(1) **(A).** When currents flow in two long, parallel wires in the same direction, the wires exert a force of attraction on each other. The magnitude of this force acting per meter length of the wires is given by

$$F = \frac{\mu_0}{2\pi}\frac{i_1 i_2}{R} = 2 \times 10^{-7}\frac{i_1 i_2}{R} \text{ N/m.}$$

Here $i_1 = 10$ A, $i_2 = 15$ A,
R = 30 cm = 0.3 m

$\therefore$ $F = 2 \times 10^{-7}\dfrac{10 \times 15}{0.3} = 1 \times 10^{-4}$ N/m.

$\therefore$ Force on 5m length of the wire
$= 5 \times (1 \times 10^{-4}) = (5 \times 10^{-4})$
$= 5 \times 10^{-4}$ N (attraction).

(2) **(D).** $B_A = \dfrac{\mu_0 I}{2R}$; $B_B = \dfrac{\mu_0 (2I)}{2(2R)}$

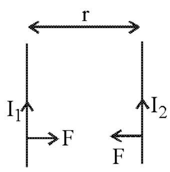
$\therefore$ $B_A : B_B = 1$

(3) **(C).** $r = \dfrac{\rho}{qB}$. Same momentum and same charge

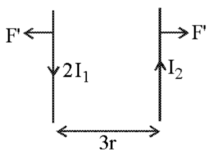
So r = constant.

(4) **(D).** Time period $T = \dfrac{2\pi m}{qB}$

(5) **(C).** $F = \dfrac{\mu_0}{2\pi}\dfrac{I_1 I_2}{r} I_1$



$$F' = \frac{\mu_0}{2\pi}\frac{(2I_1)I_2}{3r} = \frac{2}{3}F$$



(6) **(B).** $T = \dfrac{2\pi m}{qB}$

(7) **(C).** Force per unit length $= \dfrac{\mu_0 i_1 i_2}{2\pi d}$

(8) **(C).** $B_{solenoid} = \mu_0 nI$

$$B' = \frac{B}{6} = \frac{6.28 \times 10^{-2}}{6}$$
$= 1.05 \times 10^{-2}$ Weber/m^2

(9) **(A).** The magnetic field between wires is in opposite direction due to both wires

$B_{\text{in between}}$

$$= \frac{\mu_0 i}{2\pi x}\hat{j} - \frac{\mu_0 i}{2\pi(2d - x)}(-\hat{j})$$

$$= \frac{\mu_0 i}{2\pi}\left[\frac{1}{x} - \frac{\mu_0 i}{2d - x}\right](\hat{j})$$

At x = d, $B_{\text{in between}} = 0$

for x < d, $B_{\text{in between}} = (\hat{j})$;

for x > d, $B_{\text{in between}} = (-\hat{j})$ towards x net magnetic field will add up and direction will be $(-\hat{j})$ towards x' net magnetic field will add up and direction will be $(\hat{j})$

(10) **(B).** Diamagnetic substances are repelled by the magnetic field.

(11) **(C).** Couple acting on a bar magnet of dipole moment M when placed in a magnetic field, is given by $\tau = MB \sin\theta$

where θ is the angle made by the axis of magnet with the direction of field.

Given that m = 5 Am, $2\ell = 0.2$ m,
θ = 30° and B = 15 Wbm^{-2}

$\therefore$ $\tau = MB\sin\theta = (m \times 2\ell) B \sin\theta$

$$= 5 \times 0.2 \times 15 \times \frac{1}{2} = 7.5 \text{ Nm.}$$

(12) **(B).** The magnetic lines of force are in the form of closed curves whereas electric lines of force are open curves.

(13) **(C).** According to tangent law

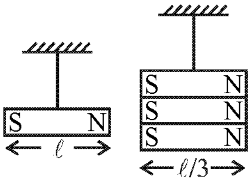
$B_A = B_B \tan\theta$

or $\dfrac{\mu_0}{4\pi}\dfrac{2M}{d_1^3} = \dfrac{\mu_0}{4\pi}\dfrac{M}{d_1^3}\tan\theta$ $\therefore$ $\dfrac{d_1}{d_2} = (2\cot\theta)^{1/3}$

(14) **(D).** $W = MB(\cos\theta_1 - \cos\theta_2)$

$$= MB(\cos 0° - \cos 60°) = \frac{MB}{2}$$

$$\tau = MB\sin 60° = \frac{\sqrt{3}}{2}MB = \sqrt{3}W$$

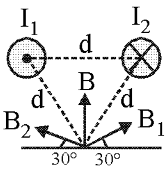
(15) **(B).** 

$$T = 2\pi\sqrt{\frac{I}{MB}} = 2\sec$$

$$T = 2\pi\sqrt{\frac{I'}{M'B}} = 2\pi\sqrt{\frac{I/9}{MB}} = \frac{T}{3} = \frac{2}{3}\sec$$

(16) **(C).** A force and a torque.

(17) **(A).** $\mu_0 H = \mu_0 nI$; $3\times10^3 = \frac{100}{0.1}\times i \Rightarrow i = 3A$

(18) **(B).** 

(19) **(A).** $R = \frac{mv}{qB}$; $\vec{F} = q(\vec{v}\times\vec{B})$, $R\downarrow v\downarrow$

Clockwise motion for upward magnetic field $\to$ +ve

(20) **(C).** Ratio of magnetic moment and angular momentum is given by $\frac{M}{L} = \frac{q}{2m}$, which is a function of q and m only.

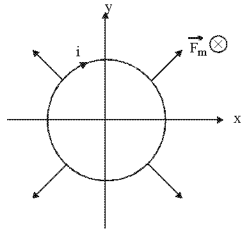
This can be derived as follows :

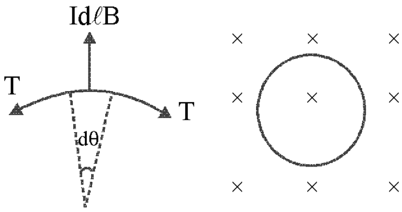
$$M = iA = (qf).(\pi r^2) = (q)\left(\frac{\omega}{2\pi}\right)(\pi r^2)$$

$$= \frac{q\omega r^2}{2} \text{ and } L = I\omega = (mr^2\omega)$$

$$\therefore \quad \frac{M}{L} = \frac{q\frac{\omega r^2}{2}}{mr^2\omega} = \frac{q}{2m}$$

(21) **(B).** Net force on a current carrying loop in uniform magnetic field is zero. Hence, the loop cannot translate. So, options (C) and (D) are wrong. From Flemming's left hand rule we can see that if magnetic field is perpendicular to paper inwards and current in the loop is clockwise (as shown) the magnetic force $\vec{F}_m$ on each element of the loop is radially outwards, or the loops will have a tendency to expand.



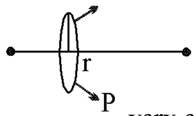
(22) **(C).** 

$$2T\sin\left(\frac{d\theta}{2}\right) = Id\ell B$$

(For small angles $\sin\theta \approx \theta$)

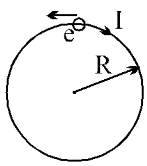
$$\Rightarrow \quad 2T\frac{d\theta}{2} = IRd\theta B \Rightarrow T = BIR = \frac{BIL}{2\pi}$$

(23) **(D).** Circular for finite length of wire



very close to wire

$$B = \frac{\mu_0 I}{4\pi r}[\sin\theta_1 - \sin\theta_2]$$

(24) **(B).** 

This is equivalent to a current loop of radius R

I = ne

$$B = \frac{\mu_0 I}{2R} = \frac{\mu_0 ne}{2R}$$

(25) **(B).** $B = \frac{\mu_0}{2\pi(d/2)}(i_1 - i_2) = 20$

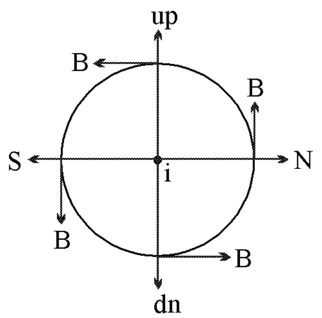
$$\frac{\mu_0}{2\pi(d/2)}(i_1 + i_2) = 50$$

$$\frac{i_1 - i_2}{i_1 + i_2} = \frac{2}{5}$$

Consider $\frac{i_1}{i_2} = x$; $x = \frac{7}{3}$

(26) **(D).** $B = \frac{\mu_0 NiR^2}{2(R^2 + x^2)^{3/2}}$; $B_{max} \Rightarrow x_{min} = 0$

(27) **(D).** When seen from E to W megnetic line of forces are shown



(28) **(B).** Liquid oxygen remains suspended between two pole faces of a magnet because it is paramagnetic.

(29) **(B).** Force in uniform field is independent on shape. Shortest distance between A and C = 5m

$F = 2 \times 5 \times 2 = 20$ N

(30) **(D).** Stationary magnet generates magnetic field only which does not affect piece of paper. When it moves, it generates electric field also which affects pieces of paper. Torque due to magnetic force

$\tau = MB \sin\theta$

Here $\vec{B}$ is $\perp$ to plane $\Rightarrow$ parallel to $\vec{M}$

$\therefore$ $\tau = 0$

(31) **(B).** Magnetic moment of loop

$$M = NIA = 100 \times \frac{1}{2} \times \pi r^2$$

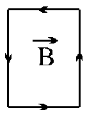
(Potential Energy) $U = -\vec{M}\cdot\vec{B}$

$\Delta U = U_f - U_i = -(-MB) - (-MB) = 2MB$

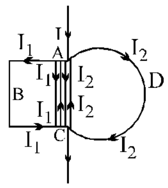
$$= 2 \times 100 \times \frac{1}{2} \times \pi \left(\frac{1}{10}\right)^2 \times 2 = 2\pi J$$

(32) **(C).** $\vec{\tau} = \vec{M}\times\vec{B}$ is $\uparrow$ direction

$\Rightarrow$ left edge is lifted up



(33) **(B).** Introducing two equal and opposite current I_1 and also I_2 between A & C.



Force on ABCA closed loop zero

Force on ADCA closed loop zero

Force on extra I_1 & I_2

$F = (I_1 + I_2)\, lB = IlB$

(34) **(D).** The loops is alwsys attracted towards wire as the region part of loop getting attracted is experiencing stronger magnetic field.

(35) **(A).** $\vec{\tau} = \vec{M}\times\vec{B} = I\left[8a^2 + \frac{\pi a^2}{2}\right] B\sin 90°$

$$= I\left(\frac{\pi a^2}{2} + 8a^2\right)B$$

(36) **(B).** $F = BI\vec{\ell}_{eff}$

(37) **(A).** $\vec{F} = q\,(\vec{v}\times\vec{B})$; $-\hat{j} = -\hat{k}\times\vec{B}$; $\vec{B}\Rightarrow\hat{i}$

(38) **(A).** $qvB = qE \Rightarrow vB = \frac{V}{D} \Rightarrow v = \frac{V}{BD}$

(39) **(B).** $T = 2\pi m/(qB)$

$\Rightarrow$ $T \propto m/q$ [B & v same]

$T_\alpha / T_P = (4m/m) \times (q/2q) = 2 : 1$

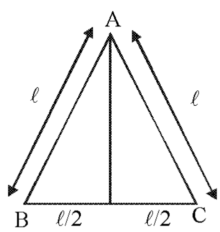
(40) **(D).** At equator magnetic field is horizontal.

(41) **(A).** Coercivity has the unit of

$$H = \frac{B}{\mu_0} = \frac{\mu_0 nI}{\mu_0} \quad \therefore \quad H = nI$$

(42) **(D).** $r = \frac{mv}{qB} \Rightarrow r \propto \frac{v}{B}$

(43) **(B).**



$\tau = mB\sin\theta$; $\tau = iAB\sin 90°$

$\therefore \quad A = \dfrac{\tau}{iB}$

$$A = \frac{1}{2}(BC)(AD) = \frac{1}{2}(\ell)\sqrt{\ell^2 - \left(\frac{\ell}{2}\right)^2}$$

$$= \frac{\sqrt{3}}{4}\ell^2$$

$$\Rightarrow \quad \frac{\sqrt{3}}{4}(\ell)^2 = \frac{\tau}{Bi} \quad \therefore \quad \ell = 2\left(\frac{\tau}{\sqrt{3}\,Bi}\right)^{1/2}$$

(44) **(A).** The magnetic dipole moment of diamagnetic material is zero as each of its pair of electrons have opposite spins, i.e., $\mu_d = 0$

Paramagnetic substances have dipole moment > 0 i.e. $\mu_p \neq 0$, because of excess of electrons in molecules spinning in the same direction.

Ferromagnetic substances are very strong magnets and they also have permanent magnetic moment i.e. $\mu_f \neq 0$.

(45) **(B).** Force on a particle moving with velocity v in a magnetic field B is $\vec{F} = q\,(\vec{v} \times \vec{B})$

If angle between $\vec{v}$ & $\vec{B}$ is either zero or 180°, the value of F will be zero as cross product of $\vec{v}$ & $\vec{B}$ will be zero.