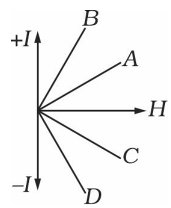
# CHAPTER - F

## Magnetism and Matter

| Date Planned : __ / __ / __ | Daily Tutorial Sheet - 1 | Expected Duration : 90 Min |
|---|---|---|
| Actual Date of Attempt : __ / __ / __ | Level - 1 | Exact Duration :________ |

**1.** The variation of intensity of magnetisation (I), with respect to the magnetizing field (H), in diamagnetic substance, is described by the graph :




**(A)** $OD$ **(B)** $OC$ **(C)** $OB$ **(D)** $OA$

**2.** A bar magnet of magnetic moment $M$ is pivoted at its centre and placed in a uniform magnetic field of strength $B$. Now, the bar magnet is rotated so that its moment vector makes an angle $\theta$ with the direction of the field. In its subsequent motion, the maximum kinetic energy of the magnet is:

**(A)** $MB(1-\cos\theta)$ **(B)** $MB\cos\theta$ **(C)** $MB(2-\cos\theta)$ **(D)** $MB(1+\cos\theta)$

**3.** The magnetic field due to a magnetic dipole at a point on the axis of the dipole varies with the distance from the dipole, $r$, as:

**(A)** $\frac{1}{r}$ **(B)** $\frac{1}{r^2}$ **(C)** $\frac{1}{r^3}$ **(D)** $\frac{1}{r^4}$

**4.** The radius of the earth is $6.4\times10^6\ m$ and its dipole moment is $8\times10^{22}\ A\ m^2$. The magnetic field intensity on the surface of the earth, close to the equator is of the order of:

**(A)** $10^{-3}\ T$ **(B)** $10^{-4}\ T$ **(C)** $10^{-5}\ T$ **(D)** $10^{-6}\ T$

**5.** A vibration magnetometer consists of two identical bar magnets placed one over the other such that they are mutually perpendicular and bisect each other, and pivoted at their point of intersection. The magnetometer is placed in a uniform magnetic field and it oscillates with a time period $T_1$. If one of the magnets is now removed, the time period of the magnetometer with only one magnet is $T_2$. Then, $\frac{T_2}{T_1}$ is equal to:

**(A)** $\sqrt{2}$ **(B)** $\frac{1}{\sqrt{2}}$ **(C)** $2^{1/4}$ **(D)** $\frac{1}{2^{1/4}}$

**6.** A magnet of length $14cm$ and magnetic moment $M$ is broken into two parts of lengths $6cm$ and $8cm$. They are put at right angle to each other with opposite poles together. The magnetic moment of the combination is:

**(A)** $M$ **(B)** $\frac{7M}{5}$ **(C)** $\frac{5M}{7}$ **(D)** $\frac{M}{2}$

**7.** Let us assume that the earth's magnetic North pole coincides perfectly with the geographical South pole and vice versa. Then, at a point on the surface of the earth, the vertical component (i.e. the component perpendicular to the surface) of the earth's magnetic field is:

**(A)** upwards in the Northern hemisphere and downwards in the Southern hemisphere
**(B)** downwards in the Northern hemisphere and upwards in the Southern hemisphere
**(C)** upwards in both hemispheres **(D)** downwards in both hemispheres

**8.** Permanent magnets are usually made of materials with:

**(A)** High retentivity and high coercivity **(B)** High retentivity and low coercivity
**(C)** Low retentivity and high coercivity **(D)** Low retentivity and low coercivity

**9.** A magnetic intensity of $2 \times 10^3 A/m$ is applied to a paramagnetic substance of magnetic susceptibility $10^{-5}$. The magnetization produced in the material (in A/m) is:

**(A)** 0.01 **(B)** 0.02 **(C)** $10^8$ **(D)** $2 \times 10^8$

**10.** Suppose at a point on the surface of the earth, the true geographic North is known. At this point, the Northward, Eastward and vertical components of the earth's magnetic field are measured to be $B_N, B_E$ *and* $B_V$. Then, the angle of inclination (also called the angle of dip) and the angle of declination, $\theta_I$ *and* $\theta_D$, at this point are given by:

**(A)** $\theta_I = \cos^{-1}\left(\dfrac{B_V}{\sqrt{B_N^2 + B_E^2}}\right), \theta_D = \sin^{-1}\left(\dfrac{B_N}{\sqrt{B_N^2 + B_E^2}}\right)$

**(B)** $\theta_I = \sin^{-1}\left(\dfrac{B_V}{\sqrt{B_N^2 + B_E^2}}\right), \theta_D = \cos^{-1}\left(\dfrac{B_E}{B_N}\right)$

**(C)** $\theta_I = \tan^{-1}\left(\dfrac{B_V}{\sqrt{B_N^2 + B_E^2 + B_V^2}}\right), \theta_D = \tan^{-1}\left(\dfrac{B_E}{\sqrt{B_N^2 + B_E^2}}\right)$

**(D)** $\theta_I = \tan^{-1}\left(\dfrac{B_V}{\sqrt{B_N^2 + B_E^2}}\right), \theta_D = \tan^{-1}\left(\dfrac{B_E}{B_N}\right)$

**11.** The magnetic susceptibility of three materials A, B and C at 300 K is $2.3 \times 10^{-5}$, $-9.8 \times 10^{-6}$ and 60 respectively. Then, the magnetic behavior of these materials should be respectively classified as:

**(A)** Diamagnetic, Paramagnetic, Ferromagnetic
**(B)** Paramagnetic, Diamagnetic, Ferromagnetic
**(C)** Paramagnetic, Ferromagnetic, Diamagnetic
**(D)** Ferromagnetic, Paramagnetic, Diamagnetic

**12.** A solenoid with a core of a material of relative permeability 80 carries a current 0.2 A. The number of turns per unit length of the solenoid is 500. The magnetisation $M$ (in A/m) and the magnitude of magnetic field $B$ (in mT) inside the core is:

(Permeability of vacuum, $\mu_0 = 4\pi \times 10^{-7}\ N/A^2$)

**(A)** $7900, \dfrac{16\pi}{3}$ **(B)** $8000, \dfrac{16\pi}{3}$ **(C)** $7900, \dfrac{79\pi}{15}$ **(D)** $8000, \dfrac{79\pi}{15}$

**13.** When a paramagnetic material is placed in a magnetic field $B_0$, the magnetisation $M$ produced in the material is given by Curie's law as: $M = C\frac{B_0}{T}$

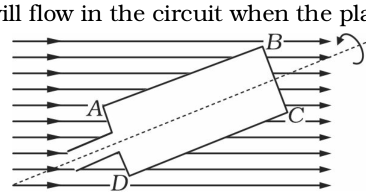
Here, $C$ is a material-specific constant, called the Curie constant, and $T$ is temperature.
This law is valid for:

**(A)** Low values of $B_0$ and low values of $T$ **(B)** Low values of $B_0$ and high values of $T$
**(C)** High values of $B_0$ and low values of $T$ **(D)** High values of $B_0$ and high values of $T$

**14.** At a point near the surface of the earth, the horizontal component of the earth's magnetic field is 0.4 Gauss. If the angle of declination at this point is $\frac{1}{10}\,rad$ West, the East-West component of the earth's magnetic field at this point is:

**(A)** 0.398 Gauss, towards West **(B)** 0.398 Gauss, towards East
**(C)** 0.04 Gauss, towards West **(D)** 0.04 Gauss, towards East

**15.** A rectangular coil ABCD which is rotated at a constant angular velocity about a horizontal axis is as shown in the figure given ahead. The axis of rotation of the coil as well as the magunetic field B are horizontal. Maximum current will flow in the circuit when the plane of the coil is :




**(A)** Inclined at 30° to the magnetic field **(B)** Perpendicular to the magnetic field
**(C)** Inclined at 45° to the magnetic field **(D)** parallel to the magnetic field

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**1.** 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 $T'$, the ratio $\frac{T'}{T}$ is: **2003]**

**(A)** $\frac{1}{2\sqrt{2}}$ **(B)** $\frac{1}{2}$ **(C)** 2 **(D)** $\frac{1}{4}$

**2.** Curie temperature is the temperature above which: **[2003]**

**(A)** A ferromagnetic material become paramagnetic
**(B)** a paramagnetic material become diamagnetic
**(C)** a ferromagnetic material becomes diamagnetic
**(D)** a paramagnetic material becomes ferromagnetic

**3.** The magnetic lines of force inside a bar magnet: **[2003]**

**(A)** are from north-pole to south-pole of the magnet
**(B)** do not exist
**(C)** depend upon the area of cross-section of the bar magnet
**(D)** are from south-pole to north-pole of the magnet

**4.** The magnetic needle lying parallel to a magnetic field requires $W$ units of work to turn it through 60°. The torque needed to maintain the needle in this position will be: **[2003]**

**(A)** $\sqrt{3}W$ **(B)** $W$ **(C)** $\left(\frac{\sqrt{3}}{2}\right)W$ **(D)** $2\ W$

**5.** The materials suitable for making electromagnets should have: **[2004]**

**(A)** high retentively and high coercivity **(B)** low retentivity and low coercivity
**(C)** high retentively and low coercivity **(D)** low retentivity and high coercivity

**6.** 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 ; **2004]**

**(A)** 2s **(B)** $\frac{2}{3}s$ **(C)** $(2\sqrt{3})s$ **(D)** $\left(\frac{2}{\sqrt{3}}\right)s$

**7.** A magnetic needle is kept in a non-uniform magnetic field. It experiences: **[2005]**

**(A)** a force and a torque **(B)** a force but not a torque
**(C)** a torque but not a force **(D)** neither a force nor a torque

**8.** Needles $N_1, N_2$ and $N_3$ are made of a ferromagnetic, a paramagnetic and a diamagnetic substance respectively. A magnet when brought close to them will : **[2006]**

**(A)** attract all three of them
**(B)** attract $N_1$ and $N_2$ strongly but repel $N_3$
**(C)** attract $N_1$ strongly, $N_2$ weakly and repel $N_3$ weakly
**(D)** attract $N_1$ strongly, but repel $N_2$ and $N_3$ weakly

**9.** Relative permittivity and permeability of a material are $\varepsilon_r$ and $\mu_r$, respectively. Which of the following values of these quantities are allowed for a diamagnetic material? **[2008]**

**(A)** $\varepsilon_r = 1.5, \mu_r = 1.5$ **(B)** $\varepsilon_r = 0.5, \mu_r = 1.5$ **(C)** $\varepsilon_r = 1.5, \mu_r = 0.5$ **(D)** $\varepsilon_r = 0.5, \mu_r = 0.5$

**10.** Two short bar magnets of length 1 *cm* each have magnetic moments 1.20 $Am^2$ and 1.00 $Am^2$ respectively. They are placed on a horizontal table parallel to each other with their *N* poles pointing towards the South. They have a common magnetic equator and are separated by a distance of 20.0 cm. The value of the resultant horizontal magnetic induction at the mid-point O of the line joining their centers is close to (Horizontal component of earth's magnetic induction is $3.6 \times 10^{-5} Wb/m^2$): **[2013]**

**(A)** $5.80 \times 10^{-4} Wb/m^2$ **(B)** $3.6 \times 10^{-5} Wb/m^2$

**(C)** $2.56 \times 10^{-4} Wb/m^2$ **(D)** $3.50 \times 10^{-4}\ Wb/m^2$

**11.** The earth's magnetic field lines resemble that of a dipole at the centre of the earth. If the magnetic moment of this dipole is close to $8 \times 10^{22} A\,m^2$, the value of earth's magnetic field near the equator is close to (radius of the earth $= 6.4 \times 10^6\ m$) **[2013]**

**(A)** 0.6 Gauss **(B)** 1.2 Gauss **(C)** 1.8 Gauss **(D)** 0.32 Gauss

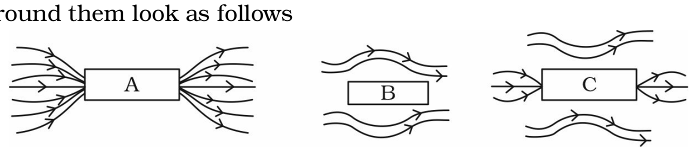
**12.** The coercivity of a small magnet where the ferromagnet gets demagnetized is $3 \times 10^3 A\,m^{-1}$. The current required to be passed in a solenoid of length 10 *cm* and number of turns 100, so that the magnet gets demagnetized when inside the solenoid, is : **[2014]**

**(A)** 6 *A* **(B)** 30 *mA* **(C)** 60 *mA* **(D)** 3 *A*

**13.** An example of a perfect diamagnet is a superconductor. This implies that when a superconductor is put in a magnetic field of intensity B, the magnetic field $B_s$ inside the superconductor will be such that : **[2014]**

**(A)** $B_s = -B$ **(B)** $B_s = 0$ **(C)** $B_s = B$ **(D)** $B_s < B$ but $B_s \neq 0$

**14.** The identical bars A, B and C are made of different magnetic materials. When kept in a uniform magnetic field, the field lines around them look as follows




Make the correspondence of these bars with their material being diamagnet (D), ferrormagnetic (F) and paramagnetic (P) : **[2014]**

**(A)** $A \leftrightarrow F, B \leftrightarrow P, C \leftrightarrow D$ **(B)** $A \leftrightarrow P, B \leftrightarrow F, C \leftrightarrow D$

**(C)** $A \leftrightarrow D, B \leftrightarrow P, C \leftrightarrow F$ **(D)** $A \leftrightarrow F, B \leftrightarrow D, C \leftrightarrow P$

**15.** The magnetic field of earth at the equator is approximately $4 \times 10^{-5} T$. The radius of earth is $6.4 \times 10^6\ m$. Then the dipole moment of the earth will be nearly of the order of **[2014]**

**(A)** $10^{23} A\,m^2$ **(B)** $10^{20} A\,m^2$ **(C)** $10^{16} A\,m^2$ **(D)** $10^{10} A\,m^2$

**16.** A short bar magnet is placed in the magnetic meridian of the earth with north pole pointing north. Neutral points are found at a distance of 30 *cm* from the magnet on the East – West line, drawn through the middle point of the magnet. The magnetic moment of the magnet in A $m^2$ is close to:

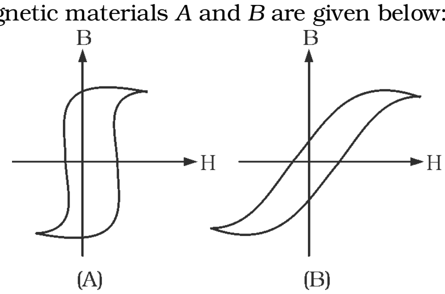
(Given $\frac{\mu_0}{4\pi} = 10^{-7}$ in *SI* units and $B_H$ = Horizontal component of earth's magnetic field $= 3.6\ 10^{-5}$ Tesla.)

**(A)** 9.7 **(B)** 4.9 **(C)** 19.4 **(D)** 14.6 **[2015]**

**17.** A 25 *cm* long solenoid has radius 2 *cm* and 500 total number of turns. It carries a current of 15 *A*. If it is equivalent to a magnet of the same size and magnetization $\vec{M}$ (magnetic moment/volume), then $|\vec{M}|$ is: **[2015]**

**(A)** $3\pi\, Am^{-1}$ **(B)** $30000\, Am^{-1}$ **(C)** $300\, Am^{-1}$ **(D)** $30000\pi Am^{-1}$

**18.** Hysteresis loops for two magnetic materials *A* and *B* are given below: **[2016]**




These materials are used to make magnets for electric generators, transformer core and electromagnet core. Then it is proper to use :

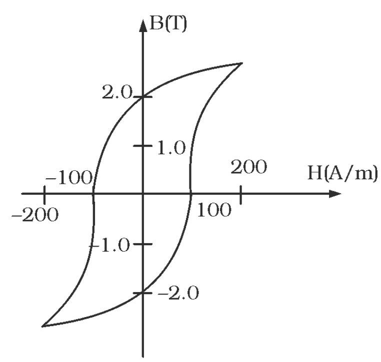
**(A)** A for electric generators and transformers

**(B)** A for electromagnets and *B* for electric generators

**(C)** A for transformers and *B* for electric generators

**(D)** B for electromagnets and transformers

**19.** The B-H curve for a ferromagnet is shown in the figure. The ferromagnet is placed inside a long solenoid with 1000 turns/cm. The current that should be passed in the solenoid to demagnetize the ferromagnet completely is : **[2018]**




**(A)** 1 *mA* **(B)** $20\mu A$ **(C)** $2\, mA$ **(D)** $40\,\mu A$

**20.** A magnet of total magnetic moment $10^{-2}\hat{i}\ A-m^2$ is placed in time varying magnetic field, $B\cos\omega t\ \hat{i}$ where B = 1 Tesla and $\omega = 0.125\, rad/s$. The work done for reversing the direction of the magnetic moment at $t = 1$ second, is: **[2019]**

**(A)** 0.01 J **(B)** 0.007 J **(C)** 0.028 J **(D)** 0.014 J

**21.** A bar magnet is demagnetized by inserting it inside a solenoid of length 0.2 m, 100 turns, and carrying a current of 5.2 A. The coercivity of the bar magnet is: **[2019]**

**(A)** 520 A/m **(B)** 285 A/m **(C)** 2600 A/m **(D)** 1200 A/m

**22.** At some location on earth the horizontal component of earth's magnetic field is $18\times10^{-6}T$. At this location magnetic needle of length 0.12m and pole strength 1.8 Am is suspended from its mid-point using a thread, it makes 45° angle with horizontal in equilibrium. To keep this needle horizontal, the vertical force that should be applied at one of its ends is : **[2019]**

**(A)** $6.5\times10^{-5}N$ **(B)** $1.3\times10^{-5}N$ **(C)** $1.8\times10^{-5}N$ **(D)** $3.6\times10^{-5}N$

**23.** A paramagnetic substance in the form of a cube with sides 1 cm has a magnetic dipole moment of $20\times10^{-6}J/T$ when a magnetic intensity of $60\times10^{3}A/m$ is applied. Its magnetic susceptibility is:

**(A)** $3.3\times10^{-2}$ **(B)** $2.3\times10^{-2}$ **(C)** $4.3\times10^{-2}$ **(D)** $3.3\times10^{-4}$ **[2019]**

**24.** A paramagnetic material has $10^{28}\,atoms/m^3$. Its magnetic susceptibility at temperature 350 $K$ is $2.8\times10^{-4}$. Its susceptibility at 300 $K$ is : **[2019]**

**(A)** $3.726\times10^{-4}$ **(B)** $2.672\times10^{-4}$ **(C)** $3.672\times10^{-4}$ **(D)** $3.267\times10^{-4}$

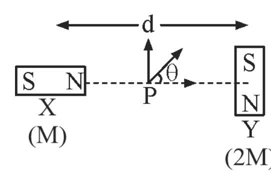
**25.** A hoop and a solid cylinder of same mass and radius are made of a permanent magnetic material with their magnetic moment parallel to their respective axes. But the magnetic moment of hoop is twice of solid cylinder. They are placed in a uniform magnetic field in such a manner that their magnetic moments make a small angle with the field. If the oscillation periods of hoop and cylinder are $T_h$ and $T_c$ respectively, then : **[2019]**

**(A)** $T_h = T_c$ **(B)** $T_h = 1.5T_c$ **(C)** $T_h = 2T_c$ **(D)** $T_h = 0.5T_c$

**26.** Two magnetic dipoles $X$ and $Y$ are placed at a separation $d$, with their axes perpendicular to each other. The dipole moment of $Y$ is twice that of $X$. A particle of charge $q$ is passing through their midpoint $P$, at angle $\theta = 45°$ with the horizontal line, as shown in figure. What would be the magnitude of force on the particle at that instant? ($d$ is much larger that the dimensions of the dipole) **[2019]**

**(A)** $\left(\frac{\mu_0}{4\pi}\right)\frac{M}{\left(\frac{d}{2}\right)^3}\times qv$ **(B)** $\left(\frac{\mu_0}{4\pi}\right)\frac{2M}{\left(\frac{d}{2}\right)^3}\times qv$

**(C)** $\sqrt{2}\left(\frac{\mu_0}{4\pi}\right)\frac{M}{\left(\frac{d}{2}\right)^3}\times qv$ **(D)** 0

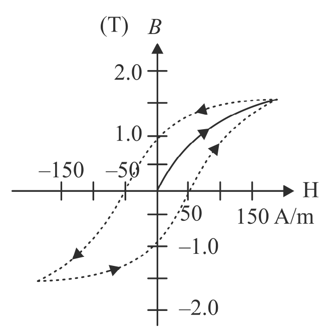



**27.** A magnetic compass needle oscillates 30 times per minute at a place where the dip is 45°, and 40 times per minute where the dip is 30°. If $B_1$ and $B_2$ are respectively the total magnetic field due to the earth at the two places, then the ratio $B_1/B_2$ is best given by: **[2019]**

**(A)** 0.7 **(B)** 2.2 **(C)** 3.6 **(D)** 1.8

**28.** The figure gives experimentally measured B vs. H variation in a ferromagnetic material. The retentivity, co-ercivity and saturation, respectively, of the material are: **[2020]**

**(A)** 1.5 T, 50 A/m and 1.0 T
**(B)** 150 A/m, 1.0 T and 1.5 T
**(C)** 1.0 T, 50 A/m and 1.5 T
**(D)** 1.5 T, 50 A/m and 1.0 T

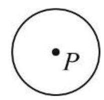


**29.** Magnetic materials used for making permanent magnets (P) and magnets in a transformer (T) have different properties of the following, which property best matches for the type of magnet required? **[2020]**

**(A)** T: Large retentivity, large coercivity **(B)** P: Large retentivity, large coercivity

**(C)** T: Large retentivity, small coercivity **(D)** P: Small retentivity, large coercivity

**30.** A perfectly diamagnetic sphere has a small spherical cavity at its centre, which is filled with a paramagnetic substance. The whole system is placed in a uniform magnetic field $\vec{B}$. Then the field inside the paramagnetic substance is: **[2020]**




**(A)** zero **(B)** $\vec{B}$

**(C)** much large than $|\vec{B}|$ but opposite to $\vec{B}$ **(D)** much large than $|\vec{B}|$ and parallel to $\vec{B}$

**31.** A small bar magnet placed with its axis at 30° with an external field of 0.06 T experiences a torque of 0.018 Nm. The minimum work required to rotate it from its stable to unstable equilibrium position is :

**(A)** $7.2\times10^{-2}\ J$ **(B)** $6.4\times10^{-2}\ J$ **(C)** $9.2\times10^{-3}\ J$ **(D)** $11.7\times10^{-3}J$ **[2020]**

**32.** A paramagnetic sample shows a net magnetisation of 6 A/m when it is placed in an external magnetic field of 0.4 T at a temperature of 4K. When the sample is placed in an external magnetic field of 0.3 T at a temperature of 24 K, then the magnetisation will be: **[2020]**

**(A)** $4\dfrac{A}{m}$ **(B)** $2.25\dfrac{A}{m}$ **(C)** $0.75\dfrac{A}{m}$ **(D)** $1\dfrac{A}{m}$

**33.** An iron rod of volume $10^{-3}$ $m^3$ and relative permeability 1000 is placed as core in a solenoid with 10 turns/cm. If a current of 0.5 A is passed through the solenoid, then the magnetic moment of the rod will be : **[2020]**

**(A)** $0.5\times10^2$ $Am^2$ **(B)** $500\times10^2$ $Am^2$ **(C)** $50\times10^2$ $Am^2$ **(D)** $5\times10^2$ $Am^2$