DPP – 5 (Magnetic Field & Force)

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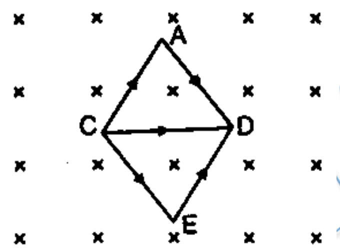
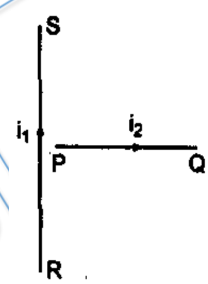
Q 1. Same current i=2A is flowing in a wire frame as shown in figure. The frame is a combination of two equilateral triangles ACD and CDE of side 1m. It is placed in uniform magnetic field B = 4 T acting perpendicular to the plane of frame. The magnitude of magnetic force acting on the frame is:



(a) 24 N (b) zero (c) 16 N (d) 8 N

Q 2. A current carrying wire PQ is placed near an another long current carrying wire RS. If free to move, wire PQ will have:

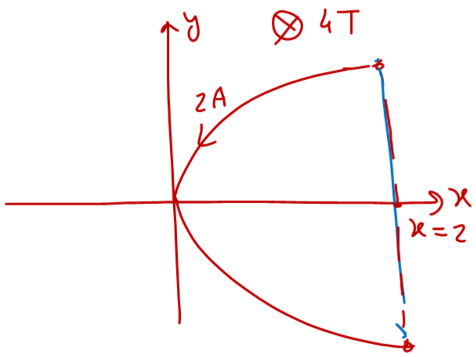


(a) translational motion only
(b) rotational motion only
(c) translational as well as rotational motion
(d) neither translational nor rotational motion

Q 3. A conducting rod of mass m and length l is placed over a smooth horizontal source. A uniform magnetic field B is acting perpendicular to the rod. Charge q is suddenly passed through the rod and it acquires an initial velocity v on the surface, then q is equal to:

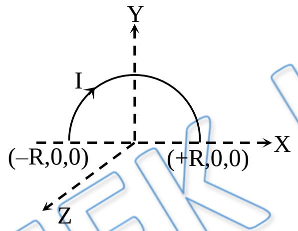
(a) $\frac{2mv}{Bl}$ (b) $\frac{Bl}{2mv}$ (c) $\frac{mv}{Bl}$ (d) $\frac{Blv}{2m}$

Q 4. A conducting wire bent in the form of a parabola $y^2 = 2x$ carries a current i = 2A as shown in figure. This wire is placed in a uniform magnetic field $\vec{B} = -4\hat{k}$ tesla. The magnetic force on the wire is: (in newton)



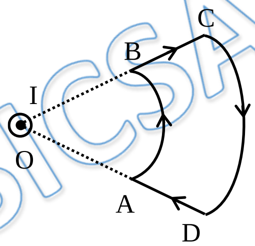
(a) – 16$\hat{i}$ (b) 32 $\hat{i}$ (c) – 32$\hat{i}$ (d) 16$\hat{i}$

Q 5. A semi circular current carrying wire having radius R is placed in x-y plane with its centre at origin 'O'. There is non-uniform magnetic field $\vec{B} = \frac{B_0 x}{2R}$ (here B_0 is +ve constant) is existing in the region. The magnetic force acting on semi circular wire will be along –



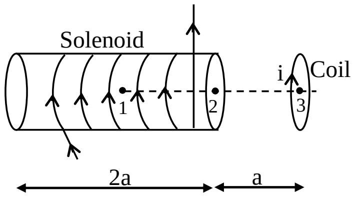
(a) – x-axis (b) + y-axis (c) – y-axis (d) + x-axis

Q 6. An infinite wire carrying current I passes through point O perpendicular to the plane containing a current carrying loop ABCD as shown in the figure.



(a) Net force on the loop is zero
(b) Net torque on the loop is zero
(c) The loop rotates in anticlockwise direction as seen from O
(d) The loop rotates in clockwise direction as seen from O

Q 7. Point 1 is at middle of solenoid, point (2) at an end face and point (3) is outside the solenoid at a distance a. Plane of coil and plane of cross-section of solenoid are parallel –



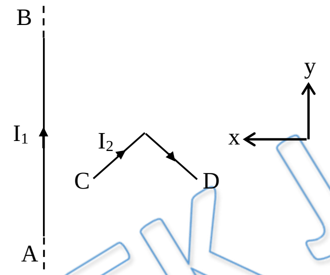
(a) Force between coil and solenoid is attractive at all three points (i.e. 1, 2, 3)
(b) Force between coil and solenoid at the point 1 is zero
(c) Among these three point force between coil and solenoid is maximum at point 2

(d) Among these three point force between coil and solenoid is maximum at point 1

Q 8. A semi–circular current carrying wire having radius R is placed in x–y plane with its centre at origin O. There is a position x dependent non–uniform magnetic field $\vec{B} = \frac{B_0 x}{2R}\hat{k}$ (here B_0 is positive constant) existing in the region. The force due to magnetic field acting on the semi–circular wire will be along :

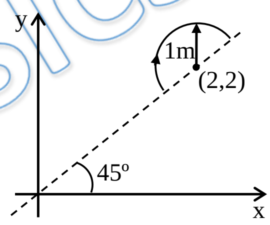
(a) negative x-axis
(b) positive x-axis
(c) negative y-axis
(d) positive y-axis

Q 9. In the figure shown a current I_1 is established in the long straight wire AB. Another wire CD carrying current I_2 is placed in the plane of the paper. The line joining the ends of this wire is perpendicular to the wire AB. The resultant force on the wire CD is-



(a) zero
(b) towards negative x-axis
(c) towards positive y-axis
(d) none of these

Q 10. A uniform magnetic field $\vec{\boldsymbol{B}}$ = $3\hat{\imath} + 4\hat{\jmath} + \hat{k}$ exists in region of space. A semicircular wire of radius 1 m carrying current 1 A having its centre at (2, 2, 0) is placed in x-y plane as shown in figure. The force on semicircular wire will be-



(a) $\sqrt{2}\left(\hat{\imath} + \hat{\jmath} + \hat{k}\right)$
(b) $\sqrt{2}\left(\hat{\imath} - \hat{\jmath} + \hat{k}\right)$
(c) $\sqrt{2}\left(\hat{\imath} + \hat{\jmath} - \hat{k}\right)$
(d) $\sqrt{2}\left(-\hat{\imath} + \hat{\jmath} + \hat{k}\right)$

Q 11. A hypothetical magnetic field existing in a region is given by $\vec{\boldsymbol{B}} = B_0\,\hat{r}$. Where $\hat{r}$ denotes the unit vector along the radial direction. A circular loop of radius a carrying a current i, is placed with its plane parallel to the x-y plane and centre at (0, 0, d) . The magnitude of magnetic force acting on the loop is-

(a) $\frac{2\pi a^2 i B_0}{d}$
(b) $\frac{2\pi a^2 i B_0}{\sqrt{a^2+d^2}}$
(c) $\frac{\pi a^2 i B_0}{d}$
(d) $\frac{\pi a^2 i B_0}{\sqrt{a^2+d^2}}$

Q 12. A straight wire of length l can slide on two parallel plastic rails kept in horizontal plane with a separation d. The coefficient of friction between the wire and the rails is μ. If the wire carries current **i** what minimum magnetic field should exist in the space in order to slide the wire on the rails ?

(a) $\frac{\mu mg}{il\sqrt{1+\mu^2}}$

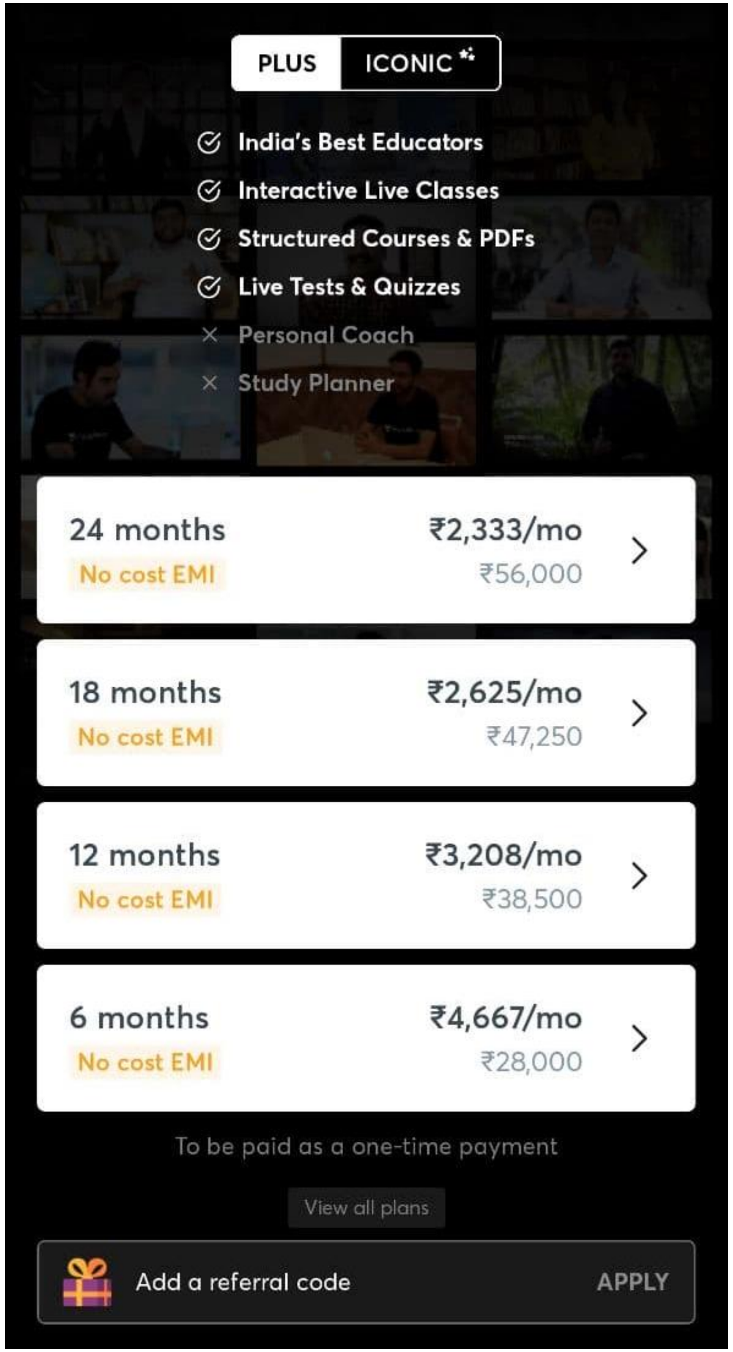
(b) $\frac{\mu m^2 g}{il}$

(c) $\frac{\mu g^2 m}{il}$

(d) $\frac{\mu mg}{l}$

Answer Key

Q.1 a	**Q.2 c**	**Q.3 c**	**Q.4 b**	**Q.5 a**
Q.6 a, d	**Q.7 b, c**	**Q.8 a**	**Q.9 d**	**Q.10 b**
Q.11 b	**Q.12 a**			



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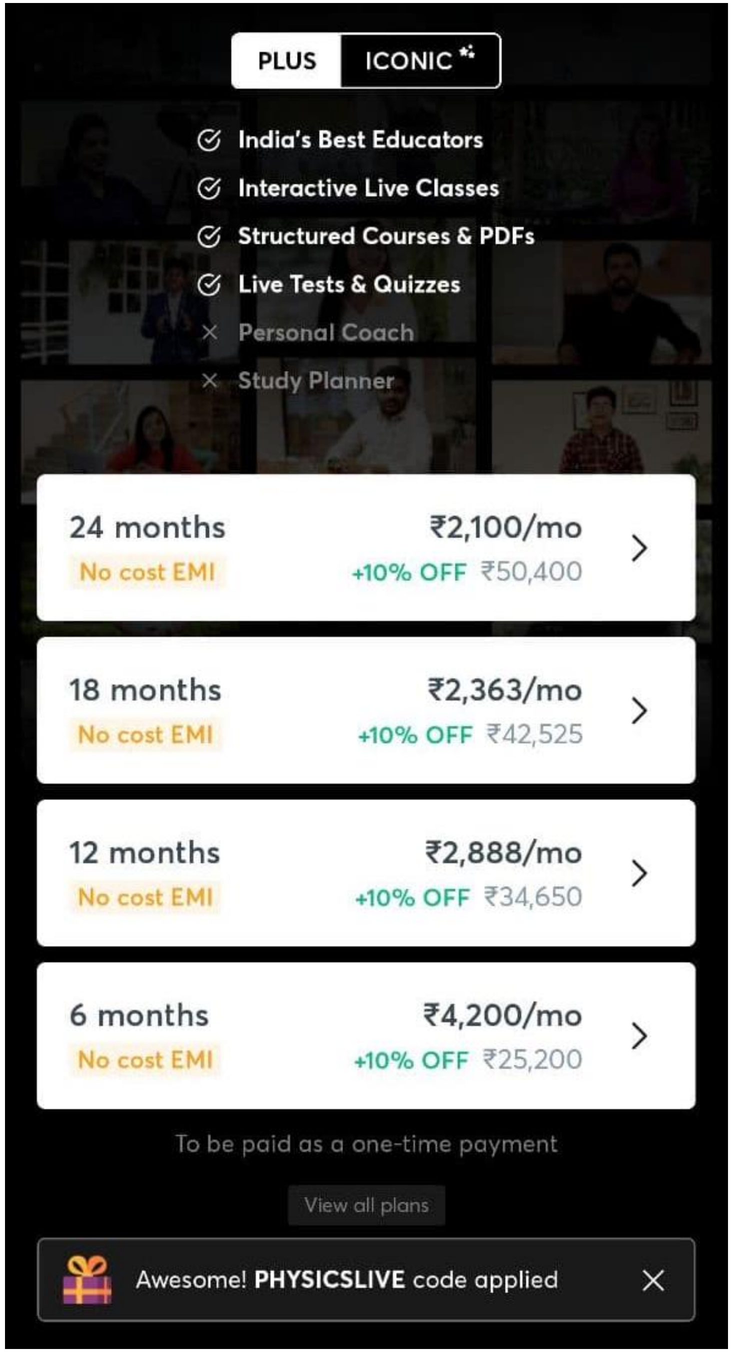

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Written Solution

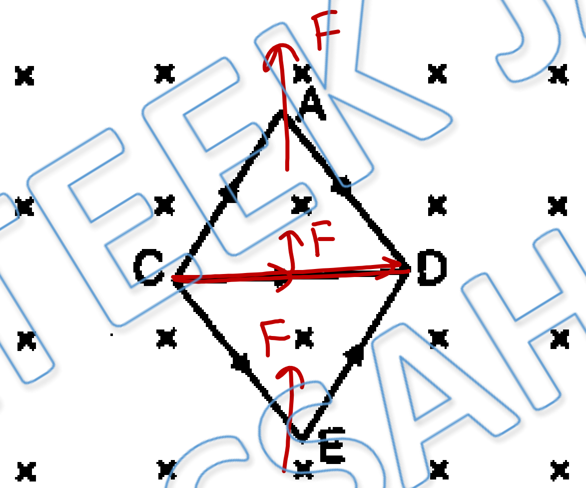
DPP-5 Current Carrying Conductor in Magnetic Field

By Physicsaholics Team

Q 1) Same current i=2A is flowing in a wire frame as shown in figure. The frame is a combination of two equilateral triangles ACD and CDE of side 1m. It is placed in uniform magnetic field B = 4 T acting perpendicular to the plane of frame. The magnitude of magnetic force acting on the frame is:

$F = 2 \times 4 \times 1$
$= 8N$

$N_{net} = 3F$
$= 24N$



$\vec{F} = i(\vec{l} \times \vec{B})$

(a) 24 N (b) zero (c) 16 N (d) 8 N

Q 2) A current carrying wire PQ is placed near an another long current carrying wire RS. If free to move, wire PQ will have:

(a) translational motion only

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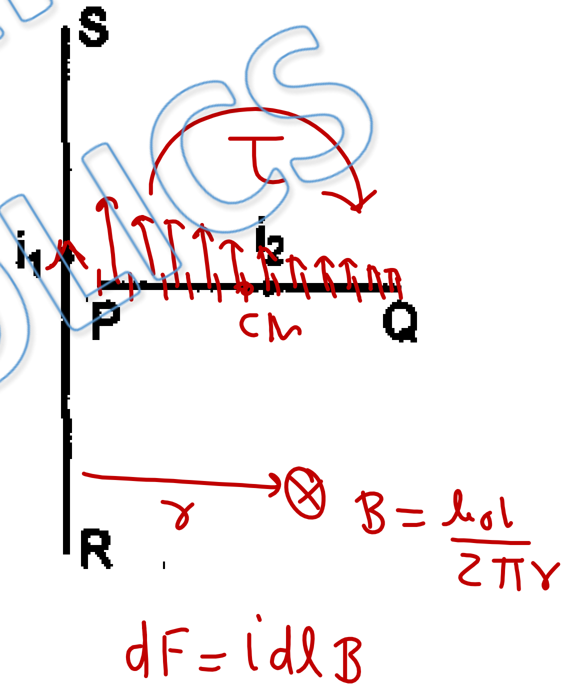
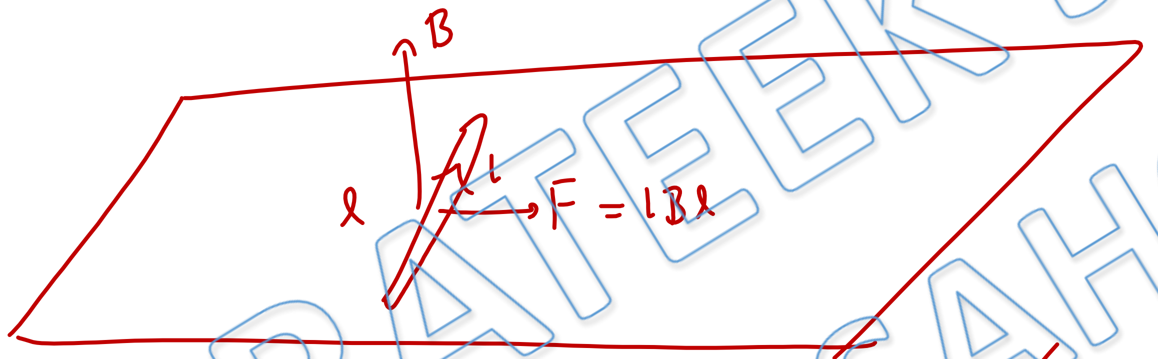


Q 3) A conducting rod of mass m and length l is placed over a smooth horizontal source. A uniform magnetic field B is acting perpendicular to the rod. Charge q is suddenly passed through the rod and it acquires an initial velocity v on the surface, then q is equal to:

$q = \int i\,dt$



(a) $\frac{2mv}{Bl}$ (b) $\frac{Bl}{2mv}$ (c) $\frac{mv}{Bl}$ ✓ (d) $\frac{Blv}{2m}$

Impulse = mV

$\int F\,dt = mV \Rightarrow \int Bli\,dt = mV$

$\Rightarrow Bl\int i\,dt = mV \Rightarrow V = \frac{Blq}{m}$

$q = \frac{mv}{Bl}$

Q 4) A conducting wire bent in the form of a parabola $y^2 = 2x$ carries a current i = 2A as shown in figure. This wire is placed in a uniform magnetic field $\vec{B} = -4\hat{k}$ tesla. The magnetic force on the wire is: (in newton)

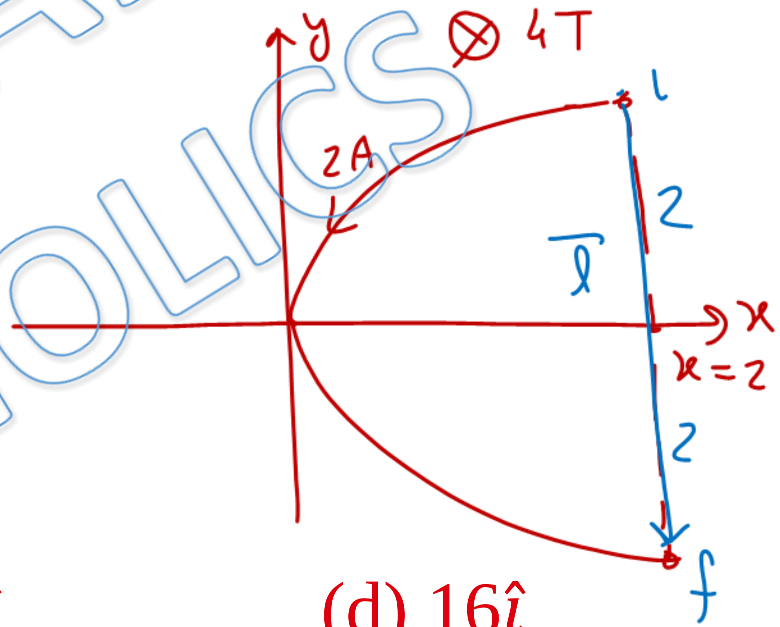
$y^2 = 2x$

at $x = 2$, $y = \pm 2$

$l = 4$

$F = iBl$

$= 2 \times 4 \times 4 = 32\hat{i}$



(a) $-16\hat{\imath}$ (b) $32\,\hat{\imath}$ (c) $-32\hat{\imath}$ (d) $16\hat{\imath}$

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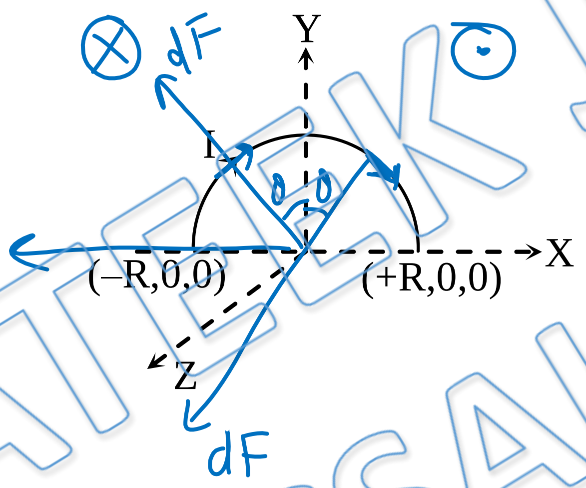
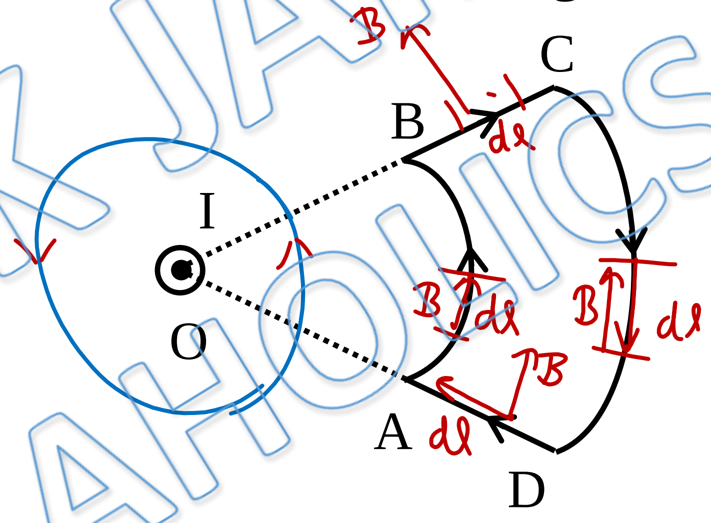


(a) – x-axis (b) + y-axis (c) – y-axis (d) + x-axis

Q 6) An infinite wire carrying current I passes through point O perpendicular to the plane containing a current carrying loop ABCD as shown in the figure.

$F_{AB} = 0 = F_{CD}$ (Since $\vec{B} \parallel \vec{dl}$)

$F_{BC} = \odot$, $F_{DA} = \otimes$



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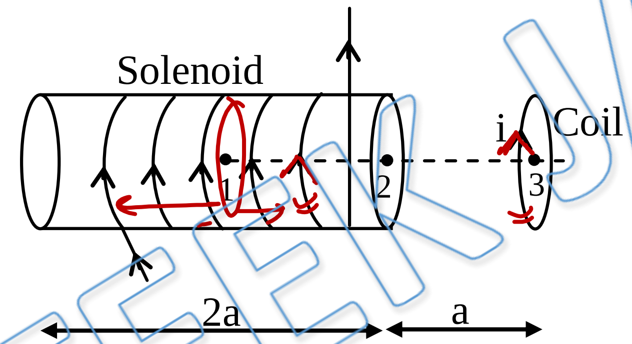

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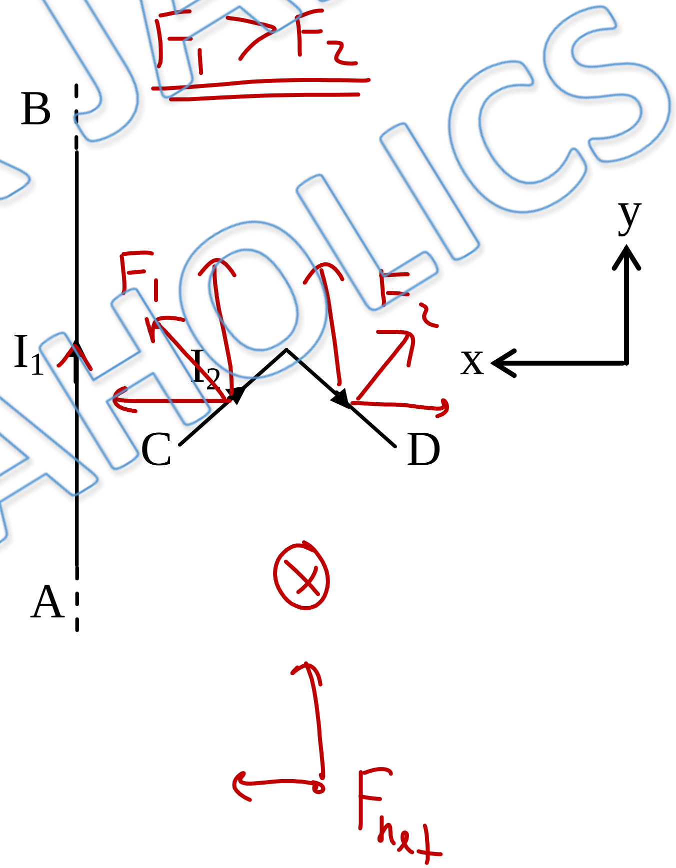

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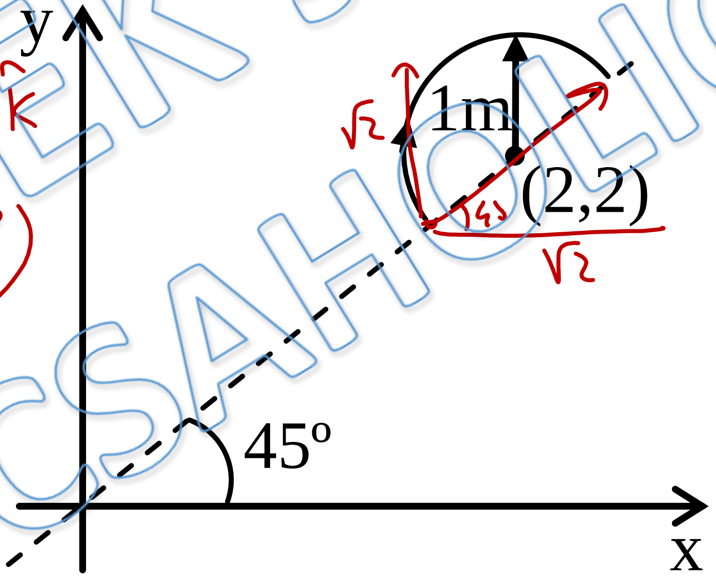
(b) $\sqrt{2}\,(\hat{\imath} - \hat{\jmath} + \hat{k})$

(c) $\sqrt{2}\,(\hat{\imath} + \hat{\jmath} - \hat{k})$

(d) $\sqrt{2}\,(-\hat{\imath} + \hat{\jmath} + \hat{k})$



$\vec{l} = \sqrt{2}\,\hat{i} + \sqrt{2}\,\hat{j}$

$\vec{B} = 3\hat{i} + 4\hat{j} + \hat{k}$

$\vec{F} = 1(\vec{l} \times \vec{B})$

$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \sqrt{2} & \sqrt{2} & 0 \\ 3 & 4 & 1 \end{vmatrix} = \hat{i}(\sqrt{2} - 0) - \hat{j}(\sqrt{2} - 0) + \hat{k}(4\sqrt{2} - 3\sqrt{2})$

$= \sqrt{2}\,\hat{i} - \sqrt{2}\,\hat{j} + \sqrt{2}\,\hat{k} = \sqrt{2}(\hat{i} - \hat{j} + \hat{k})$

Q 11) A hypothetical magnetic field existing in a region is given by $\vec{B} = B_0\,\hat{r}$. Where $\hat{r}$ denotes the unit vector along the radial direction. A circular loop of radius a carrying a current i, is placed with its plane parallel to the x-y plane and centre at (0, 0, d) . The magnitude of magnetic force acting on the loop is-

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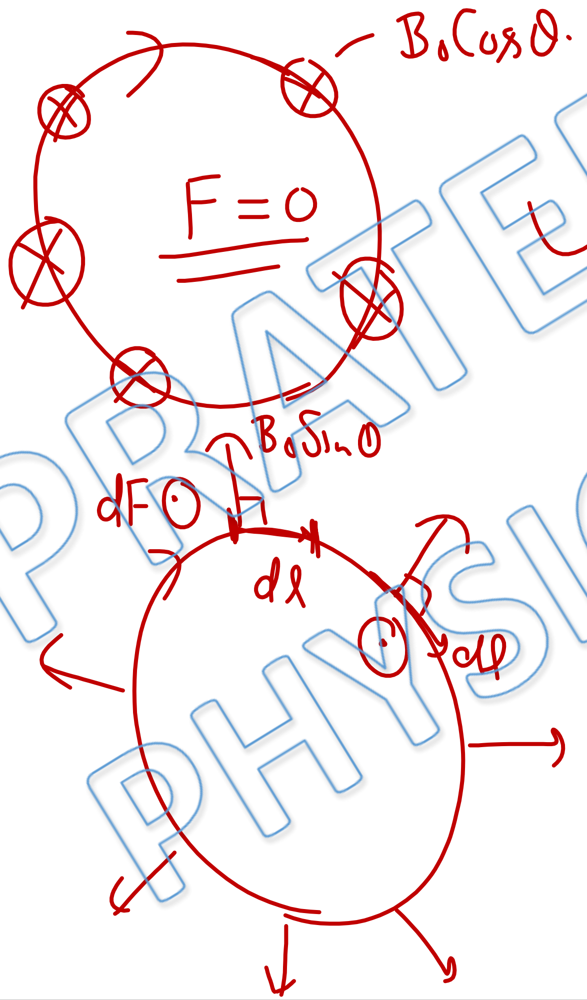
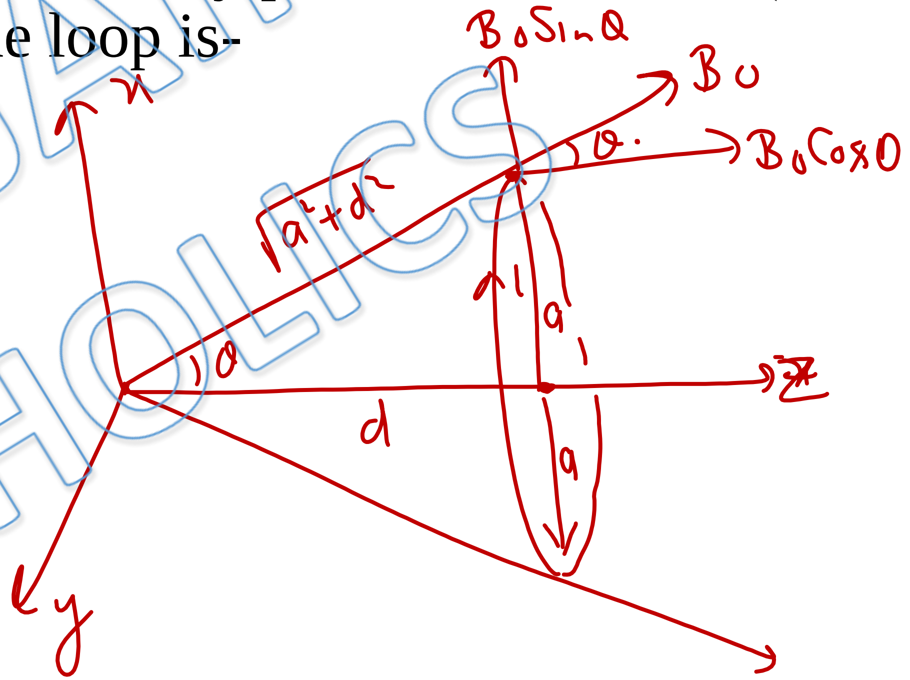
(c) $\dfrac{\pi a^2 i B_0}{d}$

(d) $\dfrac{\pi a^2 i B_0}{\sqrt{a^2+d^2}}$



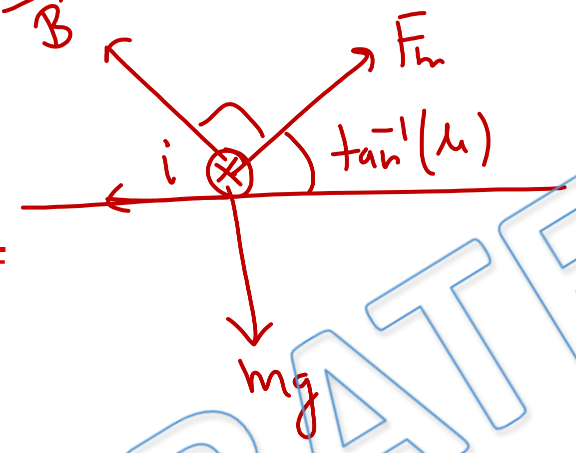


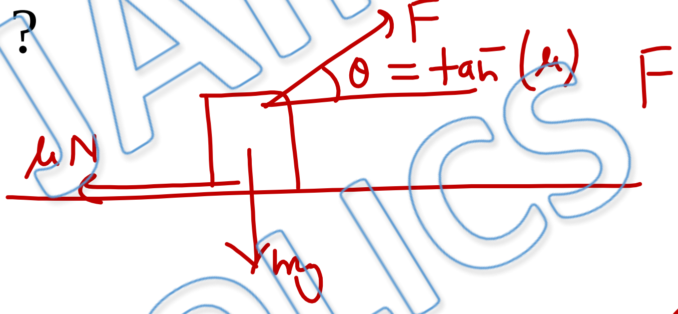
$dF = i\,dl\,B_0 \sin\theta$

$F = iB_0 \sin\theta \int dl$

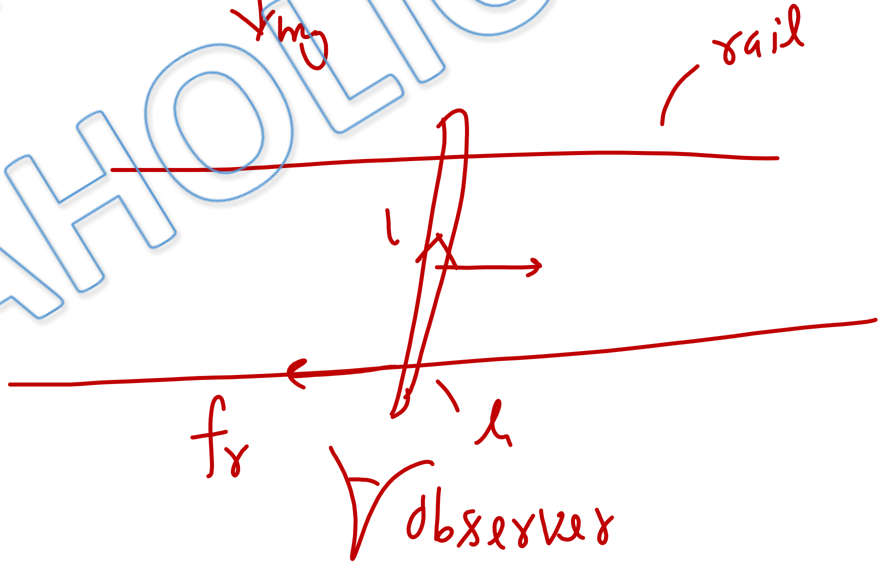
$= \dfrac{iB_0 \times 2\pi a \, a}{\sqrt{a^2+d^2}}$

Q 12) A straight wire of length l can slide on two parallel plastic rails kept in horizontal plane with a separation d. The coefficient of friction between the wire and the rails is μ. If the wire carries current **i** what minimum magnetic field should exist in the space in order to slide the wire on the rails ?





$F = \frac{\mu mg}{\sqrt{1+\mu^2}}$



(a) $\frac{\mu mg}{il\sqrt{1+\mu^2}}$ (b) $\frac{\mu m^2 g}{il}$

(c) $\frac{\mu g^2 m}{il}$ (d) $\frac{\mu mg}{l}$

$F = \frac{\mu mg}{\sqrt{1+\mu^2}} = iBl$

$B = \frac{\mu mg}{il\sqrt{1+\mu^2}}$

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