{\frac{I_1+I_2}{(M_1-M_2)B_H}}$

Here $M_1 = M_2 = M$, $\therefore T = \infty$

10. (b) Time period in vibration magnetometer

$T = 2\pi\sqrt{\frac{I}{MB_H}}$, At poles $B_H = 0$ *so* $T = \infty$

11. (c)

12. (a) $\frac{T_1}{T_2} = \sqrt{\frac{M_2}{M_1}} = \sqrt{\frac{4M}{M}} = 2 \Rightarrow \frac{2}{T_2} = 2 \Rightarrow T_2 = 1\,\sec$

13. (a) $T = 2\pi\sqrt{\frac{I}{MB_H}}$

$I = 40gm - cm^2 = 400\times10^{-8}kg - m^2$

$\therefore 3 = 2\pi\sqrt{\frac{400\times10^{-8}}{36\times10^{-6}\times M}}$

$\Rightarrow \frac{1}{M} = \frac{9}{4\pi^2}\times\frac{36}{4} \Rightarrow M = 0.5\ A\times m^2$

14. (a)

15. (b) Because moment of inertia increases i.e. $T \propto \sqrt{I}$

16. (b) $T = 2\pi\sqrt{\frac{I}{MB_H}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{(B_H)_2}{(B_H)_1}}$

$\Rightarrow T_2 = T\sqrt{\frac{(BH)_1}{(BH)_2}} = \frac{T}{2}$ $(\because (B_H)_2 = 4(B_H)_1)$

17. (b) In sum position $T \propto \frac{1}{\sqrt{M_1+M_2}}$ and in difference position

$T \propto \frac{1}{\sqrt{M_1-M_2}}$

$\Rightarrow \frac{3^2}{T^2} = \frac{2M-M}{2M+M} \Rightarrow T^2 = 9\times3\,\sec^2$

$\therefore T = 3\sqrt{3}\,\sec$

18. (d)

19. (b) Given $\nu_1 = \frac{20}{60} = \frac{1}{3}\sec^{-1}$ and $\nu_2 = \frac{15}{60} = \frac{1}{4}\sec^{-1}$

Now $\nu = \frac{1}{2\pi}\sqrt{\frac{MB_H}{I}} = \frac{1}{2\pi}\sqrt{\frac{MB\cos\phi}{I}}$ $(\because B_H = B\cos\phi)$

$\therefore \frac{\nu_1}{\nu_2} = \sqrt{\frac{B_1\cos\phi_1}{B_2\cos\phi_2}} \Rightarrow \frac{B_1}{B_2} = \left(\frac{\nu_1}{\nu_2}\right)^2\left(\frac{\cos\phi_2}{\cos\phi_1}\right)^2$

$\Rightarrow \frac{B_1}{B_2} = \left(\frac{1/3}{1/4}\right)^2\frac{\cos 60°}{\cos 30°} = \frac{16}{9}\times\frac{1/2}{\sqrt{3}/2} = \frac{16}{9\sqrt{3}}$.

20. (c) $T \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{M_2}{M_1}} \Rightarrow \frac{1.5}{T_2} = \sqrt{\frac{M_1/4}{M_1}} = \frac{1}{2}$

$\Rightarrow T_2 = 3\,\sec$

21. (c) $\nu = \frac{1}{2\pi}\sqrt{\frac{MB_H}{I}} \Rightarrow \nu \propto \sqrt{M}$

$\Rightarrow \frac{\nu_A}{\nu_B} = \sqrt{\frac{M_A}{M_B}} \Rightarrow \frac{2}{1} = \sqrt{\frac{M_A}{M_B}} \Rightarrow M_A = 4M_B$

22. (c) $T = 2\pi\sqrt{\frac{I}{MB_H}} \Rightarrow T \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{M_A}{M_B} = \left(\frac{T_B}{T_A}\right)^2 = \frac{4}{1}$

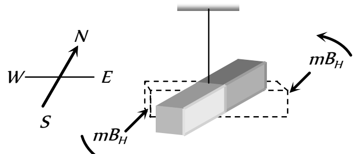
23. (c) No. of oscillation per minute $= \frac{1}{2\pi}\sqrt{\frac{MB_H}{I}}$

$\Rightarrow n \propto \sqrt{MB_H}$; $M \to 4$ *times*

$B_H \to 2$ *times*

So $\nu \to \sqrt{8}$ *times i.e.* $\nu' = \sqrt{8}\nu = 2\sqrt{2}n$

24. (c)



25. (a) $T = 2\pi\sqrt{\frac{I}{MH}} \Rightarrow T \propto \frac{1}{\sqrt{H}} \Rightarrow \frac{T_A}{T_B} = \sqrt{\frac{H_B}{H_A}}$

$\Rightarrow \frac{H_A}{H_B} = \left(\frac{T_B}{T_A}\right)^2 = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$.

26. (a) $T = 2\pi\sqrt{\frac{I}{MB_H}}$ and $I = \frac{w(l^2+b^2)}{12}$; $\therefore T \propto \sqrt{w}$

(w = Mass of the magnet)

27. (c) $T_{Sum} = 2\pi\sqrt{\frac{(I_1+I_2)}{(M_1+M_2)B_H}}$

$T_{diff} = 2\pi\sqrt{\frac{I_1+I_2}{(M_1-M_2)B_H}}$

$\Rightarrow \frac{T_s}{T_d} = \frac{T_1}{T_2} = \sqrt{\frac{M_1-M_2}{M_1+M_2}} = \sqrt{\frac{2M-M}{2M+M}} = \frac{1}{\sqrt{3}}$

28. (a) $T = 2\pi\sqrt{\frac{I}{MB}} \Rightarrow \frac{T}{T'} = \sqrt{\frac{B'}{B}} = \sqrt{\frac{B}{B_H}}$

$\Rightarrow \frac{T}{T'} = \sqrt{\frac{1}{\cos\phi}} = \sqrt{\frac{1}{\cos 60^o}} = \sqrt{2} \Rightarrow T' = \frac{T}{\sqrt{2}}$

29. (a)

30. (a)

31. (b) For tangent galvanometer $I = \frac{2rB}{\mu_0 n}\tan\theta$

$\therefore \tan\theta = \frac{I\mu_0 n}{2rB} = \frac{0.1\times 4\pi\times 10^{-7}\times 50}{0.04\times 7\times 10^{-5}\times 2} = 1.12$

or $\theta = \tan^{-1}(1.12) = 48.2^o$

32. (d) Time period of a magnet $T = 2\pi\sqrt{\frac{I}{MB}}$

or $I = \frac{T^2 MB}{4\pi^2} = \frac{225\times 5\times 10^{-5}\times 8\pi\times 10^{-4}}{4\pi^2}$

$\therefore I = 7.16\times 10^{-7}\, kg - m^2$

33. (b) $T = 2\pi\sqrt{\frac{I}{MB_H}} = 4$ sec

When magnet is cut into two equal halves, then New magnetic moment $M' = \frac{M}{2}$

New moment of inertia $I' = \frac{(w/2)(l/2)^2}{12} = \frac{1}{8}\cdot\frac{wl^2}{12}$

Where w is the initial mass of the magnet

But $I = \frac{wl^2}{12}$; $\therefore I' = \frac{I}{8}$

$\therefore$ New time period $T' = 2\pi\sqrt{\frac{I'}{M'B_H}}$

$= 2\pi\sqrt{\frac{I/8}{(M/2)B_H}} = \frac{1}{2}2\pi\sqrt{\frac{I}{M_H}} = \frac{1}{2}\times T = \frac{1}{2}\times 4 = 2$ sec

34. (d)

35. (a) $K = \frac{2RB_H}{\mu_0 N}$ (R = radius, N= number of turns)

36. (c) $T \propto \frac{1}{\sqrt{M}}$. Since magnetic moment decreases with increase in temperature hence time period T increases.

37. (b) Sensitivity $S = \frac{\theta}{i} = \frac{\theta}{K\tan\theta}$ where $K = \frac{2RB_H}{\mu_0 N}$

For increasing sensitivity K should be decreased and hence number of turns should be increased.

38. (d) In the first galvanometer

$i_1 = K_1\tan\theta_1 = K_1\tan 60^o = K_1\sqrt{3}$

In the second galvanometer

$i_2 = K_2\tan\theta_2 = K_2\tan 45^o = K_2$

In series $i_1 = i_2 \Rightarrow K_1\sqrt{3} = K_2 \Rightarrow \frac{K_1}{K_2} = \frac{1}{\sqrt{3}}$

But $K \propto \frac{1}{n} \Rightarrow \frac{K_1}{K_2} = \frac{n_2}{n_1}$ $\therefore \frac{n_1}{n_2} = \frac{\sqrt{3}}{1}$.

39. (b) $T = 2\pi\sqrt{\frac{I}{MB_H}}$. If Q is an identical bar magnet then time period of system will be $T' = 2\pi\sqrt{\frac{2I}{(2M)B_H}} = T$

40. (a) Frequency $\nu \propto \sqrt{B_H}$

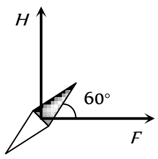
41. (b) In tangent galvanometer, $I \propto \tan\theta$

$$\therefore \frac{I_1}{I_2} = \frac{\tan\theta_1}{\tan\theta_2} \Rightarrow \frac{I_1}{I_1/\sqrt{3}} = \frac{\tan 45^0}{\tan\theta_2}$$

$$\Rightarrow \sqrt{3}\tan\theta_2 = 1 \Rightarrow \tan\theta_2 = \frac{1}{\sqrt{3}} \Rightarrow \theta_2 = 30^o$$

So deflection will decrease by 45°- 30° = 15°.

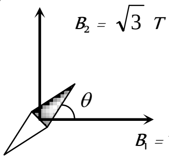
42. (d) From figure at equilibrium



$$\tan 60° = \frac{H}{F}$$

$$\Rightarrow \sqrt{3} = \frac{H}{F} \Rightarrow \frac{F}{H} = \frac{1}{\sqrt{3}}$$

43. (d) In balance condition $B_2 = B_1 \tan\theta$



$$\Rightarrow \tan\theta = \frac{\sqrt{3}}{1}$$

$$\Rightarrow \theta = 60^o$$

44. (d) In the sum and difference method of vibration magnetometer

$$\frac{M_1}{M_2} = \frac{T_2^2 + T_1^2}{T_2^2 - T_1^2}$$

Here $T_1 = \frac{1}{n_1} = \frac{60}{12} = 5\,\text{sec}$. $T_2 = \frac{1}{n_2} = \frac{60}{4} = 15\,\text{sec}$

$$\therefore \frac{M_1}{M_2} = \frac{15^2 + 5^2}{15^2 - 5^2} = \frac{225+25}{225-25} = \frac{5}{4}$$

45. (c)

46. (b) $i \propto \tan\theta \Rightarrow \frac{i_1}{i_2} = \frac{\tan\theta_1}{\tan\theta_2} \Rightarrow \frac{\sqrt{3}}{3} = \frac{\tan 30^o}{\tan\theta_2} \Rightarrow \theta = 45^o$

47. (b) $T = 2\pi\sqrt{\frac{I}{MB}} = 2\pi\sqrt{\frac{wl^2/12}{\text{Pole strength} \times 2l \times B}}$

$$\therefore T \propto \sqrt{Wl}$$

$$\therefore \frac{T_2}{T_1} = \sqrt{\frac{w_2}{w_1} \times \frac{l_2}{l_1}} = \sqrt{\frac{w_1/2}{w_1} \times \frac{l_1/2}{l_1}} = \frac{1}{2}$$

$$\Rightarrow T_2 = \frac{T_1}{2} = 0.5\ sec$$

48. (d) $T' = \frac{T}{n} \Rightarrow T' = \frac{2}{2} = 1 sec$

49. (c) It is due to the magnetic field produced by coil.

50. (d)

51. (c) $T = 2\pi\sqrt{\frac{I}{MB_H}} \Rightarrow T \propto \sqrt{I} \propto \sqrt{w} \Rightarrow T' = \sqrt{2}\ T_0$

52. (d) $\frac{M_1}{M_2} = \left(\frac{d_1}{d_2}\right)^3 \Rightarrow \frac{27}{8} = \left(\frac{d_1}{0.12}\right)^3$

$$\Rightarrow \frac{3}{2} = \frac{d_1}{0.12} \Rightarrow 0.18\ m$$

53. (c) $T = 2\pi\sqrt{\frac{I}{MB_H}} \Rightarrow T \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{M_2}{M_1}}$

If M_1 =100 than M_2 (100 – 19) = 81

So $\frac{T_1}{T_2} = \sqrt{\frac{81}{100}} = \frac{9}{10} \Rightarrow T_2 = \frac{10}{9}T_1 = 1.11\,T_1$

⇒ Time period increases by 11%

54. (b) $T = 2\pi\sqrt{\frac{I}{M \times B_H}} \Rightarrow T \propto \frac{1}{\sqrt{B_H}}$

$$\Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{(B_H)_2}{(B_H)_1}} \Rightarrow \frac{60/40}{2.5} = \sqrt{\frac{(B_H)_2}{0.1 \times 10^{-5}}}$$

$$\Rightarrow (B_H)_2 = 0.36 \times 10^{-6}\,T$$

55. (a) $i = \frac{2rB_H}{\mu_0 N}\tan\theta$

$$\Rightarrow i = \frac{2 \times 15 \times 10^{-2} \times 3 \times 10^{-5}}{4\pi \times 10^{-7} \times 25} \times \tan 45^o \Rightarrow i = 0.29\ A$$

56. (a) $T = 2\pi\sqrt{\frac{I}{MB_H}}$; $I \to 3$ times and $M \to \frac{1}{3}$ times

So $T \to 3$ times *i.e.* $T' = 3T_0$

57. (c) In case of tangent galvanometer as

$$i = k\tan\phi$$

Differentiating both side *w.r.t.* ϕ

$$\frac{di}{d\phi} = k\sec^2\phi \Rightarrow di = k\sec^2 d\phi$$

$$\Rightarrow \frac{di}{i} = \frac{d\phi}{\sin\phi\cos\phi} = \frac{2d\phi}{\sin 2\phi}$$

Hence the error in the measurement will be least when

$$\sin 2\phi = \text{max} = 1 \Rightarrow 2\phi = 90^o \Rightarrow \phi = 45^o$$

58. (a)

59. (a) $T' = \frac{T}{n}$

60. (c) $\frac{T_A}{T_B} = \sqrt{\frac{(B_H)_B}{(B_H)_A}} \Rightarrow \frac{60/10}{60/20} = \sqrt{\frac{(B_H)_B}{36 \times 10^{-6}}}$

$$\Rightarrow (B_H)_B = 144 \times 10^{-6}\,T$$

61. (d) $i \propto \tan\phi \Rightarrow \frac{i_1}{i_2} = \frac{\tan\phi_1}{\tan\phi_2}$

$$\Rightarrow \frac{2}{i_2} = \frac{\tan 30}{\tan 60} \Rightarrow i_2 = 6\ amp$$

62. (a) In tangent galvanometer experiment. The plane of the coil firstly set in the magnetic meridian.

63. (c) $T \propto \frac{1}{\sqrt{M}} \Rightarrow T \propto \frac{1}{\sqrt{m}}$; If $m \to 4$ times.

$T \to \frac{1}{2}$ times i.e. $T' = \frac{T}{2} = \frac{2}{2} = 1\,\text{sec}$

64. (d) $\frac{M_1}{M_2} = \frac{\tan\theta_1}{\tan\theta_2} \Rightarrow \frac{m_1 L_1}{m_2 L_2} = \frac{\tan\theta_1}{\tan\theta_2}$

$\Rightarrow \frac{m_1}{m_2} = \frac{2}{1} \times \frac{\tan 45°}{\tan 30°} = \frac{2\sqrt{3}}{1}$

65. (b) $B = B_H \tan\theta = 0.34 \times 10^{-4} \tan 30° = 1.96 \times 10^{-5}\,T$

66. (b) $i \propto \tan\phi \Rightarrow \frac{i_1}{i_2} = \frac{\tan\phi_1}{\tan\phi_2}$

$\Rightarrow \frac{0.1}{i_2} = \frac{\tan 30°}{\tan 60°} = \frac{1}{3} \Rightarrow i_2 = 0.3A$

67. (a) As $T \propto \sqrt{I}$; where I = moment of inertia

$= \frac{wL^2}{12} \Rightarrow T \propto \sqrt{w}$ (w = Mass of magnet. If w $\to$ quadrupled, then $T \to$ doubled *i.e.* $T' = 2T$

68. (c) Oscillation of n part of magnet $T' = \frac{T}{n}$

$\Rightarrow \frac{T'}{T} = \frac{1}{n}$; here $n = 2$ so $\frac{T'}{T} = \frac{1}{2}$.

69. (b) $T = 2\pi\sqrt{\frac{I}{M B_H}}$; where $I = \frac{w(L^2 + b^2)}{12}$

(w =Mass of magnet)

$\Rightarrow T \propto \sqrt{w}$, If w $\to$ four times then $T \to$ Two times

70. (b) Initially, the time period of the magnet

$T = 2 = 2\pi\sqrt{\frac{I}{MB}}$ ..... (i)

For each part, it's moment of inertia $= \frac{I}{27}$ and magnetic moment $= \frac{M}{3}$

$\therefore$ Moment of inertia of system $I_s = \frac{I}{27} \times 3 = \frac{I}{9}$

Magnetic moment of system $M_s = \frac{M}{3} \times 3 = M$

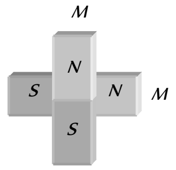
Time period of system

$T_s = 2\pi\sqrt{\frac{I_s}{M_s B}} = \frac{1}{3} \times 2\pi\sqrt{\frac{I}{MB}} = \frac{T}{3} = \frac{2}{3}\,\text{sec}$

71. (c) $T \propto \frac{1}{\sqrt{B_H}} = \frac{1}{\sqrt{B\cos\phi}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{B_2\cos\phi_2}{B_1\cos\phi_1}}$

$\Rightarrow \frac{B_1}{B_2} = \frac{T_2^2}{T_1^2} \times \frac{\cos\phi_2}{\cos\phi_1} = \left(\frac{3}{2}\right)^2 \times \frac{\cos 60°}{\cos 30°} \Rightarrow \frac{B_1}{B_2} = \frac{9}{4\sqrt{3}}$

72. (c) Time period of combination



$T = 2\pi\sqrt{\frac{2I}{\sqrt{2}\,M.H}}$ .....(i)

and time period of each magnet

$T' = 2\pi\sqrt{\frac{I}{MH}}$ ......(ii)

from (i) and (ii) we get

$T' = \frac{T}{2^{1/4}} = 2^{-1/4}\,T$

73. (b) $B = B_H \tan\theta \Rightarrow \frac{\mu_0 ni}{2r} = B_H \tan\theta$

$\Rightarrow i = \frac{2r.\,B_H \tan\theta}{\mu_0 n} = \frac{2 \times 0.1 \times 4 \times 10^{-5}}{10 \times 4\pi \times 10^{-7}} = 1.1A$

Magnetic Materials

1. (c)
2. (a) Neon atom is diamagnetic, hence it's net magnetic moment is zero.
3. (a) Soft iron is highly ferromagnetic.
4. (d)
5. (b) On heating, different domains have net magnetisation in them which are randomly distributes. Thus the net magnetisastion of the substance due to various domains decreases to minimum.
6. (b) Repelled due to induction of similar poles.
7. (d) From the characteristic of *B-H* curve.
8. (c)
9. (d)
10. (b)
11. (a)
12. (c) The property of paramagnetism is found in these substances whose atoms have an excess of electrons spinning in the same direction. Hence atoms of paramagnetic substances have a net non-zero magnetic moment of their own.
13. (c)
14. (a)
15. (a, b)
16. (d) $\chi_m = (\mu_r - 1) \Rightarrow \chi_m = (5500 - 1) = 5499$
17. (b)
18. (b)
19. (c)
20. (b) Because, diamagnetic substance, moves from stronger magnetic field to weaker field.
21. (d)

22. (b) With rise in temperature their magnetic susceptibility decreases *i.e.* $\chi_m \propto \frac{1}{T}$

23. (c)

24. (b)

25. (c) Diamagnetic substances are repelled by magnetic field.

26. (b) As we know for circulating electron magnetic moment

$$M = \frac{1}{2}evr \quad \text{...... (i)}$$

and angular momentum $J = mvr$ ...... (ii)

From equation (i) and (ii) $M = \frac{eJ}{2m}$

27. (b)

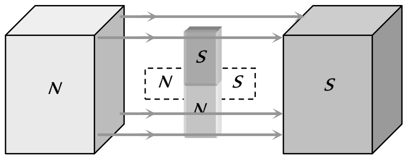
28. (a)

29. (c) The energy lost per unit volume of a substance in a complete cycle of magnetisation is equal to the area of the hysteresis loop.

30. (c)

31. (d)

32. (a) A diamagnetic rod set itself perpendicular to the field if free to rotate between the poles of a magnet as in this situation the field is strongest near the poles.



33. (c)

34. (b)

35. (b) Diamagnetic substances are repelled by the magnetic field.

36. (d)

37. (b)

38. (b)

39. (c)

40. (b)

41. (d) Net magnetic induction $B = B_0 + B_m = \mu_0 H + \mu_0 M$

42. (c)

43. (d) $\mu_r = \frac{B}{B_0} = 4$

44. (d)

45. (a)

46. (b)

47. (c)

48. (c) Susceptibility of diamagnetic substance is negative and it does not change with temperature.

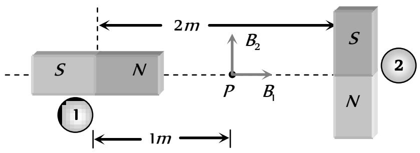
49. (a)

50. (d) When a ferromagnetic material in heated above its curie temperature then it behaves like paramagnetic material.

Critical Thinking Questions

1. (b) With respect to 1st magnet, *P* lies in end side-on position

$$\therefore B_1 = \frac{\mu_0}{4\pi}\left(\frac{2M}{d^3}\right) \quad \text{(RHS)}$$



With respect to 2nd magnet. *P* lies in broad side on position.

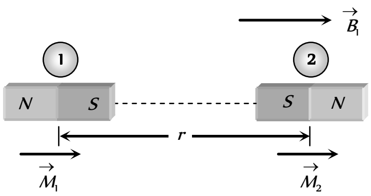
$$\therefore B_2 = \frac{\mu_0}{4\pi}\left(\frac{M}{d^3}\right) \quad \text{(Upward)}$$

$$B_1 = 10^{-7} \times \frac{2 \times 1}{1} = 2 \times 10^{-7}\,T,\ B_2 = \frac{B_1}{2} = 10^{-7}\,T$$

As B_1 and B_2 are mutually perpendicular, hence the resultant magnetic field

$$B_R = \sqrt{B_1^2 + B_2^2} = \sqrt{(2\times10^{-7})^2 + (10^{-7})^2} = \sqrt{5}\times10^{-7}\,T$$

2. (d)



Both the magnets are placed in the field of one another, hence potential energy of dipole (2) is

$$U_2 = -M_2 B_1 \cos 0 = -M_2 B_1 = M_2 \times \frac{\mu_0}{4\pi}.\frac{2M_1}{r^3}$$

By using $F = -\frac{dU}{dr}$, Force on magnet (2) is

$$F_2 = -\frac{dU_2}{dr} = -\frac{d}{dr}\left(\frac{\mu_0}{4\pi}.\frac{2M_1M_2}{r^3}\right) = -\frac{\mu_0}{4\pi}.6\frac{M_1M_2}{r^4}$$

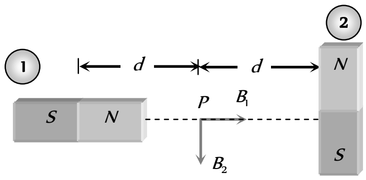
It can be proved $|F_1| = |F_2| = F = \frac{\mu_0}{4\pi}.\frac{6M_1M_2}{r^4}$

$$\Rightarrow F \propto \frac{1}{r^4}$$

3. (d) At point *P* net magnetic field $B_{net} = \sqrt{B_1^2 + B_2^2}$

where $B_1 = \frac{\mu_0}{4\pi}.\frac{2M}{d^3}$ and $B_2 = \frac{\mu_0}{4\pi}.\frac{M}{d^3}$

$$\Rightarrow B_{net} = \frac{\mu_0}{4\pi}.\frac{\sqrt{5}M}{d^3}$$



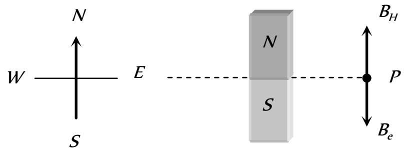
4. (a) Let the real dip be ϕ, then $\tan\phi = \frac{B_V}{B_H}$

For apparent dip,

$$\tan\phi' = \frac{B_V}{B_H\cos\beta} = \frac{B_V}{B_H\cos 30^o} = \frac{2B_V}{\sqrt{3}B_H}$$

or $\tan 45^o = \frac{2}{\sqrt{3}}.\tan\phi$ or $\phi = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

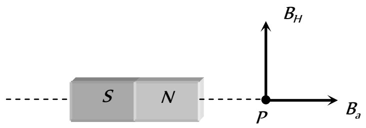
5. (d) Initially



Neutral point obtained on equatorial line and at neutral point $|B_H| = |B_e|$

where B_H = Horizontal component of earth's magnetic field, B_e = Magnetic field due to bar magnet on it's equatorial line

Finally



Point P comes on axial line of the magnet and at P, net magnetic field $B = \sqrt{B_a^2 + B_H^2}$

$$= \sqrt{(2B_e)^2 + (B_H)^2} = \sqrt{(2B_H)^2 + B_H^2} = \sqrt{5}\ B_H$$

6. (b) $\tan\phi' = \frac{\tan\phi}{\cos\beta}$; where ϕ' =Apparent angle of dip,

ϕ = True angle of dip, β =Angle made by vertical plane with magnetic meridian.

$$\Rightarrow \tan\phi' = \frac{\tan 60^o}{\cos 30^o} = 2 \Rightarrow \phi' = \tan^{-1}(2)$$

7. (c) Initially magnetic moment of system

$M_1 = \sqrt{M^2 + M^2} = 2M$ and moment of inertia

$I_1 = I + I = 2I.$

Finally when one of the magnet is removed then

$M_2 = M$ and $I_2 = I$

So $T = 2\pi\sqrt{\frac{I}{M\ B_H}}$

$$\frac{T_1}{T_2} = \sqrt{\frac{I_1}{I_2}\times\frac{M_2}{M_1}} = \sqrt{\frac{2I}{I}\times\frac{M}{\sqrt{2}M}} \Rightarrow T_2 = \frac{2^{5/4}}{2^{1/4}} = 2\text{ sec}.$$

8. (b) $T \propto \frac{1}{\sqrt{H}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{H_2}{H_1}} \Rightarrow \frac{2}{1} = \sqrt{\frac{H+F}{H}} \Rightarrow F = 3H$

or $\frac{H}{F} = \frac{1}{3}$

9. (b) Relation for dipole moment is, $M = I\times V$. Volume of the cylinder $V = \pi r^2 l$, Where r is the radius and l is the length of the cylinder, then dipole moment,

$$M = I\pi r^2 l = (5.30\times10^3)\times\frac{22}{7}\times(0.5\times10^{-2})^2(5\times10^{-2})$$

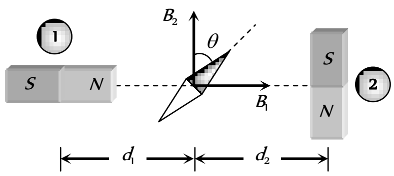
$$= 2.08\times10^{-2}\ J/T$$

10. (b) For equilibrium of the system torques on M_1 and M_2 due to B_H must counter balance each other *i.e.* $M_1\times B_H = M_2\times B_H$. If θ is the angle between M_1 and B_H will be $(90-\theta)$; so $M_1 B_H\sin\theta = M_2 B_H\sin(90-\theta)$

$$\Rightarrow \tan\theta = \frac{M_2}{M_1} = \frac{M}{3M} = \frac{1}{3} \Rightarrow \theta = \tan^{-1}\left(\frac{1}{3}\right)$$

11. (a) $I = \frac{M}{V} = \frac{\mu N}{V} = \frac{1.5\times10^{-23}\times2\times10^{26}}{1} = 3\times10^3\ Amp/m$

12. (c) In equilibrium $B_1 = B_2\tan\theta$

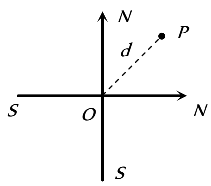


$$\Rightarrow \frac{\mu_0}{4\pi}.\frac{2M}{d_1^3} = \frac{\mu_0}{4\pi}.\frac{M}{d_2^3}\tan\theta$$

$$\Rightarrow \frac{d_1}{d_2} = (2\cot\theta)^{1/3}$$

13. (c) Resultant magnetic moment of the two magnets is

$$M_{net} = \sqrt{M^2 + M^2} = \sqrt{2}M$$



Imagine a short magnet lying along OP with magnetic moment equal to $M\sqrt{2}$. Thus point P lies on the axial line of the magnet.

$\therefore$ Magnitude of magnetic field at P is given by

$$B = \frac{\mu_0}{4\pi}.\frac{2\sqrt{2}M}{d^3}$$

14. (a) On passing current through the coil, it acts as a magnetic dipole. Torque acting on magnetic dipole is counter balanced by the moment of additional weight about position O. Torque acting on a magnetic dipole

$$\tau = MB\sin\theta = (NiA)B\sin 90^o = NiAB.$$

Again $\tau = Force \times Lever\ arm = \Delta mg \times l$

$\Rightarrow NiAB = \Delta mgl$

$\Rightarrow B = \frac{\Delta mgl}{NiA} = \frac{60\times10^{-3}\times9.8\times30\times10^{-2}}{200\times22\times10^{-3}\times1\times10^{-4}} = 0.4\ T$

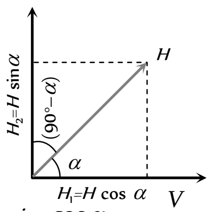
15. (a) The weight of upper magnet should be balanced by the repulsion between the two magnet

$\therefore \frac{\mu}{4\pi}.\frac{m^2}{r^2} = 50gm - wt$

$\Rightarrow 10^{-7}\times\frac{m^2}{(9\times10^{-6})} = 50\times10^{-3}\times9.8$

$\Rightarrow m = 6.64amp\times m$

16. (d) Let α be the angle which one of the planes make with the magnetic meridian the other plane makes an angle $(90^o - \alpha)$ with it. The components of H in these planes will be $H\cos\alpha$ and $H\sin\alpha$ respectively. If ϕ_1 and ϕ_2 are the apparent dips in these two planes, then



$\tan\phi_1 = \frac{V}{H\cos\alpha}$ i.e. $\cos\alpha = \frac{V}{H\tan\phi_1}$ ..... (i)

$\tan\phi_2 = \frac{V}{H\sin\alpha}$ i.e. $\sin\alpha = \frac{V}{H\tan\phi_2}$ ..... (ii)

Squaring and adding (i) and (ii), we get

$\cos^2\alpha + \sin^2\alpha = \left(\frac{V}{H}\right)^2\left(\frac{1}{\tan^2\phi_1} + \frac{1}{\tan^2\phi_2}\right)$

i.e. $1 = \frac{V^2}{H^2}\left(\cot^2\phi_1 + \cot^2\phi_2\right)$

or $\frac{H^2}{V^2} = \cot^2\phi_1 + \cot^2\phi_2$ i.e. $\cot^2\phi = \cot^2\phi_1 + \cot^2\phi_2$

This is the required result.

17. (c) The number of atoms per unit volume in a specimen,

$n = \frac{\rho N_A}{A}$

For iron, $\rho = 7.8\times10^{-3}kgm^{-3}$,

$N_A = 6.02\times10^{26}/kgmol$, A=56

$\Rightarrow n = \frac{7.8\times10^3\times6.02\times10^{26}}{56} = 8.38\times10^{28}m^{-3}$

Total number of atoms in the bar is

$N_0 = nV = 8.38\times10^{28}\times(5\times10^{-2}\times1\times10^{-2}\times1\times10^{-2})$

$N_0 = 4.19\times10^{23}$

The saturated magnetic moment of bar

$= 4.19\times10^{23}\times1.8\times10^{-23} = 7.54\ Am^2$

18. (d) We have, $B = \mu_0 H + \mu_0 I$

or $I = \frac{B - \mu_0 H}{\mu_0}$ or $I = \frac{\mu H - \mu_0 H}{\mu_0} = \left(\frac{\mu}{\mu_0} - 1\right)H$

$I = (\mu_r - 1)H$

For a solenoid of n-turns per unit length and current i $H = ni$

$\therefore I = (\mu_r - 1)ni = (1000-1)\times500\times0.5$

$I = 2.5\times10^5\ Am^{-1}$

$\therefore$ Magnetic moment M=IV

$M = 2.5\times10^5\times10^{-4} = 25\ Am$

19. (d) The bar magnet coercivity $4\times10^3\ Am^{-1}$ i.e., it requires a magnetic intensity $H = 4\times10^3\ Am^{-1}$ to get demagnetised. Let i be the current carried by solenoid having n number of turns per metre length, then by definition $H = ni$. Here $H = 4\times10^3$ *Amp turn metre*

$n = \frac{N}{l} = \frac{60}{0.12} = 500$ *turn metre*

$\Rightarrow i = \frac{H}{n} = \frac{4\times10^3}{500} = 8.0\ A$

20. (c) Let M and $M_,$ be the magnetic moments of magnets and H the horizontal component of earth's field.

We have $\tau = MH\sin\theta$. If ϕ is the twist of wire, then $\tau = C\phi$, C being restoring couple per unit twist of wire

$\Rightarrow C\phi = MH\sin\theta$

Here $\phi_1 = (180^o - 30^o) = 150^o = 150\times\frac{\pi}{180}\ rad$

$\phi_2 = (270^o - 30^o) = 240^o = 240\times\frac{\pi}{180}\ rad$

So, $C\phi_1 = M_1 H\sin\theta$ (For deflection $\theta = 30^o$ of I magnet)

$C\phi_2 = M_2 H\sin\theta$ (For deflection $\theta = 30^o$ of II magnet)

Dividing $\frac{\phi_1}{\phi_2} = \frac{M_1}{M_2}$

$\Rightarrow \frac{M_1}{M_2} = \frac{\phi_1}{\phi_2} = \frac{150\times\left(\frac{\pi}{180}\right)}{240\times\left(\frac{\pi}{180}\right)} = \frac{15}{24} = \frac{5}{8}$

$\Rightarrow M_1 : M_2 = 5 : 8$

21. (c) In vertical plane perpendicular to magnetic meridian.

$T = 2\pi\sqrt{\frac{I}{MB_V}}$ ..... (i)

In horizontal plane $T = 2\pi\sqrt{\dfrac{I}{MB_H}}$ ..... (ii)

Equation (i) and (ii) gives $B_V = B_H$

Hence by using $\tan\phi = \dfrac{B_V}{B_H} \Rightarrow \tan\phi = 1 \Rightarrow \phi = 45^o$

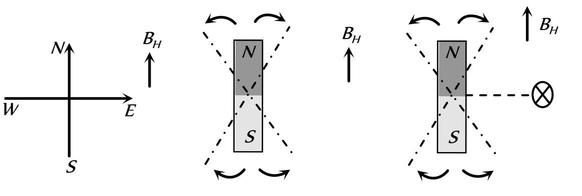
22. (a) Molar susceptiblity

$$= \frac{\text{Volume susceptiblity}}{\text{Density of material}} \times \text{molecular weight}$$

$$= \frac{I/H}{\rho} \times M = \frac{I/H}{M/V} \times M$$

So it's unit is m.

23. (c)



Initially $T = 2\pi\sqrt{\dfrac{I}{mB_H}}$, Finally $T' = 2\pi\sqrt{\dfrac{I}{m(B+B_H)}}$

Where B = Magnetic field due to down ward conductor

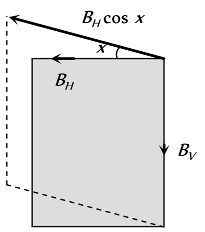
$$= \frac{\mu_0}{4\pi}.\frac{2i}{a} = 18\mu T$$

$$\therefore \frac{T'}{T} = \sqrt{\frac{B_H}{B+B_H}} \Rightarrow \frac{T'}{0.1} = \frac{24}{18+24} \Rightarrow T' = 0.076\,s.$$

24. (a) In first case $\tan\theta = \dfrac{B_V}{B_H}$ ..... (i)

Second case $\tan\theta' = \dfrac{B_V}{B_H \cos x}$ ..... (ii)

From equation (i) and (ii), $\dfrac{\tan\theta'}{\tan\theta} = \dfrac{1}{\cos x}$



25. (c) $\tan\theta = \dfrac{B_V}{B_H}$ ... (i)

If apparent dip is θ' then

$$\tan\theta' = \frac{B'_V}{B'_H} = \frac{B_V}{B_H \cos 30°} = \frac{B_V}{B_H \times \frac{\sqrt{3}}{2}}$$

$$\Rightarrow \tan\theta' = \left(\frac{2}{\sqrt{3}}\right)\tan\theta \Rightarrow \tan\theta' > \tan\theta \Rightarrow \theta' > \theta$$

Graphical Questions

1. (d) For a temporary magnet the hysteresis loop should be long and narrow.

2. (c) Magnetism of a magnet falls with rise of temperature and becomes practically zero above curie temperature.

3. (b) For a diamagnetic substance χ is small, negative and independent of temperature.

4. (a) Susceptibility of a paramagnetic substance is independent of magnetising field.

5. (a) Susceptibility of a ferromagnetic substance falls with rise of temperature $\left(\chi = \dfrac{c}{T - T_c}\right)$ and the substance becomes paramagnetic above curie temperature, so magnetic susceptibility becomes very small above curie temperature.

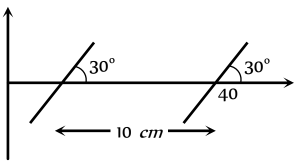
6. (c)

7. (b) $B = \mu_0\mu_r H \Rightarrow \mu_r \propto \dfrac{B}{H}$ = slope of B- H curve

According to the given graph, slope of the graph is highest point Q.

8. (b) $i \propto \tan\theta$

9. (b) $|B| = \dfrac{\Delta V}{\Delta x} = \dfrac{0.1\times10^{-4}}{0.1\sin 30^o} = 2\times10^{-4}T$



10. (a) $X = C \times \dfrac{1}{T} = \dfrac{0.4}{7\times10^{-3}} = 57K$

11. (b) In the given figure OQ refers to retentivity while OR refers to corecivity, for permanents both retentivity and corecivity should be high.

12. (b) Intensity of magnetisation of diamagnetic substance is very small and negative.

13. (d) $\mu_r = 1 + \dfrac{I}{H}$; as we know I dependent on H, initially value of $\dfrac{I}{H}$ is smaller so value of μ increases with H but slowly but with further increases of H value of $\dfrac{I}{H}$ also increases *i.e.* μ increases speedily. When material fully magnetised I becomes constant then with the increase of H ($\dfrac{I}{H}$ decreases) μ decreases. This is confirm with the option (d).

14. (a) For paramagnetic substance magnetization M proportional to magnetising field H, and M is positive.

Assertion and Reason

1. (d) It is quite clear that magnetic poles always exists in pairs. Since, one can imagine magnetic field configuration with three poles. When north poles or south poles of two magnets are glued together. They provide a three pole field configuration. It is also known that a bar magnet does not exert a torque on itself due to own its field.

2. (b) As we know every atom of a magnet acts as a dipole, So poles cannot be separated. When magnet is broken into two equal pieces, magnetic moment of each part will be half of the original magnet.

3. (a) In case of the electric field of an electric dipole, the electric lines of force originate from positive charge and end at negative charge. Since isolated magnetic lines are closed continuous loops extending through out the body of the magnet.

4. (c) In an atom, electrons revolve around the nucleus and as such the circular orbits of electrons may be considered as the small current loops. In addition to orbital motion, an electron has got spin motion also. So the total magnetic moment of electron is the vector sum of its magnetic moments due to orbital and spin motion. Charge particles at rest do not produce electric field.

5. (b) Magnetic dipole moment of the current loop

= Ampere turns × Area of the coil

Initially magnetic moment $M = i\pi r$, new magnetic moment $M' = i\pi(2r)^2 = 4i(\pi r^2) = 4M.$

So magnetic moment becomes four times when radius is doubled.

6. (e) The temperature inside the earth is so high that it is impossible for iron core to behave as magnet and act as a source of magnetic field. The magnetic field of earth is considered to be due to circulating electric current in the iron (In molten state) and other conducting materials inside the earth.

7. (d) The earth has only vertical component of its magnetic field at the magnetic poles. Since compass needle is only free to rotate in horizontal plane. At north pole the vertical component of earth's field will exert torque on the magnetic needle so as to align it along its direction. As the compass needle can not rotate in vertical plane, it will rest horizontally, when placed on the magnetic pole of the earth.

8. (b) In tangent galvanometer the current through the coil is given by $I = \frac{2r}{n\mu_0}.B_H \tan\theta \Rightarrow \tan\theta \propto n/r$

i.e. by reducing its radius or by increasing number of turns of coil we can increase the sensitivity of tangent galvanometer.

9. (b) The susceptibility of ferromagnetic substance decreases with the rise of temperature in a complicated manner. After Curies point the susceptibility of ferromagnetic substance varies inversely with its absolute temperature. Ferromagnetic substance obey's Curies law only above its Curie point.

10. (e) The properties of substance is due to alignment of molecules in it. When these substance are heated, molecules acquire some kinetic energy. Some of molecules may get back to the closed chain arrangement (produce zero resultant). So they lose their magnetic property or magnetism. Therefor the properties of both ferromagnetic and paramagnetic are effected by heating.

11. (a) The core of a transformer undergoes cycles of magnetisation again and again. During each cycle of magnetisation, energy numerically equal to the area of the hysteresis loop is spent per unit volume of the core. Therefore, for high efficiency of transformer, the energy loss will be lesser if the hystersis loop is of lesser area, i.e. narrow. That's why the soft iron is used as core, which has narrow hysteresis loop (or area of $B-H$ curve is very small). Also soft iron (ferromegnetic substance) has high permeability, high retentivity, low coercivity and low hystersis loss.

12. (a) A magnetic field is produced by the motion of electric charge. Since motion is relative, the magnetic field is also relative.

13. (a) In a moving coil galvanometer, the coil is suspended in a very strong uniform magnetic field created by two magnetic pole pieces. The earth's magnetic field is quite weak as compared to that field, therefore, it does not effect the working of magnetic field.

14. (c) A paramagnetic sample display greater magnetisation when cooled, this is because at lower temperature, the tendency to disrupt the alignment of dipoles (due to magnetising field) decreases on account of reduced random thermal motion.

15. (a) Electromagnets are magnets, which can be turned on and off by switching the current on and off. As the material in electromagnets is subjected to cyclic change (magnification and demagentisation), the hysteresis loss of the material must be small. The material should attain high value of *I* and *B* with low value of magnetising field intensity *H*. As soft iron has small coercivity, so it is a best choice for this purpose.

16. (a) Since iron is ferromagnetic in nature, therefore, lines of force due to external magnetic field prefer to pass through iron.

17. (d) In general, the field due to a magnet is non-uniform. Therefore, it exerts both, a net force and a torque on the nails which will translate and also rotate the nails before striking to north pole of magnet with their induced south poles and vice-versa.

18. (d) In a non-uniform magnetic field, both a torque and a net force acts on the dipole. If magnetic field were uniform, net force on dipole would be zero.

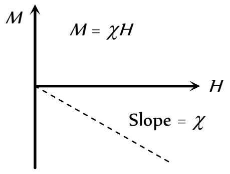
19. (c) The reduction factor of tangent galvanometer is

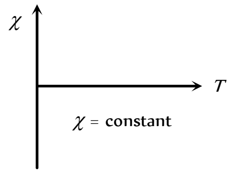
$$K = \frac{B_H}{G} = B_H \times \frac{2r}{n\mu_0}$$

Thus reduction factor of a tangent galvanometer depends upon the geometry of its coil. It increases with increase of radius and decreases with increase in number of turn of the coil of the galvanometer.

20. (c) Diamagnetism is non-cooperative behaviour of orbiting electrons when exposed to an applied magnetic field. Diamagnetic substance are composed of atom which have no net magnetic moment (*i.e.*, all the orbital shells are filled and there are no unpaired electrons). When exposed to a field, a negative magnetization is produced and thus the susceptibility is negative.

Behaviour of diamagnetic material is that the susceptibility is temperature independent.





21. (d) The permeability of a ferromagnetic material is not independent of magnetic field, $\vec{B} = K_m \vec{B}_0$.

B_0 is applied field. The total magnetic field $\vec{B}$ inside a ferromagnet may be 10^3 or 10^4 times the applied field B_0. The permeability K_m of a ferromagnetic material is not constant, neither the field $\vec{B}$ nor the magnetization $\vec{M}$ increases linearly with $\vec{B}$. Even at small value of B_0. From the hysteresis curve, magnetic permeability is greater for lower field.

22. (e) For a perfectly diamagnetic substance,

$B = \mu_0(H + I) = 0 \qquad \therefore I = -H.$

Therefore, $\chi_m = \frac{I}{H} = -1$

Therefore relative permeability

$\mu_r = 1 + \chi_m = 1 - 1 = 0. \quad \therefore \mu = \mu_0 \mu_r =$ zero.

i.e. for a perfectly diamagnetic material permeability is zero.

23. (a)

24. (a) Helium atom has paired electrons so their electron spin are opposite to each other and hence it's net magnetic moment is zero.

25. (b) Steel is preferred over soft iron for making permanent magnets, because coercivity of steel is larger.

Magnetism

SET Self Evaluation Test - 22

1. A compass needle whose magnetic moment is 60 *amp* × *m* pointing geographical north at a certain place, where the horizontal component of earth's magnetic field is 40 μ *Wb/m*, experiences a torque $1.2\times10^{-3}\ N\times m$. What is the declination at this place

(a) 30° (b) 45°

(c) 60° (d) 25°

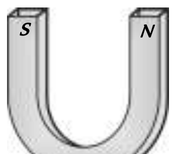
2. The distance between the poles of a horse shoe magnet is 0.1 *m* and its pole strength is 0.01 *amp-m*. The induction of magnetic field at a point midway between the poles will be

(a) $2\times10^{-5}\,T$

(b) $4\times10^{-6}\,T$

(c) $8\times10^{-7}\,T$

(d) Zero



3. Due to a small magnet intensity at a distance *x* in the end on position is 9 Gauss. What will be the intensity at a distance $\frac{x}{2}$ on broad side on position

(a) 9 *Gauss* (b) 4 *Gauss*

(c) 36 *Gauss* (d) 4.5 *Gauss*

4. The magnetic moment produced in a substance of $1 gm$ is $6\times10^{-7} ampere-metre^2$. If its density is $5\,gm/cm^3$, then the intensity of magnetisation in *A/m* will be

(a) 8.3×10^6 (b) 3.0

(c) 1.2×10^{-7} (d) 3×10^{-6}

5. The needle of a deflection galvanometer shows a deflection of 60° due to a short bar magnet at a certain distance in $\tan A$ position. If the distance is doubled, the deflection is

(a) $\sin^{-1}\left(\frac{\sqrt{3}}{8}\right)$ (b) $\cos^{-1}\left(\frac{\sqrt{3}}{8}\right)$

(c) $\tan^{-1}\left(\frac{\sqrt{3}}{8}\right)$ (d) $\cot^{-1}\left(\frac{\sqrt{3}}{8}\right)$

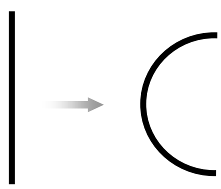
6. The area of hysteresis loop of a material is equivalent to 250 *joule*. When 10 *kg* material is magnetised by an alternating field of 50 *Hz* then energy lost in one *hour* will be if the density of material is $7.5\ gm/cm^3$

(a) $6\times10^4\ J$ (b) $6\times10^4\ erg$

(c) $3\times10^2\ J$ (d) $3\times10^2\ erg$

7. A magnetised wire of moment *M* is bent into an arc of a circle subtending an angle of 60° at the centre; then the new magnetic moment is

(a) $(2M/\pi)$



(b) (M/π)

(c) $(3\sqrt{3}M/\pi)$

(d) $(3M/\pi)$ [EAMCET (Engg.) 1996]

8. A tangent galvanometer shows a deflection 45° when 10 *mA* current pass through it. If the horizontal component of the earth's field is $3.6\times10^{-5}\ T$ and radius of the coil is 10 *cm*. The number of turns in the coil is

(a) 5700 turns (b) 57 turns

(c) 570 turns (d) 5.7 turns

9. A magnet is parallel to a uniform magnetic field. If it is rotated by 60°, the work done is 0.8 *J*. How much work is done in moving it 30° further

(a) $0.8\times10^7\ ergs$ (b) 0.4 *J*

(c) 8 *J* (d) 0.8 *ergs*

10. Susceptibility of *Mg* at 300 *K* is 1.2×10^{-5}. The temperature at which susceptibility will be 1.8×10^{-5} is [Roorkee 1999]

(a) 450 *K* (b) 200 *K*

(c) 375 *K* (d) None of these

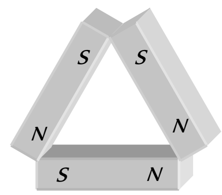
11. Three identical bar magnets each of magnetic moment *M* are placed in the form of an equilateral triangle as shown. The net magnetic moment of the system is

(a) Zero

(b) 2 *M*

(c) $M\sqrt{3}$

(d) $\frac{3M}{2}$



12. A magnetic needle is placed on a cork floating in a still lake in the northern hemisphere. Does the needle together with the cork move towards the north of the lake

(a) Yes

(b) No

(c) May be or may not be move

(d) Nothing can be said

13. The magnet of vibration magnetometer is heated so as to reduce its magnetic moment by 36%. By doing this the periodic time of the magnetometer will

(a) Increases by 36% (b) Increases by 25%

(c) Decreases by 25% (d) Decreases by 64%

14. The ratio of magnetic moments of two bar magnet is 13 : 5. These magnets are held together in a vibration magnetometer are allowed to oscillate in earth's magnetic field with like poles together 15 oscillation per minute are made. What will be the frequency of oscillation of system if unlike poles are together

(a) 10 *oscillations/min* (b) 15 *oscillations/min*

(c) 12 *oscillations/min* (d) $\frac{75}{13}$ *oscillations/min*

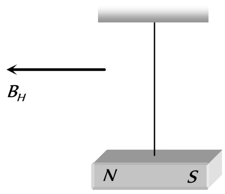
15. A magnet is suspended horizontally in the earth's magnetic field. When it is displaced and then released it oscillates in a horizontal plane with a period *T*. If a place of wood of the same moment of inertia (about the axis of rotation) as the magnet is attached to the magnet what would the new period of oscillation of the system become

(a) $\frac{T}{3}$

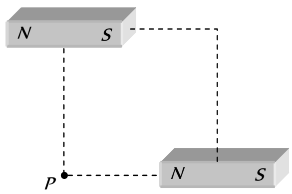
(b) $\frac{T}{2}$

(c) $\frac{T}{\sqrt{2}}$

(d) $T\sqrt{2}$



16. Two short magnets of magnetic moment 1000 Am^2 are placed as shown at the corn ers of a square of side 10 *cm*. The net magnetic induction at *P* is



(a) 0.1 *T* (b) 0.2 *T*

(c) 0.3 *T* (d) 0.4 *T*

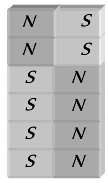
17. The length of *a* magnet is large compared to it's width and breadth. The time period of its oscillation in a vibration magnetometer is *T*. The magnet is cut along it's length into six parts and these parts are then placed together as shown in the figure. The time period of this combination will be

(a) *T*

(b) $\frac{T}{\sqrt{3}}$

(c) $\frac{T}{2\sqrt{3}}$

(d) Zero

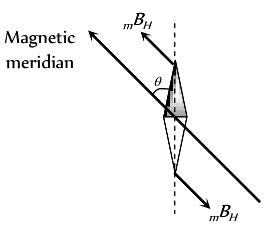


Answers and Solutions

(SET -22)

1. (a) As the compass needle is free to rotate in a horizontal plane and points along the magnetic meridian,

so when it is pointing along the geographic meridian, it will experience a torque due



to the horizontal component of earth's magnetic field *i.e.* $\tau = MB_H \sin\theta$

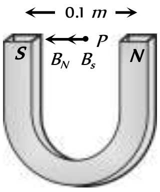
where θ = angle between geographical and magnetic meridians called angle of declination

So, $\sin\theta = \dfrac{1.2\times10^{-3}}{60\times40\times10^{-6}} = \dfrac{1}{2} \Rightarrow \theta = 30^o$

2. (c) Net magnetic field at mid point P, $B = B_N + B_S$

where B_N = magnetic field due to N- pole

B_S = magnetic field due to S- pole



$B_N = B_S = \dfrac{\mu_0}{4\pi}\dfrac{m}{r^2}$

$= 10^{-7}\times\dfrac{0.01}{\left(\dfrac{0.1}{2}\right)^2} = 4\times10^{-7}\,T$

$\therefore B_{net} = 8\times10^{-7}\,T.$

3. (c) In C.G.S. $B_{axial} = 9 = \dfrac{2M}{x^3}$ .....(i)

$B_{\text{equaterial}} = \dfrac{M}{\left(\dfrac{x}{2}\right)^3} = \dfrac{8M}{x^3}$ .....(ii)

From equation (i) and (ii) $B_{\text{equaterial}} = 36$ *Gauss*.

4. (b) $I = \dfrac{M}{V} = \dfrac{M}{\text{mass/density}}$,

given mass = $1gm$ = $10^{-3}\,kg$,

and density $= 5gm/cm^3 = \dfrac{5\times10^{-3}\,kg}{(10^{-2})^3\,m^3} = 5\times10^3\,kg/m^3$

Hence $I = \dfrac{6\times10^{-7}\times5\times10^3}{10^{-3}} = 3$

5. (c) For short bar magnet in tan A-position

$\dfrac{\mu_0}{4\pi}\dfrac{2M}{d^3} = H\tan\theta$ .....(i)

When distance is doubled, then new deflection θ' is given by

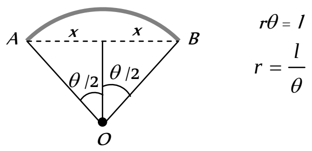
$\dfrac{\mu_0}{4\pi}\dfrac{2M}{(2d)^3} = H\tan\theta'$ .....(ii)

$\therefore \dfrac{\tan\theta'}{\tan\theta} = \dfrac{1}{8} \Rightarrow \tan\theta' = \dfrac{\tan\theta}{8} = \dfrac{\tan 60^\circ}{8} = \dfrac{\sqrt{3}}{8}$

$\Rightarrow \theta' = \tan^{-1}\left(\dfrac{\sqrt{3}}{8}\right)$

6. (a) $E = nAVt = nA\dfrac{m}{d}t = \dfrac{50\times250\times10\times3600}{7.5\times10^3} = 6\times10^4\,J$

7. (d) From figure



$\sin\dfrac{\theta}{2} = \dfrac{x}{r}$

$\Rightarrow x = r\sin\dfrac{\theta}{2}$

Hence new magnetic moment $M' = m(2x) = m.2r\sin\dfrac{\theta}{2}$

$= m.\dfrac{2l}{\theta}\sin\dfrac{\theta}{2} = \dfrac{2ml\sin\theta/2}{\theta} = \dfrac{2M\sin(\pi/6)}{\pi/3} = \dfrac{3M}{\pi}$

8. (c) $K = \dfrac{2rB_H}{\mu_0 n}$

or $n = \dfrac{2rB_H}{\mu_0 K} = \dfrac{2\times0.1\times3.6\times10^{-5}}{4\pi\times10^{-7}\times10\times10^{-3}} = \dfrac{1.8\times10^3}{3.14} = 570$

9. (a) $W = MB(\cos\theta_1 - \cos\theta_2)$

When the magnet is rotated from 0° to 60°, then work done is 0.8 J

$0.8 = MB(\cos 0^\circ - \cos 60^\circ) = \dfrac{MB}{2}$

$\Rightarrow MB = 1.6\,N-m$

In order to rotate the magnet through an angle of 30°, *i.e.*, from 60° to 90°, the work done is

$W' = MB(\cos 60^\circ - \cos 90^\circ) = MB\left(\dfrac{1}{2} - 0\right)$

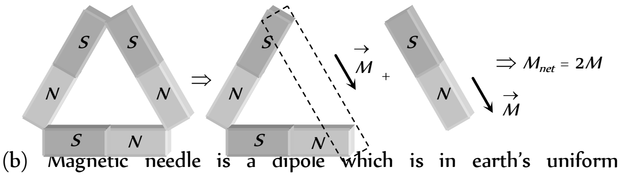
$= \dfrac{MB}{2} = \dfrac{1.6}{2} = 0.8\,J = 0.8\times10^7\,ergs$

10. (b) $\chi \propto \dfrac{1}{T}$

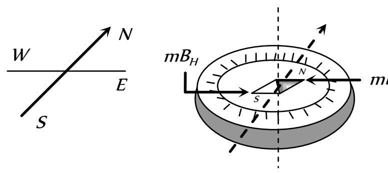
$\therefore \chi_1 T_1 = \chi_2 T_2$

Hence $T_2 = \dfrac{1.2\times10^{-5}\times300}{1.8\times10^{-5}} = 200\,K$

11. (b) The resultant magnetic moment can be calculated as follows.



12. (b) Magnetic needle is a dipole which is in earth's uniform magnetic field and as a dipole in a uniform field does not experience any net force but may experience a couple as shown in figure, so the needle together with the cork will not translate *i.e.* move towards the north of the lake, but will rotate and set itself parallel to the field with it's north pole pointing north.



13. (b) $T = 2\pi\sqrt{\dfrac{I}{MB_H}} \Rightarrow T \propto \dfrac{1}{\sqrt{M}} \Rightarrow \dfrac{T_1}{T_2} = \sqrt{\dfrac{M_2}{M_1}}$

If $M_1 = 100$ then $M_2 = (100-36) = 64$

So $\dfrac{T_1}{T_2} = \sqrt{\dfrac{64}{100}} = \dfrac{8}{10} \Rightarrow T_2 = \dfrac{10}{8}T_1 = 1.25\,T_1$

So % increase in time period = 25%

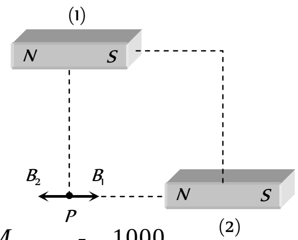
14. (a) $\frac{M_1}{M_2}=\frac{\nu_s^2+\nu_d^2}{\nu_s^2-\nu_d^2} \Rightarrow \frac{13}{5}=\frac{(15)^2+\nu_d^2}{(15)^2-\nu_d^2}$

$\Rightarrow \nu_d = 10$ *oscillations/min*

15. (d) Due to wood moment of inertia of the system becomes twice but there is no change in magnetic moment of the system.

Hence by using $T=2\pi\sqrt{\frac{I}{MB_H}} \Rightarrow T \propto \sqrt{I} \Rightarrow T' = \sqrt{2}\,T$

16. (a) Point P lies on equatorial line of magnet (1) and axial line of magnet (2) as shown



$B_1=\frac{\mu_0}{4\pi}\cdot\frac{M}{d^3}=10^{-7}\times\frac{1000}{(0.1)^3}=0.1\,T$

$B_2=\frac{\mu_0}{4\pi}\cdot\frac{2M}{d^3}=10^{-7}\times\frac{2\times 1000}{(0.1)^3}=0.2\,T$

$\therefore\ B_{net}=B_2-B_1=0.1\,T$

17. (c) $T=2\pi\sqrt{\frac{I}{MH}}$; MI of each part $=\frac{I}{6^3}$

and magnetic moment of each part $=\frac{M}{6}$

so net MI of system $=\frac{I}{6^3}\times 6=\frac{I}{6^2}$

and net magnetic moment $=\frac{4M}{6}-\frac{2M}{6}=\frac{M}{3}$

$\therefore$ time period of the system

$T'=2\pi\sqrt{\frac{I/36}{(M/3)H}}=\frac{1}{2\sqrt{3}}2\pi\sqrt{\frac{I}{MH}}=\frac{T}{2\sqrt{3}}$

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