MAGNETISM

1. A soft ferromagnetic material is placed in an external magnetic field. The magnetic domains :
(1) increase in size but no change in orientation.
(2) have no relation with external magnetic field.
(3) decrease in size and changes orientation.
(4) may increase or decrease in size and change its orientation.

2. A proton, a deuteron and an α particle are moving with same momentum in a uniform magnetic field. The ratio of magnetic forces acting on them is ____ and their speed is ____ in the ratio.
(1) 1 : 2 : 4 and 2 : 1 : 1
(2) 2 : 1 : 1 and 4 : 2 : 1
(3) 4 : 2 : 1 and 2 : 1 : 1
(4) 1 : 2 : 4 and 1 : 1 : 2

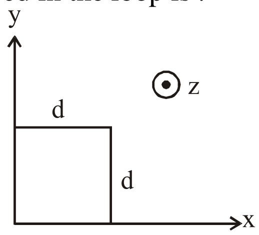
3. Magnetic fields at two points on the axis of a circular coil at a distance of 0.05m and 0.2 m from the centre are in the ratio 8 : 1. The radius of coil is ____.
(1) 0.2 m (2) 0.1 m
(3) 0.15 m (4) 1.0 m

4. In a ferromagnetic material, below the curie temperature, a domain is defined as :
(1) a macroscopic region with zero magnetization.
(2) a macroscopic region with consecutive magnetic dipoles oriented in opposite direction.
(3) a macroscopic region with randomly oriented magnetic dipoles.
(4) a macroscopic region with saturation magnetization.

5. A bar magnet of length 14 cm is placed in the magnetic meridian with its north pole pointing towards the geographic north pole. A neutral point is obtained at a distance of 18 cm from the center of the magnet. If $B_H = 0.4$ G, the magnetic moment of the magnet is (1 G = 10^{-4}T)
(1) 2.880×10^{3} J T^{-1} (2) 2.880×10^{2} J T^{-1}
(3) 2.880 J T^{-1} (4) 28.80 J T^{-1}

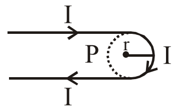
6. A charge Q is moving $\vec{dl}$ distance in the magnetic field $\vec{B}$. Find the value of work done by $\vec{B}$.
(1) 1 (2) Infinite
(3) Zero (4) –1

7. The magnetic field in a region is given by $\vec{B} = B_0\left(\frac{x}{a}\right)\hat{k}$. A square loop of side d is placed with its edges along the x and y axes. The loop is moved with a constant velocity $\vec{v} = v_0\hat{i}$. The emf induced in the loop is :



(1) $\frac{B_0 v_0^2 d}{2a}$
(2) $\frac{B_0 v_0 d}{2a}$
(3) $\frac{B_0 v_0 d^2}{a}$
(4) $\frac{B_0 v_0 d^2}{2a}$

8. A hairpin like shape as shown in figure is made by bending a long current carrying wire. What is the magnitude of a magnetic field at point P which lies on the centre of the semicircle ?



(1) $\frac{\mu_0 I}{4\pi r}(2-\pi)$
(2) $\frac{\mu_0 I}{4\pi r}(2+\pi)$
(3) $\frac{\mu_0 I}{2\pi r}(2+\pi)$
(4) $\frac{\mu_0 I}{2\pi r}(2-\pi)$

9. A loop of flexible wire of irregular shape carrying current is placed in an external magnetic field. Identify the effect of the field on the wire.
(1) Loop assumes circular shape with its plane normal to the field.
(2) Loop assumes circular shape with its plane parallel to the field.
(3) Wire gets stretched to become straight.
(4) Shape of the loop remains unchanged.

10. Which of the following statements are correct?

(A) Electric monopoles do not exist whereas magnetic monopoles exist.

(B) Magnetic field lines due to a solenoid at its ends and outside cannot be completely straight and confined.

(C) Magnetic field lines are completely confined within a toroid.

(D) Magnetic field lines inside a bar magnet are not parallel.

(E) $\chi = -1$ is the condition for a perfect diamagnetic material, where χ is its magnetic susceptibility.

Choose the correct answer from the options given below :

(1) (C) and (E) only (2) (B) and (D) only

(3) (A) and (B) only (4) (B) and (C) only

11. A deuteron and an alpha particle having equal kinetic energy enter perpendicular into a magnetic field. Let r_d and r_α be their respective radii of circular path. The value of $\frac{r_d}{r_\alpha}$ is equal to :

(1) $\frac{1}{\sqrt{2}}$ (2) $\sqrt{2}$ (3) 1 (4) 2

12. At an angle of 30° to the magnetic meridian, the apparent dip is 45°. Find the true dip :

(1) $\tan^{-1}\sqrt{3}$ (2) $\tan^{-1}\frac{1}{\sqrt{3}}$

(3) $\tan^{-1}\frac{2}{\sqrt{3}}$ (4) $\tan^{-1}\frac{\sqrt{3}}{2}$

13. The magnetic susceptibility of a material of a rod is 499. Permeability in vacuum is $4\pi \times 10^{-7}$ H/m. Absolute permeability of the material of the rod is :

(1) $4\pi \times 10^{-4}$ H/m (2) $2\pi \times 10^{-4}$ H/m

(3) $3\pi \times 10^{-4}$ H/m (4) $\pi \times 10^{-4}$ H/m

14. **Statement I :** The ferromagnetic property depends on temperature. At high temperature, ferromagnet becomes paramagnet.

Statement II : At high temperature, the domain wall area of a ferromagnetic substance increases.

In the light of the above statements, choose the **most appropriate** answer from the options given below :

(1) **Statement I** is true but **Statement II** is false

(2) Both **Statement I** and **Statement II** are true

(3) Both **Statement I** and **Statement II** are false

(4) **Statement I** is false but **Statement II** is true

15. Choose the correct option :

(1) True dip is not mathematically related to apparent dip.

(2) True dip is less than apparent dip.

(3) True dip is always greater than the apparent dip.

(4) True dip is always equal to apparent dip.

16. The value of aluminium susceptibility is 2.2×10^{-5}. The percentage increase in the magnetic field if space within a current carrying toroid is filled with aluminium is $\frac{x}{10^4}$. Then the value of x is ______.

17. Two ions having same mass have charges in the ratio 1 : 2. They are projected normally in a uniform magnetic field with their speeds in the ratio 2 : 3. The ratio of the radii of their circular trajectories is :

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

18. The relative permittivity of distilled water is 81. The velocity of light in it will be : (Given μ_r = 1)

(1) 4.33×10^7 m/s (2) 2.33×10^7 m/s

(3) 3.33×10^7 m/s (4) 5.33×10^7 m/s

19. In a uniform magnetic field, the magnetic needle has a magnetic moment 9.85×10^{-2} A/m^2 and moment of inertia 5×10^{-6} kg m^2. If it performs 10 complete oscillations in 5 seconds then the magnitude of the magnetic field is ________ mT. [Take π^2 as 9.85]

20. Match **List I** with **List II**.

List-I	List-II
(a) Capacitance, C	(i) $M^1L^1T^{-3}A^{-1}$
(b) Permittivity of free space, ε_0	(ii) $M^{-1}L^{-3}T^4A^2$
(c) Permeability of free space, μ_0	(iii) $M^{-1}L^{-2}T^4A^2$
(d) Electric field, E	(iv) $M^1L^1T^{-2}A^{-2}$

Choose the correct answer from the options given below

(1) (a) $\rightarrow$ (iii), (b) $\rightarrow$ (ii), (c) $\rightarrow$ (iv), (d) $\rightarrow$ (i)
(2) (a) $\rightarrow$ (iii), (b) $\rightarrow$ (iv), (c) $\rightarrow$ (ii), (d) $\rightarrow$ (i)
(3) (a) $\rightarrow$ (iv), (b) $\rightarrow$ (ii), (c) $\rightarrow$ (iii), (d) $\rightarrow$ (i)
(4) (a) $\rightarrow$ (iv), (b) $\rightarrow$ (iii), (c) $\rightarrow$ (ii), (d) $\rightarrow$ (i)

21. Figure A and B shown two long straight wires of circular cross-section (a and b with a < b), carrying current I which is uniformly distributed across the cross-section. The magnitude of magnetic field B varies with radius r and can be represented as :

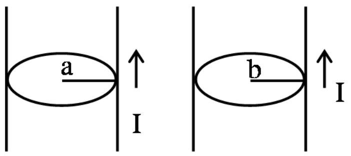
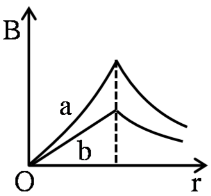
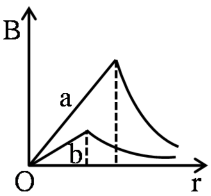
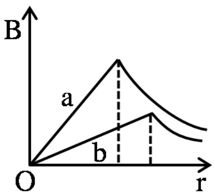
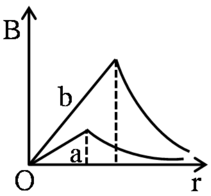


Fig. A Fig. B

(1)


(2)


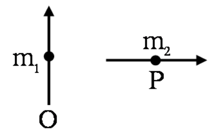
(3)


(4)


22. The fractional change in the magnetic field intensity at a distance 'r' from centre on the axis of current carrying coil of radius 'a' to the magnetic field intensity at the centre of the same coil is : (Take r < a)

(1) $\frac{3}{2}\frac{a^2}{r^2}$ (2) $\frac{2}{3}\frac{a^2}{r^2}$ (3) $\frac{2}{3}\frac{r^2}{a^2}$ (4) $\frac{3}{2}\frac{r^2}{a^2}$

23. Two short magnetic dipoles m_1 and m_2 each having magnetic moment of 1 Am^2 are placed at point O and P respectively. The distance between OP is 1 meter. The torque experienced by the magnetic dipole m_2 due to the presence of m_1 is ...... $\times 10^{-7}$ Nm.



24. If the maximum value of accelerating potential provided by a ratio frequency oscillator is 12 kV. The number of revolution made by a proton in a cyclotron to achieve one sixth of the speed of light is ....
[$m_p = 1.67 \times 10^{-27}$ kg, $e = 1.6 \times 10^{-19}$ C,
Speed of light $= 3 \times 10^8$ m/s]

25. A coil in the shape of an equilateral triangle of side 10 cm lies in a vertical plane between the pole pieces of permanent magnet producing a horizontal magnetic field 20 mT. The torque acting on the coil when a current of 0.2 A is passed through it and its plane becomes parallel to the magnetic field will be $\sqrt{x} \times 10^{-5}$ Nm. The value of x is..........

26. Two ions of masses 4 amu and 16 amu have charges +2e and +3e respectively. These ions pass through the region of constant perpendicular magnetic field. The kinetic energy of both ions is same. Then :

(1) lighter ion will be deflected less than heavier ion
(2) lighter ion will be deflected more than heavier ion
(3) both ions will be deflected equally
(4) no ion will be deflected.

27. A uniform conducting wire of length is 24a, and resistance R is wound up as a current carrying coil in the shape of an equilateral triangle of side 'a' and then in the form of a square of side 'a'. The coil is connected to a voltage source V_0. The ratio of magnetic moment of the coils in case of equilateral triangle to that for square is $1 : \sqrt{y}$ where y is ....

28. A coaxial cable consists of an inner wire of radius 'a' surrounded by an outer shell of inner and outer radii 'b' and 'c' respectively. The inner wire carries an electric current i_0, which is distributed uniformly across cross-sectional area. The outer shell carries an equal current in opposite direction and distributed uniformly. What will be the ratio of the magnetic field at a distance x from the axis when (i) x < a and (ii) a < x < b ?

(1) $\frac{x^2}{a^2}$ (2) $\frac{a^2}{x^2}$

(3) $\frac{x^2}{b^2-a^2}$ (4) $\frac{b^2-a^2}{x^2}$

29. A coil having N turns is wound tightly in the form of a spiral with inner and outer radii 'a' and 'b' respectively. Find the magnetic field at centre, when a current I passes through coil :

(1) $\frac{\mu_0 IN}{2(b-a)}\log_e\left(\frac{b}{a}\right)$ (2) $\frac{\mu_0 I}{8}\left[\frac{a+b}{a-b}\right]$

(3) $\frac{\mu_0 I}{4(a-b)}\left[\frac{1}{a}-\frac{1}{b}\right]$ (4) $\frac{\mu_0 I}{8}\left(\frac{a-b}{a+b}\right)$

30. A current of 1.5 A is flowing through a triangle, of side 9 cm each. The magnetic field at the centroid of the triangle is :
(Assume that the current is flowing in the clockwise direction.)

(1) 3×10^{-7} T, outside the plane of triangle

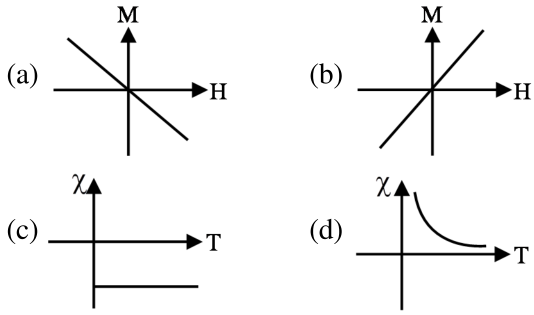
(2) $2\sqrt{3} \times 10^{-7}$ T, outside the plane of triangle

(3) $2\sqrt{3} \times 10^{-5}$ T, inside the plane of triangle

(4) 3×10^{-5} T, inside the plane of triangle

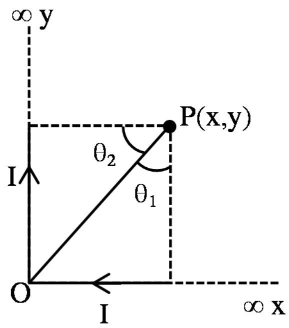
31. A long solenoid with 1000 turns/m has a core material with relative permeability 500 and volume 10^3 cm^3. If the core material is replaced by another material having relative permeability of 750 with same volume maintaining same current of 0.75 A in the solenoid, the fractional change in the magnetic moment of the core would be approximately $\left(\frac{x}{499}\right)$. Find the value of x.

32. Following plots show Magnetization (M) vs Magnetising field (H) and Magnetic susceptibility (χ) vs temperature (T) graph :



Which of the following combination will be represented by a diamagnetic material?

33. There are two infinitely long straight current carrying conductors and they are held at right angles to each other so that their common ends meet at the origin as shown in the figure given below. The ratio of current in both conductor is 1 : 1. The magnetic field at point P is ____.



(1) $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}+(x+y)\right]$

(2) $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}-(x+y)\right]$

(3) $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}-(x+y)\right]$

(4) $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}+(x+y)\right]$

SOLUTION

1. Official Ans. by NTA (4)

Sol. Soft ferromagnetic materials are materials which can be easily magnetised and demagnetised by external magnetic field. When external field is applied, the domains experiences a net torque hence change its orientation.

Hence option (4) is correct

2. Official Ans. by NTA (2)

Sol. $F = q\left(\vec{v}\times\vec{B}\right) = \dfrac{q}{m}\left(\vec{P}\times\vec{B}\right) \Rightarrow F \propto \dfrac{q}{m}$

thus $F_1 : F_2 : F_3 = \dfrac{q_1}{m_1} : \dfrac{q_2}{m_2} : \dfrac{q_3}{m_3}$

$= \dfrac{e}{m_p} : \dfrac{e}{2m_p} : \dfrac{2e}{4m_p}$

$= \dfrac{1}{1} : \dfrac{1}{2} : \dfrac{2}{4} = 2 : 1 : 1$

Now for speed calculation

$P = \text{constant} \Rightarrow v \propto \dfrac{1}{m}$

thus $v_1 : v_2 : v_3 = \dfrac{1}{m_p} : \dfrac{1}{2m_p} : \dfrac{1}{4m_p}$

$= \dfrac{1}{1} : \dfrac{1}{2} : \dfrac{1}{4} = 4 : 2 : 1$

3. Official Ans. by NTA (2)

Sol. We know, the magnetic field on the axis of a current carrying circular ring is given by

$$B = \frac{\mu_0}{4\pi}\frac{2NIA}{\left(R^2+x^2\right)^{3/2}}$$

$$\therefore \frac{B_1}{B_2} = \frac{8}{1} = \left[\frac{R^2+(0.2)^2}{R^2+(0.05)^2}\right]^{3/2}$$

$4[R^2 + (0.05)^2] = [R^2 + (0.2)^2]$

$4R^2 - R^2 = (0.2)^2 - 4 \times (0.05)^2$

$4R^2 - R^2 = (0.2)^2 - (0.1)^2$

$3R^2 = 0.3 \times 0.1$

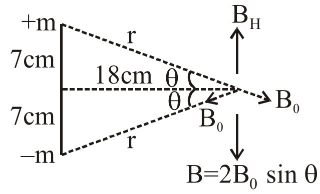
$R^2 = (0.1)^2 \Rightarrow R = 0.1$

4. Official Ans. by NTA (4)

Sol. (4) conceptual

5. Official Ans. by NTA (3)

Sol.



i.e. $\dfrac{2\mu_0}{4\pi}\dfrac{m}{r^2} \times \dfrac{7}{r} = 0.4 \times 10^{-4}$

$\Rightarrow 2 \times 10^{-7} \times \dfrac{m \times 7}{(7^2+18^2)^{3/2}} \times 10^4 = 0.4 \times 10^{-4}$

$m = \dfrac{4\times10^{-2}\times(373)^{3/2}}{14}$

$M = m \times 14\text{ cm} = m \times \dfrac{14}{100}$

$= \dfrac{0.04\times(373)^{3/2}}{14} \times \dfrac{14}{100}$

$= 4 \times 10^{-4} \times 7203.82 = 2.88$ J/T

6. Official Ans. by NTA (3)

Sol. Since force on a point charge by magnetic field is always perpendicular to $\vec{v}\left[\vec{F} = q\vec{V}\times\vec{B}\right]$

$\therefore$ Work by magnetic force on the point charge is zero.

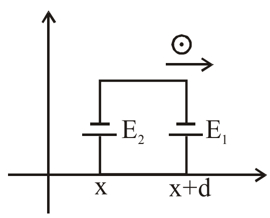
7. Official Ans. by NTA (3)

Sol. $E_1 = \dfrac{B_0(x+d)}{a}v_0 d$

$E_2 = \dfrac{B_0(x)}{a}v_0 d$

$E_{net} = E_1 - E_2$

$E_{net} = \dfrac{B_0 v_0 d^2}{a}$



8. Official Ans. by NTA (2)

Sol. (2) $B = 2 \times B_{st.wire} + B_{loop}$

$B = 2 \times \dfrac{\mu_0 i}{4\pi r} + \dfrac{\mu_0 i}{2r}\left(\dfrac{\pi}{2\pi}\right)$

$B = \dfrac{\mu_0 i}{4\pi r}\left(2+\pi\right)$

9. Official Ans. by NTA (1)

Sol. Every part ($d\ell$) of the wire is pulled by force $i(d\ell)B$ acting perpendicular to current & magnetic field giving it a shape of circle.

10. Official Ans. by NTA (1)

Sol. Statement (C) is correct because, the magnetic field outside the toroid is zero and they form closed loops inside the toroid itself.
Statement (E) is correct because we know that super conductors are materials inside which the net magnetic field is always zero and they are perfect diamagnetic.

$\mu_r = 1 + \chi$

$\chi = -1$

$\mu_r = 0$

For superconductors.

11. Official Ans. by NTA (2)

Sol. $r = \frac{mv}{qB} = \frac{\sqrt{2mk}}{qB}$

$$\frac{r_d}{r_\alpha} = \sqrt{\frac{m_d}{m_\alpha}}\frac{q_\alpha}{q_d} = \sqrt{\frac{2}{4}}\left(\frac{2}{1}\right) = \sqrt{2}$$

Hence option (2).

12. Official Ans. by NTA (4)

Sol. $A \tan\delta = \tan\delta' \cos\theta$

$= \tan 45° \cos 30°$

$\tan\delta = 1 \times \frac{\sqrt{3}}{2}$

$\delta = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

13. Official Ans. by NTA (2)

Sol. $\mu = \mu_0 (1 + x_m)$

$= 4\pi \times 10^{-7} \times 500$

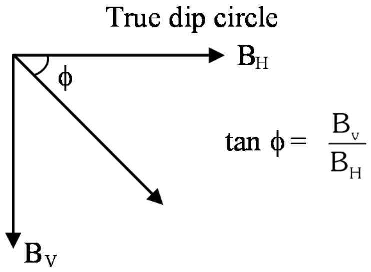
$= 2\pi \times 10^{-4}$ H/m

14. Official Ans. by NTA (1)

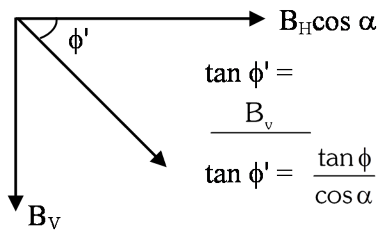
Sol. As temperature increases, domains disintegrate so ferromagnetism decreases and above curie temperature it become paramagnet.

15. Official Ans. by NTA (2)

Sol. If apparent dip circle is at an angle α with true dip circle then



Apparent dip circle



As $\cos\alpha < 1$

Hence true dip (ϕ) is less than apparent dip (ϕ')

16. Official Ans. by NTA (22)

Sol. $B = \mu.(H+I)$

$B = \mu.H\left(1+\frac{I}{H}\right)$

$B = B_0(1+x)$

$B - B_0 = B_0 x$

$\frac{B - B_0}{B_0} = x$

$\frac{B - B_0}{B_0} \times 100 = 100x = 2.2 \times 10^{-3} = \frac{22}{10^4}$

17. Official Ans. by NTA (2)

Sol. $R = \frac{mv}{qB} \Rightarrow \frac{R_1}{R_2} = \frac{\frac{mv_1}{q_1 B}}{\frac{mv_2}{q_2 B}}$

$= \frac{v_1}{q_1} \times \frac{q_2}{v_2} = \frac{q_2}{q_1} \times \frac{v_1}{v_2} = \frac{2}{1} \times \left(\frac{2}{3}\right) = \frac{4}{3}$

18. Official Ans. by NTA (3)

Sol. $V = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$

$= 3.33 \times 10^7$ m/sec

19. Official Ans. by NTA (8)

Sol. $T = 2\pi\sqrt{\dfrac{I}{MB}}$

$B = 80 \times 10^{-4} = 8\text{mT}$

20. Official Ans. by NTA (1)

Sol. $q = CV$

$[C] = \left[\dfrac{q}{V}\right] = \dfrac{(A\times T)^2}{ML^2T^{-2}}$

$= M^{-1}L^{-2}\,T^4A^2$

$[E] = \left[\dfrac{F}{q}\right] = \dfrac{MLT^{-2}}{AT}$

$= MLT^{-3}\,A^{-1}$

$F = \dfrac{q_1q_2}{4\pi\in_o r^2}$

$[\in_o] = M^{-1}L^{-3}T^4A^2$

Speed of light $c = \dfrac{1}{\sqrt{\mu_o\in_o}}$

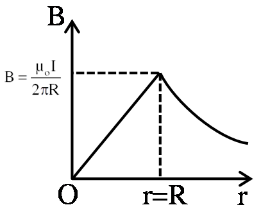
$\mu_o = \dfrac{1}{\in_o c^2}$

$[\mu_o] = \dfrac{1}{[M^{-1}L^{-3}T^4A^2][LT^{-1}]^2}$

$= [M^1L^1T^{-2}A^{-2}]$

21. Official Ans. by NTA (3)

Sol. Graph for wire of radius R :



As $b > a$

$B_a > B_b$

$B_a = \dfrac{\mu_0 i}{2\pi a}$; $B_b = \dfrac{\mu_0 i}{2\pi b}$

22. Official Ans. by NTA (4)

Sol. $B_{axis} = \dfrac{\mu_0 iR^2}{2\left(R^2+x^2\right)^{3/2}}$; $B_{centre} = \dfrac{\mu_0 i}{2R}$

$\therefore B_{centre} = \dfrac{\mu_0 i}{2a}$ $\therefore B_{axis} = \dfrac{\mu_0 ia^2}{2\left(a^2+r^2\right)^{3/2}}$

$\therefore$ fractional change in magnetic field

$$= \frac{\dfrac{\mu_0 i}{2a} - \dfrac{\mu_0 ia^2}{2\left(a^2+r^2\right)^{3/2}}}{\dfrac{\mu_0 i}{2a}} = 1 - \frac{1}{\left[1+\left(\dfrac{r^2}{a^2}\right)\right]^{3/2}}$$

$$\approx 1 - \left[1 - \frac{3}{2}\frac{r^2}{a^2}\right] = \frac{3}{2}\frac{r^2}{a^2}$$

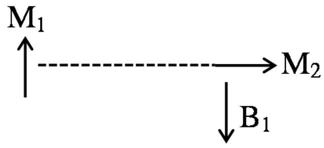
Note : $\left(1+\dfrac{r^2}{a^2}\right)^{-3/2} \approx \left(1-\dfrac{3}{2}\dfrac{r^2}{a^2}\right)$

[True only if r << a]

Hence option (4) is the most suitable option

23. Official Ans. by NTA (1)

Sol.



$\vec{\tau} = \vec{M}_2 \times \vec{B}_1$

$\tau = M_2B_1 \sin 90°$

$= 1 \times \dfrac{\mu_0}{4\pi}\dfrac{M_1}{(1)^3} 1 = 10^{-7}$ N.m

Ans. 1.00

24. Official Ans. by NTA (543)

Sol. $V = 12$ kV

Number of revolution = n

$n\left[2 \times q_P \times V\right] = \dfrac{1}{2} m_P \times v_P^2$

$n[2\times 1.6 \times 10^{-19} \times 12 \times 10^3$

$= \dfrac{1}{2} \times 1.67 \times 10^{-27} \times \left[\dfrac{3\times10^8}{6}\right]^2$

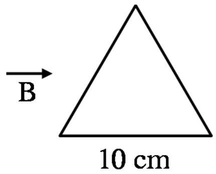
$n(38.4\times10^{-16}) = 0.2087 \times 10^{-11}$

$n = 543.4$

Ans. 543

25. Official Ans. by NTA (3)

Sol.



$\vec{\tau} = \vec{M} \times \vec{B} = MB\sin 90°$

$= MB = \dfrac{i\sqrt{3}\ell^2}{4}B$

$= \sqrt{3} \times 10^{-5} N - m$

Ans. 3

26. Official Ans. by NTA (2)

Sol. $r = \dfrac{P}{qB} = \dfrac{\sqrt{2mk}}{qB}$

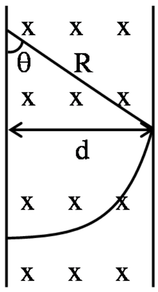
Given they have same kinetic energy

$r \propto \dfrac{\sqrt{m}}{q}$

$\dfrac{r_1}{r_2} = \dfrac{\sqrt{4}}{2} \times \dfrac{3}{\sqrt{16}} = \dfrac{3}{4}$

$\boxed{r_2 = \dfrac{4r_1}{3}}$

(r_2 is for hearier ion and r_1 is for lighter ion)



$\sin\theta = \dfrac{d}{R}$

$\theta \to$ Deflection

$\theta \propto \dfrac{1}{R}$

($R \to$ Radius of path)

$\because R_2 > R_1 \Rightarrow \theta_2 < \theta_1$

27. Official Ans. by NTA (3)

Sol. In triangle shape $N_t = \dfrac{24a}{3a} = 8$

In square $N_s = \dfrac{24a}{4a} = 6$

$\dfrac{M_t}{M_3} = \dfrac{N_t I A_t}{N_s I A_s}$ [I will be same in both]

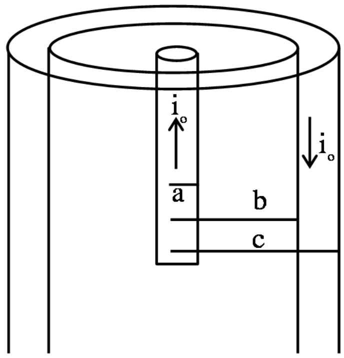
$= \dfrac{8 \times \dfrac{\sqrt{3}}{4} \times a^2}{6 \times a^2}$

$\dfrac{M_t}{M_s} = \dfrac{1}{\sqrt{3}}$

$\boxed{y = 3}$

28. Official Ans. by NTA (1)

Sol.



when $x < a$

$B_1 (2\pi x) = \mu_o \left(\dfrac{i_o}{\pi a^2}\right)\pi x^2$

$B(2\pi x) = \dfrac{\mu_o i_o x^2}{a^2}$

$B_1 = \dfrac{\mu_o i_o x}{2\pi a^2}$ ...(1)

when $a < x < b$

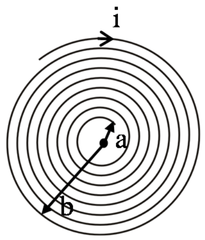
$B_2(2\pi x) = \mu_o i_o$

$B_2 = \dfrac{\mu_o i_o}{2\pi x}$ ...(2)

$\dfrac{B_1}{B_2} = \dfrac{\mu_o i_o \dfrac{x}{2\pi a^2}}{\dfrac{\mu_o i_o}{2\pi x}} = \dfrac{x^2}{a^2}$

29. Official Ans. by NTA (1)

Sol.



No. of turns in dx width $= \frac{N}{b-a}dx$

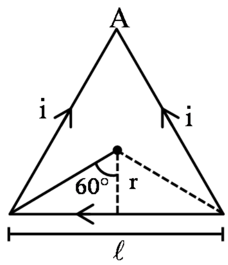
$$\int dB = \int_a^b \left(\frac{N}{b-a}\right)dx\,\frac{\mu_0 i}{2x}$$

$$B = \frac{N\mu_0 i}{2(b-a)}\ell n\left(\frac{b}{a}\right)$$

Option (1)

30. Official Ans. by NTA (4)

Sol.



$$B = 3\left[\frac{\mu_0 i}{4\pi r}(\sin 60° + \sin 60°)\right]$$

$$\tan 60° = \frac{\ell/2}{r}$$

Where r $= \frac{9\times10^{-2}}{2\sqrt{3}}M$

$\therefore$ B = 3×10^{-5} T

Current is flowing in clockwise direction so, $\vec{B}$ is inside plane of triangle by right hand rule.

31. Official Ans. by NTA (250)

Sol. $\frac{\Delta M}{M} = \frac{\Delta\mu}{\mu} = \frac{250}{500} = \frac{1}{2}$

$$\frac{1}{2} = \frac{x}{499} \Rightarrow x \simeq 250$$

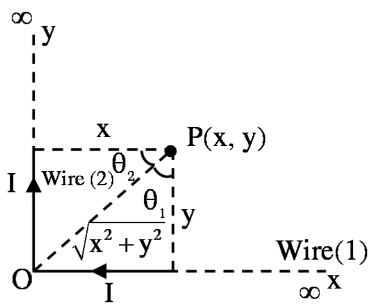
32. Official Ans. by NTA (1)

Sol. Conceptual question

Option (1)

33. Official Ans. by NTA (1)

Sol.



$$B_{\text{due to wire (1)}} = \frac{\mu_0 I}{4\pi y}[\sin 90 + \sin\theta_1]$$

$$= \frac{\mu_0}{4\pi}\frac{I}{y}\left(1+\frac{x}{\sqrt{x^2+y^2}}\right) \quad \ldots\ldots(1)$$

$$B_{\text{due to wire (2)}} = \frac{\mu_0}{4\pi}\frac{I}{x}(\sin 90° + \sin\theta_2)$$

$$= \frac{\mu_0}{4\pi}\frac{I}{x}\left(1+\frac{y}{\sqrt{x^2+y^2}}\right) \quad \ldots..(2)$$

Total magnetic field

B = $B_1 + B_2$

$$B = \frac{\mu_0 I}{4\pi}\left[\frac{1}{y}+\frac{x}{y\sqrt{x^2+y^2}}+\frac{1}{x}+\frac{y}{x\sqrt{x^2+y^2}}\right]$$

$$B = \frac{\mu_0 I}{4\pi}\left[\frac{x+y}{xy}+\frac{x^2+y^2}{xy\sqrt{x^2+y^2}}\right]$$

$$B = \frac{\mu_0 I}{4\pi}\left[\frac{x+y}{xy}+\frac{\sqrt{x^2+y^2}}{xy}\right]$$

$$B = \frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}+(x+y)\right]$$

Option (1)