Q 1: A paramagnetic material has 10^{28} atoms/m^3. It's magnetic susceptibility at temperature 350 K is 2.8×10^{-4}. Its susceptibility at 300 K is

(a) 3.267×10^{-4}

(b) 3.672×10^{-4}

(c) 2.672×10^{-4}

(d) 3.726×10^{-4}

Solution

For a paramagnetic material, magnetic susceptibility $\chi \propto 1/T$

$\chi_2 = \chi_1 (T_1/T_2) = 2.8 \times 10^{-4} \times (350/300) = 3.267 \times 10^{-4}$

Answer : (a) 3.267×10^{-4}

Q2: 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

(a) 0.7

(b) 3.6

(c) 1.8

(d) 2.2

Solution

Frequency of oscillation = $\sqrt{magnetic\ field}$

$$\frac{30}{40} = \sqrt{\frac{B_1 cos45^0}{B_2 cos30^0}}$$

(Horizontal component of magnetic field = B cosδ)

$(B_1/B_2) = 0.7$

Answer (a) 0.7

Q3: A magnetic needle of magnetic moment 6.7×10^{-2} A m^2 and moment of inertia 7.5×10^{-6} kg m^2 is performing simple harmonic oscillations in a magnetic field of 0.01 T. Time taken for 10 complete oscillations is

(a) 6.65 s

(b) 8.89 s

(c) 6.98 s

(d) 8.76 s

Solution

Time period of magnetic needle oscillating simple harmonically is given by

$$T = 2\pi\sqrt{\frac{I}{MB}} \quad T = 2\pi\sqrt{\frac{7.5\times10^{-6}}{6.7\times10^{-2}\times0.01}}$$

T = (2π/10) x 1.05s

For 10 oscillations, total time taken

T' = 10T = 2π x 1.05 = 6.65 s

Answer: (a) 6.65 s

Q4: A magnetic dipole is acted upon by two magnetic fields which are inclined to each other at an angle of 75°. One of the fields has a magnitude of 15 mT. The dipole attains stable equilibrium at an angle of 30° with this field. The magnitude of the other field (in mT) is close to

(a) 1

(b) 11

(c) 36

(d) 1060

Solution

The magnetic dipole attains stable equilibrium under the influence of these two fields making an angle θ_1 = 30° with B_1 and θ_2 = 75° – 30° = 45° with B_2.

For stable equilibrium, net torque acting on dipole must be zero,

I.e., $\tau_1 + \tau_2 = 0$

$\tau_1 = \tau_2$

$mB_1\sin\theta_1 = mB_2\sin\theta_2$

$B_2 = B_1 (\sin\theta_1/\sin\theta_2)$ = 15mT x ($\sin 30^0/\sin 45^0$)

$= 15mT \times (1/2) \times \sqrt{2} = 10.6mT =$

$11mT$

Answer: (b) 11

Q5: A short bar magnet is placed in the magnetic meridian of the earth with a 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 Am^2 is close to

(Given $(\mu_0/4\pi) = 10^{-7}$ 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

Solution

$(\mu_0/4\pi)(M/r^3) = 3.6 \times 10^{-5}$

$M = [(3.6 \times 10^{-5})/(10^{-7})](0.3)^3$

$M = 9.7\ Am^2$

Answer: (a) 9.7

Q6: Two short bar magnets of length 1 cm each have magnetic moments 1.20 Am^2 and 1.00 A m^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 centres is close to (Horizontal component of earth's magnetic induction is 3.6×10^{-5} Wb/m^2)

(a) 5.80×10^{-4} Wb/m^2

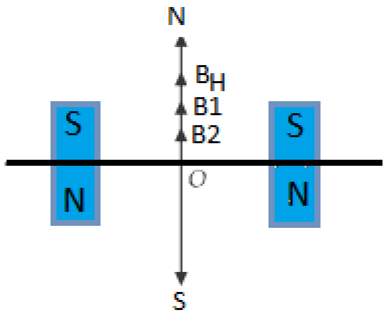
(b) 3.6×10^{-5} Wb/m^2

(c) 2.56×10^{-4} Wb/m^2

(d) 3.50×10^{-4} Wb/m^2

Solution

The situation is as shown in the figure



As the point O lies on the brod-side position with respect to both the magnets. Therefore, the net magnetic field at point O is

$B_{net} = B_1 + B_2 + B_H$

$B_{net} = 2.56 \times 10^{-4}$ Wb/m^2

B_{net} = $$B_{net} = \frac{\mu_0}{4\pi}\frac{(M_1+M_2)}{r^3} + B_H$$

$$B_{net} = \frac{10^{-7}(1.2+1)}{(0.1)^3} + 3.6 \times 10^{-5}$$

Answer : (c) 2.56 × 10^{-4} Wb/m^2

Q7: 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

(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

Answer: (c) Magnet will attract N_1 strongly, N_2 weakly and repel N_3 weakly

Q8: A magnetic needle is kept in a non-uniform magnetic field. It experiences

(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

Solution

Answer: (a) A force and a torque act on a magnetic needle kept in a non-uniform magnetic field

Q9: The magnetic lines of force inside a bar magnet

(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

Answer: (b) Materials of low retentivity and low coercivity are suitable for making electromagnets

Q10: Curie temperature is the temperature above which

(a) a ferromagnetic material becomes paramagnetic

(b) a paramagnetic material becomes diamagnetic

(c) a ferromagnetic material becomes diamagnetic

(d) a paramagnetic material becomes ferromagnetic

Answer: (a) a ferromagnetic material becomes paramagnetic

Q11:The materials suitable for making electromagnets should have

(a) high retentivity and high coercivity

(b) low retentivity and low coercivity

(c) high retentivity and low coercivity

(d) low retentivity and high coercivity

Answer: (b) Materials of low retentivity and low coercivity are suitable for making electromagnets.

Q12: Relative permittivity and permeability of a material are ϵ_r and μ_r, respectively. Which of the following values of these quantities are allowed for a diamagnetic material?

(a) $\epsilon_r = 1.5, \mu_r = 1.5$

(b) $\epsilon_r = 0.5, \mu_r = 1.5$

(c) $\epsilon_r = 1.5, \mu_r = 0.5$

(d) $\epsilon_r = 0.5$, $\mu_r = 0.5$

Solution

The values of relative permeability of diamagnetic materials are slightly less than 1 and ε_r is quite high. Therefore $\varepsilon_r = 1.5$ and $\mu_r = 0.5$ could be the allowed values

Answer: (c) $\epsilon_r = 1.5$, $\mu_r = 0.5$

Q13: In a region, steady and uniform electric and magnetic fields are present. These two fields are parallel to each other. A charged particle is released from rest in this region. The path of the particle will be a

(a) circle

(b) helix

(c) straight line

(d) ellipse

Solution

Magnetic field exerts a force = Bevsin0 = 0

Electric field exerts force along a straight line

The path of the charged particle will be a straight line

Answer: (c) straight line

Q14: A charged particle moves through a magnetic field perpendicular to its direction. Then

(a) kinetic energy changes but the momentum is constant

(b) the momentum changes but the kinetic energy is constant

(c) both momentum and kinetic energy of the particle are not constant

(d) both momentum and kinetic energy of the particle are constant.

Solution:

The magnetic force will act perpendicular to velocity at every instant, the path will be circular. Due to change in direction momentum will change but the total energy will remain the same.

Answer: (b) the momentum changes but the kinetic energy is constant

Q15: A coil is suspended in a uniform magnetic field, with the plane of the coil parallel to the magnetic lines of force. When a current is passed through the coil it starts oscillating it is very difficult to stop. But if an aluminium plate is placed near to the coil, it stops. This is due to

(a) induction of electrical charge on the plate

(b) shielding of magnetic lines of force as aluminium is a paramagnetic material

(c) electromagnetic induction in the aluminium plate giving rise to electromagnetic damping

(d) development of air current when the plate is placed

Answer: (c) electromagnetic induction in the aluminium plate giving rise to electromagnetic damping.