DPP – 4 (Magnetic Field & Force)

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Q 1. An electron is moving along positive x-axis. A uniform electric field exists towards negative y-axis What should be the direction of magnetic field of suitable magnitude so that net force on electron is zero?

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

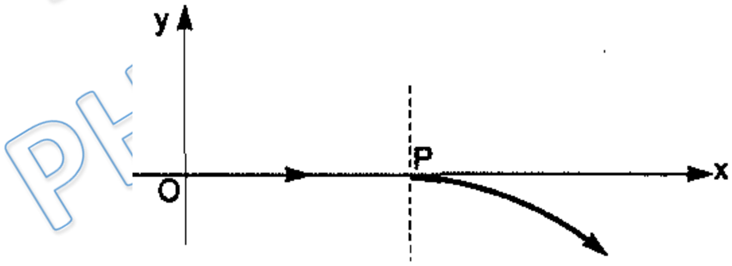
Q 2. A particle of charge q and mass m starts moving from the $\vec{E} = E\hat{\imath}$ and magnetic field $\vec{B} = B\hat{\imath}$ wth a velocity $\vec{v} = v_0\hat{\jmath}$. The speed of the particle will become $2v_0$ after a time :

(a) $t = \frac{2mv_0}{qE}$
(b) $t = \frac{2Bq}{mv_0}$
(c) $t = \frac{\sqrt{3}Bq}{mv_0}$
(d) $t = \frac{\sqrt{3}mv_0}{qE}$

Q 3. A particle of specific charge (charge/mass) α starts moving from the origin under the action of an electric field $\vec{E} = E_0\hat{\imath}$ and magnetic field $\vec{B} = B_0\hat{k}$. Its velocity at $(x_0, 0, 0)$ is $(4\hat{\imath} + 3\hat{\jmath})$. The value of x_0 is :

(a) $\frac{13}{2}\frac{\alpha E_0}{B_0}$
(b) $\frac{16\alpha B_0}{E_0}$
(c) $\frac{25}{2\alpha E_0}$
(d) $\frac{5\alpha}{2B_0}$

Q 4. For a positively charged particle moving in a x –y plane initially along the x-axis, there is a sudden change in its path due to the presence of electric and/or magnetic fields beyond P. The curved path is shown in the x - y plane and is found to be non-circular. Which one of the following combinations is possible?

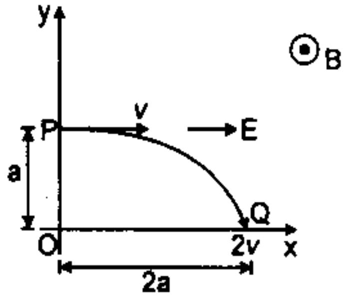


(a) $\vec{E} = 0; \vec{B} = b\hat{\jmath} + c\hat{k}$
(b) $\vec{E} = a\hat{\imath}; \vec{B} = c\hat{k} + a\hat{\imath}$
(c) $\vec{E} = 0; \vec{B} = c\hat{\jmath} - b\hat{k}$
(d) $\vec{E} = a\hat{\imath}; \vec{B} = c\hat{k} + b\hat{\jmath}$

Q 5. A proton enters in a uniform electric and magnetic fields $\vec{E}$ and $\vec{B}$ respectively. Velocity of proton is $\vec{v}$. All three vectors are mutually perpendicular. The proton is deflected along positive x-axis when either of the fields or both are switched on simultaneously. Which of the following statement(s) is/are correct?

(a) $\vec{v}$ may be along positive y-axis
(b) $\vec{E}$ is along positive x-axis
(c) $\vec{B}$ may be along positive z-axis
(d) $\vec{B}$ may be along negative y-axis

Q 6. A particle of charge +q and mass m moving under the influence of a uniform electric field E$\hat{i}$ and uniform magnetic field B $\hat{k}$ follows a trajectory from P to Q as shown in figure. The velocities at P and Q are v$\hat{i}$ and – 2v$\hat{j}$. Which of the following statements is/are correct?



(a) $E = \frac{3}{4}\left(\frac{mv^2}{qa}\right)$

(b) Rate of work done by the electric field at P is $\frac{3}{4}\left(\frac{mv^2}{a}\right)$

(c) Rate of work done by electric field at P is zero

(d) Rate of work done by both the fields at Q is zero

Q 7. In a certain region of space, electric and magnetic fields are crossed

(a)A charged particle moves undeflected in the region only if $\vec{V}$ is perpendicular $\vec{E}$ to $\vec{B}$ both

(b)A charged particle must move undeflected in the region, if $\vec{V}$ is perpendicular $\vec{E}$ to $\vec{B}$ both

(c)A positron moves undeflected if its velocity is $\vec{V}$, for an electron to move undeflected its velocity must be - $\vec{V}$.

(d)A charged particle may move undeflected even if it is not moving with $\vec{V}$ perpendicular to $\vec{B}$

Q 8. A charged particle goes undeflected in a region containing electric and magnetic field. It is possible that -

(a) $\vec{E}||\vec{B}, \vec{v}||\vec{E}$

(b) $\vec{E}$ is not parallel to $\vec{B}$

(c) $\vec{v}||\vec{B}$ but $\vec{E}$ is not parallel to $\vec{B}$

(d) $\vec{E}||\vec{B}$ but $\vec{v}$ is not parallel to $\vec{E}$

Comprehension(Q.9 to Q.11)

A particle having charge q = 1C and mass m = 1 kg is released from rest at origin. There are electric and magnetic fields given by : $\vec{E} = (10\hat{i})$ N/C for x £ 1.8 m and $\vec{B} = (-5\hat{k})T$ for 1.8 m £ x £ 2.4 m A screen is placed parallel to y – z plane at x = 3.0 m. Neglect gravity forces.

Q 9. The speed with which the particle with collide the screen (in m/s) is :

(a) 3 (b) 6 (c) 9 (d) 12

Q 10. y-coordinate of particle where it collides with the screen is ..... m.:

(a) $\frac{0.6(\sqrt{3}-1)}{\sqrt{3}}$ (b) $\frac{0.6(\sqrt{3}+1)}{\sqrt{3}}$

(c) 1.2 ($\sqrt{3}$ + 1) (d) $\frac{1.2(\sqrt{3}-1)}{\sqrt{3}}$

Q 11. Time after which the particle will collide the screen is ...... second –

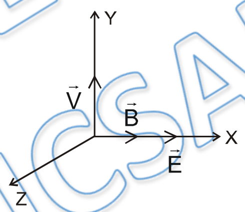
(a) $\frac{1}{5}\left(3+\frac{\pi}{6}+\frac{1}{\sqrt{3}}\right)$ (b) $\frac{1}{5}\left(6+\frac{\pi}{3}+\sqrt{3}\right)$

(c) $\frac{1}{3}\left(5+\frac{\pi}{6}+\frac{1}{\sqrt{3}}\right)$ (d) $\frac{1}{3}\left(6+\frac{\pi}{18}+\sqrt{3}\right)$

Q 12. Column I lists the field in a region and Column II lists the path of a charge q and mass m on which the particle can move. Match the appropriate entries of Column II with entries of Column I. [Consider all fields to be uniform]

Column I	**Column II**
(A) Only uniform electric field $\vec{E}$ is present	(p)The particle can move on straight line
(B) Only uniform magnetic field $\vec{B}$ is present	(q)The particle can move on circle
(C) Only uniform gravitational field $\vec{g}$ is present	(r)The particle can move on parabolic path
(D) Both uniform $\vec{E}$ and uniform $\vec{B}$ are present	(s)The particle can remain in rest
	(t)The particle can move in a helical path of constant pitch

Q 13. A particle of charge = 1μC and mass m = 1 gm starts moving from origin at t = 0 under an electric field of 10^3 N/C along x-axis and magnetic field of 10 tesla along the same axis with the velocity of $\vec{v} = 20\hat{j}$ m/sec as shown, the speed of the particle at the time of $20\sqrt{3}$ sec will be :



(a) 20 m/sec (b) 40 m/sec (c) 10 m/sec (d) None

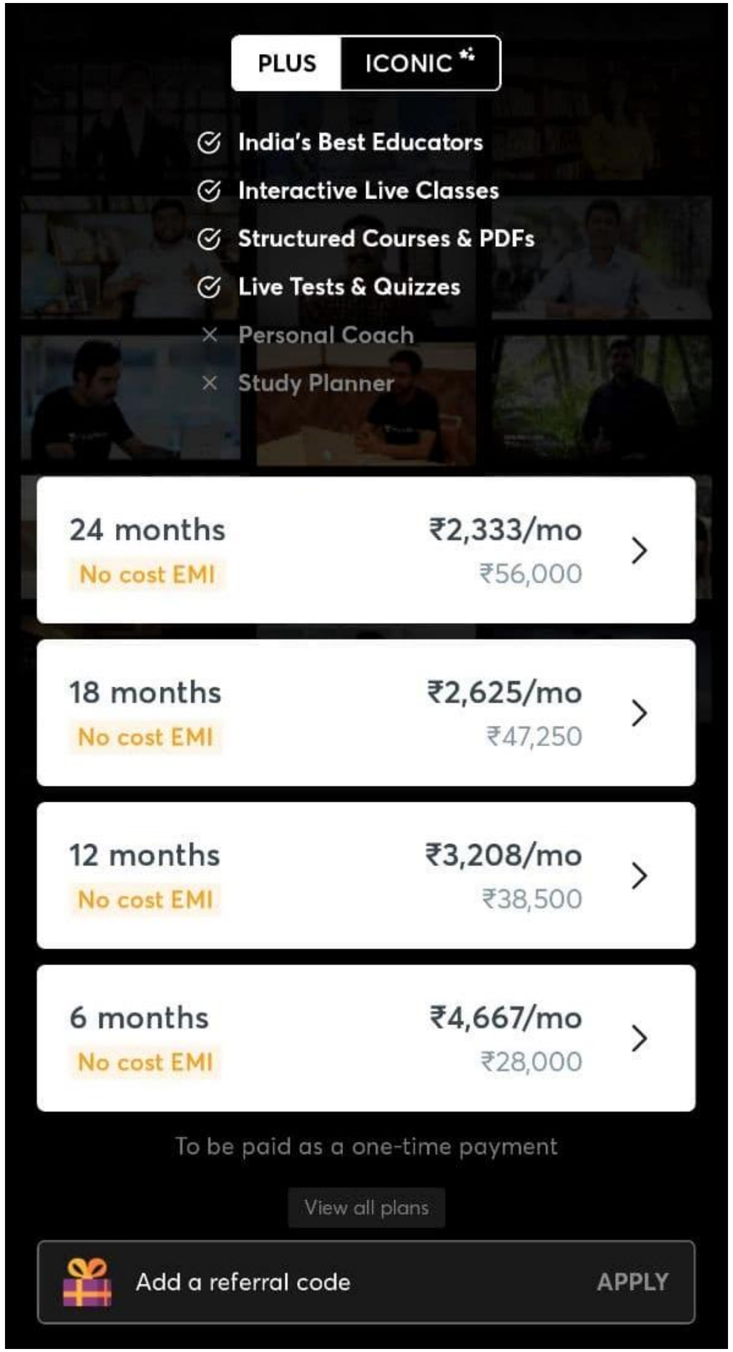
Q 14. A positively charge particle is projected from origin with speed 8m/sec at an angle $\pi/3$ with + x axis and $\pi/6$ with +y axis. There are unifom electric and magnetic field along -x axis and + x axis respectively. If B= 1T and E = 1N/c and π = 22/7

(a) Charge will return to origin after some time.
(b) Its kinetic energy will first decrease then increase.
(c) charge will cross yz plane with positive y coordinate.
(d)Nothing can be said as charge and mass are not given

Answer Key

Q.1 a	Q.2 d	Q.3 c	Q.4 b	Q.5 a, b, c
Q.6 a, b, d	Q.7 d	Q.8 a, b	Q.9 b	Q.10 d
Q.11 a	Q.13 b	Q.14 b,c		

Q.12 A(p, r), B(p, q, s, t), C(p, r), D(p)



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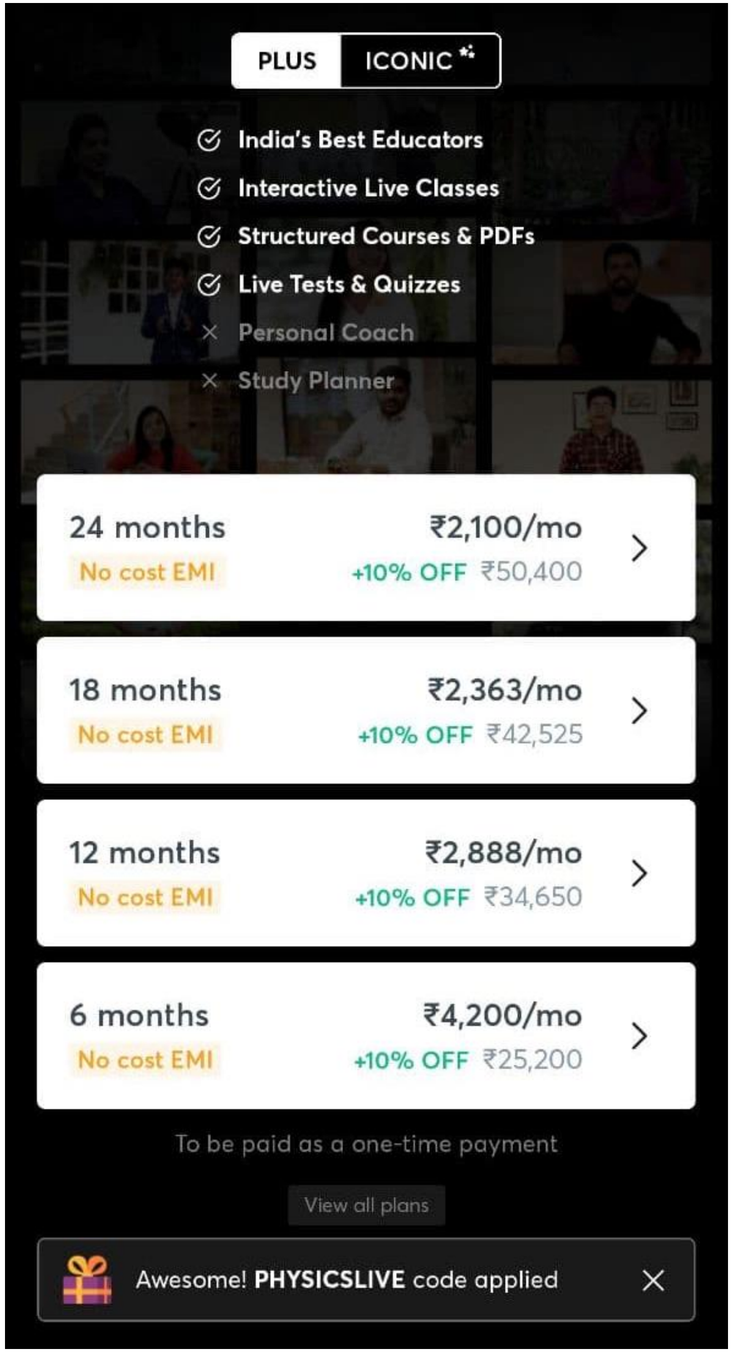

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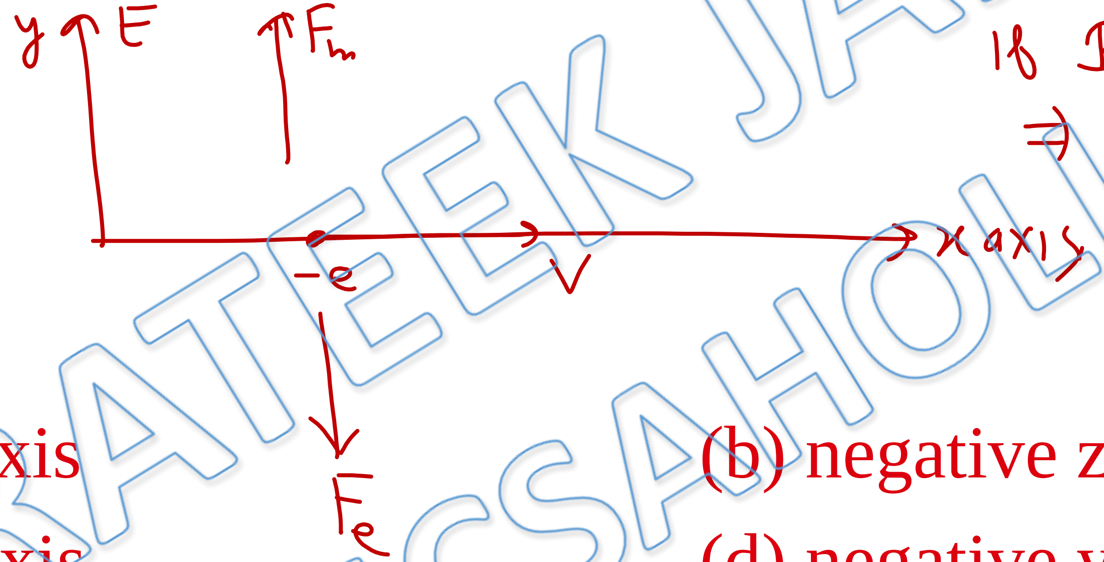
Written Solution

DPP- 4 Magnetic Field and Force: Lorentz Force

By Physicsaholics Team

Q.1) An electron is moving along positive x-axis. A uniform electric field exists towards negative y-axis What should be the direction of magnetic field of suitable magnitude so that net force on electron is zero?



If B is along −z
⇒ F_m will be along −y
⇒ B is along +z

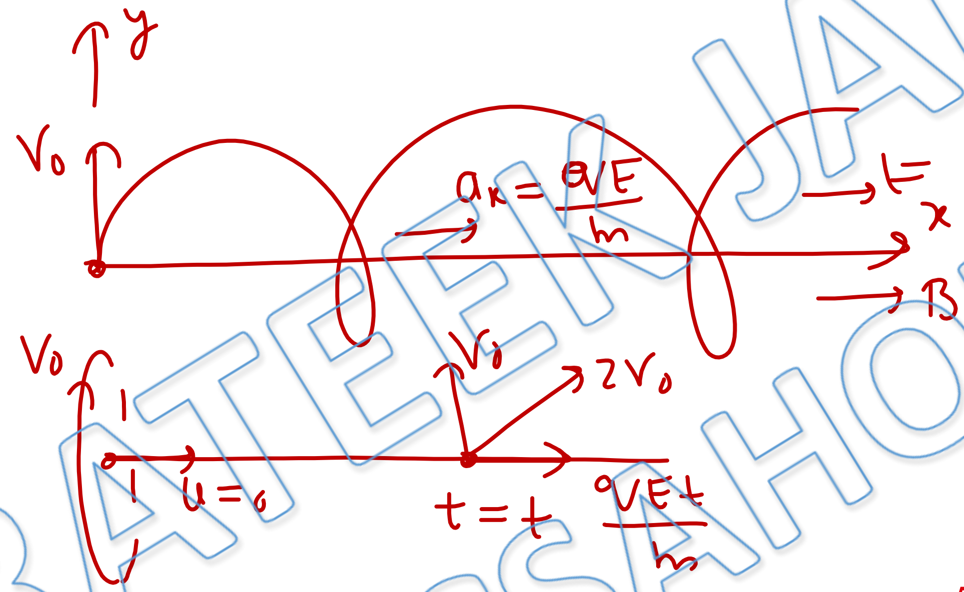
(a) positive z-axis

(b) negative z-axis

(c) positive y-axis

(d) negative y-axis

Q.2) A particle of charge q and mass m starts moving from the $\vec{E} = E\hat{\imath}$ and magnetic field $\vec{B} = B\hat{\imath}$ wth a velocity $\vec{v} = v_0\hat{\jmath}$. The speed of the particle will become $2v_0$ after a time :

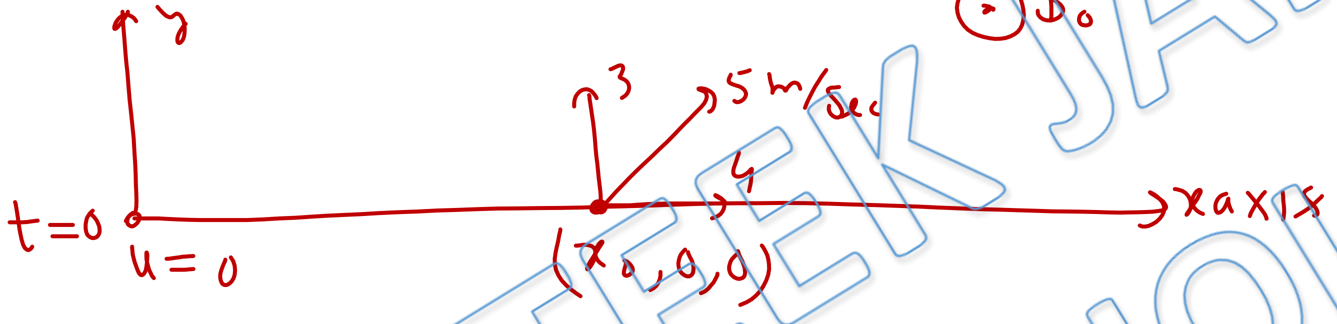


(a) $t = \frac{2mv_0}{qE}$ (b) $t = \frac{2Bq}{mv_0}$ (c) $t = \frac{\sqrt{3}Bq}{mv_0}$ (d) $t = \frac{\sqrt{3}mv_0}{qE}$ ✓

$$\left(\frac{qEt}{m}\right)^2 = 4V_0^2 - V_0^2$$

$$t = \frac{\sqrt{3}\, mV_0}{qE}$$

Q.3) A particle of specific charge (charge/mass) a starts moving from the origin under the action of an electric field $\vec{E} = E_0\hat{\imath}$ and magnetic field $\vec{B} = B_0\hat{k}$. Its velocity at $(x_0, 0, 0)$ is $(4\hat{\imath} + 3\hat{\jmath})$. The value of x_o is :



$W_B + W_{E_0} = K_f - K_i$

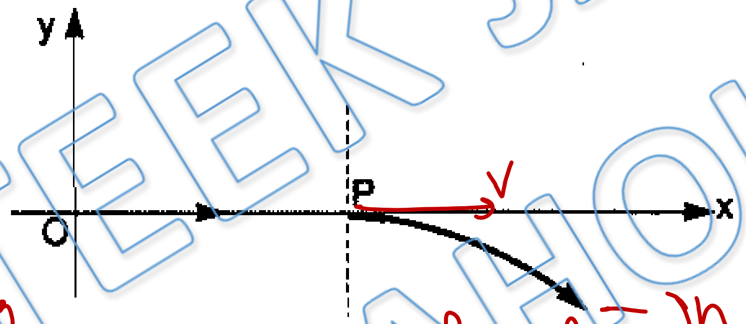
$0 + qE_0 x_0 = \frac{1}{2} m v^2$

$qE_0 x_0 = \frac{25m}{2}$

$x_0 = \frac{25}{2E_0(q/m)} = \frac{25}{2E_0\alpha}$

(a) $\frac{13}{2}\frac{\alpha E_0}{B_0}$ (b) $\frac{16\alpha B_0}{E_0}$ (c) $\frac{25}{2\alpha E_0}$ (d) $\frac{5\alpha}{2B_0}$

Q.4) For a positively charged particle moving in a x –y plane initially along the x-axis, there is a sudden change in its path due to the presence of electric and/or magnetic fields beyond P. The curved path is shown in the x - y plane and is found to be non-circular. Which one of the following combinations is possible?



(a) $\vec{E} = 0; \vec{B} = b\hat{j} + c\hat{k}$

(b) $\vec{E} = a\hat{i}; \vec{B} = c\hat{k} + a\hat{i}$

(c) $\vec{E} = 0; \vec{B} = c\hat{j} - b\hat{k}$

(d) $\vec{E} = a\hat{i}; \vec{B} = c\hat{k} + b\hat{j}$

Q.5) A proton enters in a uniform electric and magnetic fields $\vec{E}$ and $\vec{B}$ respectively. Velocity of proton is $\vec{v}$. All three vectors are mutually perpendicular. The proton is deflected along positive x-axis when either of the fields or both are switched on simultaneously. Which of the following statement(s) is/are correct?

Net force is along +x axis

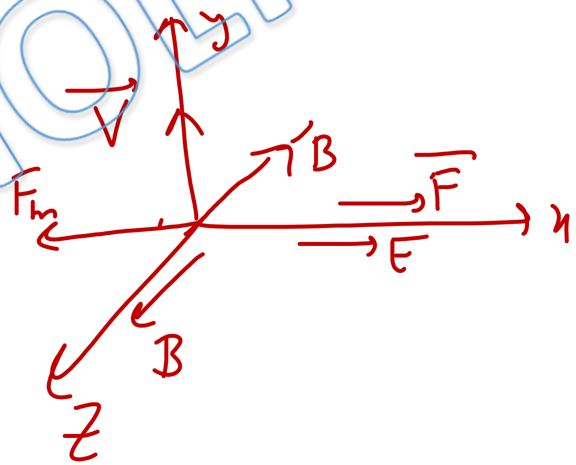
$\vec{F} = q\vec{E} + q(\vec{v} \times \vec{B})$

(a) $\vec{v}$ may be along positive y-axis

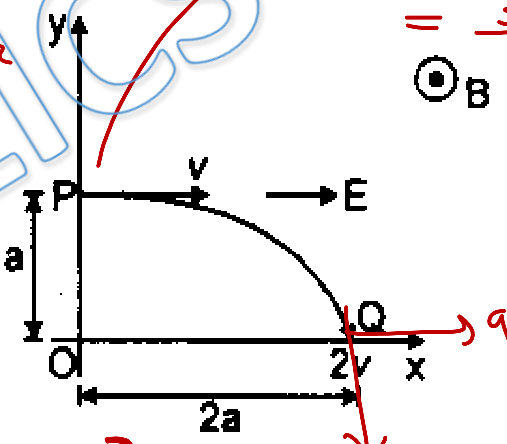
(b) $\vec{E}$ is along positive x-axis

(c) $\vec{B}$ may be along positive z-axis

(d) $\vec{B}$ may be along negative y-axis



Q.6) A particle of charge +q and mass m moving under the influence of a uniform electric field E$\hat{\imath}$ and uniform magnetic field B $\hat{k}$ follows a trajectory from P to Q as shown in figure. The velocities at P and Q are v$\hat{\imath}$ and – 2v$\hat{\jmath}$. Which of the following statements is/are correct?



(a) $E = \frac{3}{4}\left(\frac{mv^2}{qa}\right)$

(b) Rate of work done by the electric field at P is $\frac{3}{4}\left(\frac{mv^3}{a}\right)$

(c) Rate of work done by electric field at P is zero

(d) Rate of work done by both the fields at Q is zero

Q.7) In a certain region of space, electric and magnetic fields are crossed

$\vec{F} = 0 = q\vec{E} + q(\vec{V} \times \vec{B}) = 0$

$\Rightarrow \vec{E} = \vec{B} \times \vec{V} \Rightarrow \vec{E} \perp \vec{B}, \vec{E} \perp \vec{V}$

(a) A charged particle moves undeflected in the region only if $\vec{V}$ is perpendicular $\vec{E}$ to $\vec{B}$ both

(b) A charged particle must move undeflected in the region, if $\vec{V}$ is perpendicular $\vec{E}$ to $\vec{B}$ both

(c) A positron moves undeflected if its velocity is $\vec{V}$, for an electron to move undeflected its velocity must be - $\vec{V}$.

(d) A charged particle may move undeflected even if it is not moving with $\vec{V}$ perpendicular to $\vec{B}$

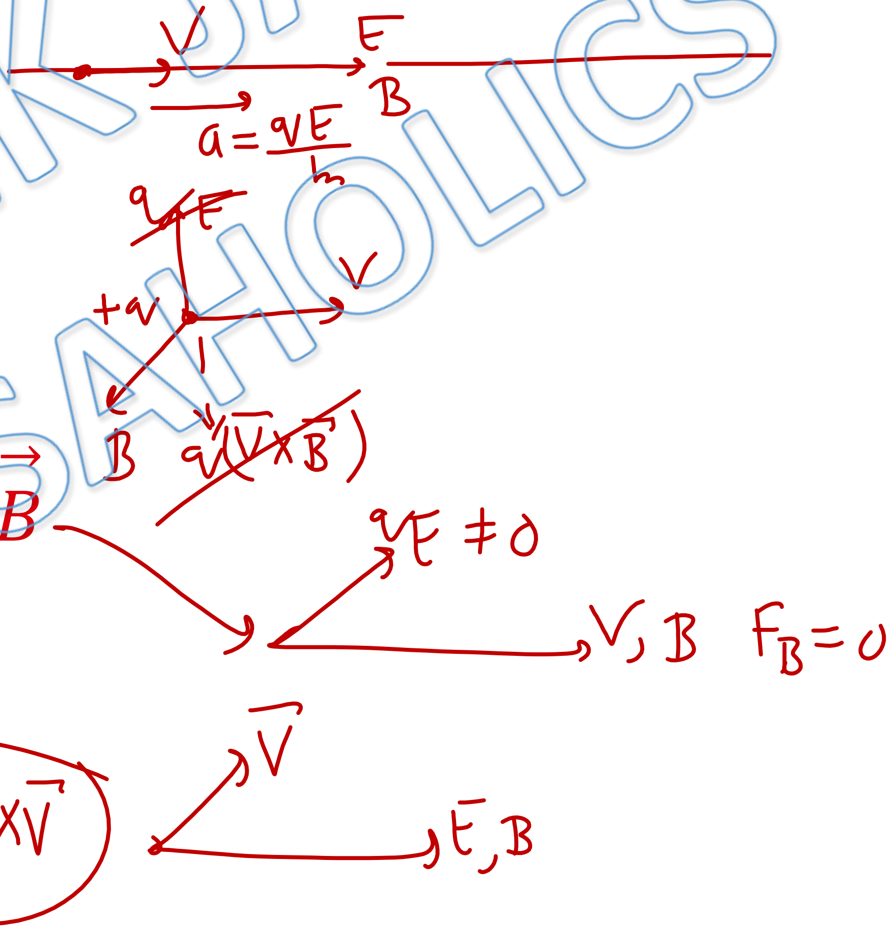
Q.8) A charged particle goes undeflected in a region containing electric and magnetic field. It is possible that -

(a) $\vec{E}||\vec{B}$, $\vec{v}||\vec{E}$

(b) $\vec{E}$ is not parallel to $\vec{B}$

(c) $\vec{v}||\vec{B}$ but $\vec{E}$ is not parallel to $\vec{B}$

(d) $\vec{E}||\vec{B}$ but $\vec{v}$ is not parallel to $\vec{E}$



COMPREHENSION(Q.9 TO Q.11)

A particle having charge q = 1C and mass m = 1 kg is released from rest at origin. There are electric and magnetic fields given by :

$\vec{E} = (10\hat{\imath})$ N/C for $x \leq 1.8$ m and $\vec{B} = (-5\hat{k})T$ for $1.8 \text{ m} \leq x \leq 2.4$ m

A screen is placed parallel to y – z plane at x = 3.0 m. Neglect gravity forces.

Q.9) The speed with which the particle with collide the screen (in m/s) is :

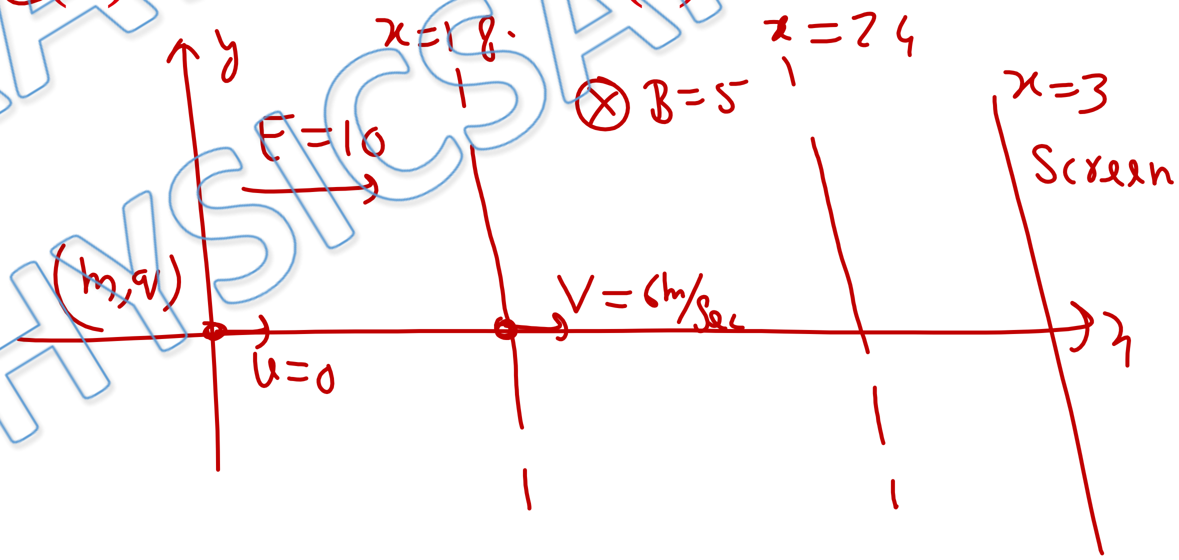
(a) 3 (b) 6 (c) 9 (d) 12

$\frac{1}{2}mV^2 = qE \times 1.8$

$\frac{V^2}{2} = 18$

$V^2 = 36$

$V = 6$ m/sec.



Q.10) y-coordinate of particle where it collides with the screen is ..... m.

$R = \frac{mV}{qB} = \frac{1 \times 6}{1 \times 5} = 1.2\,m$

$\sin\theta = \frac{.6}{1.2} = \frac{1}{2}$

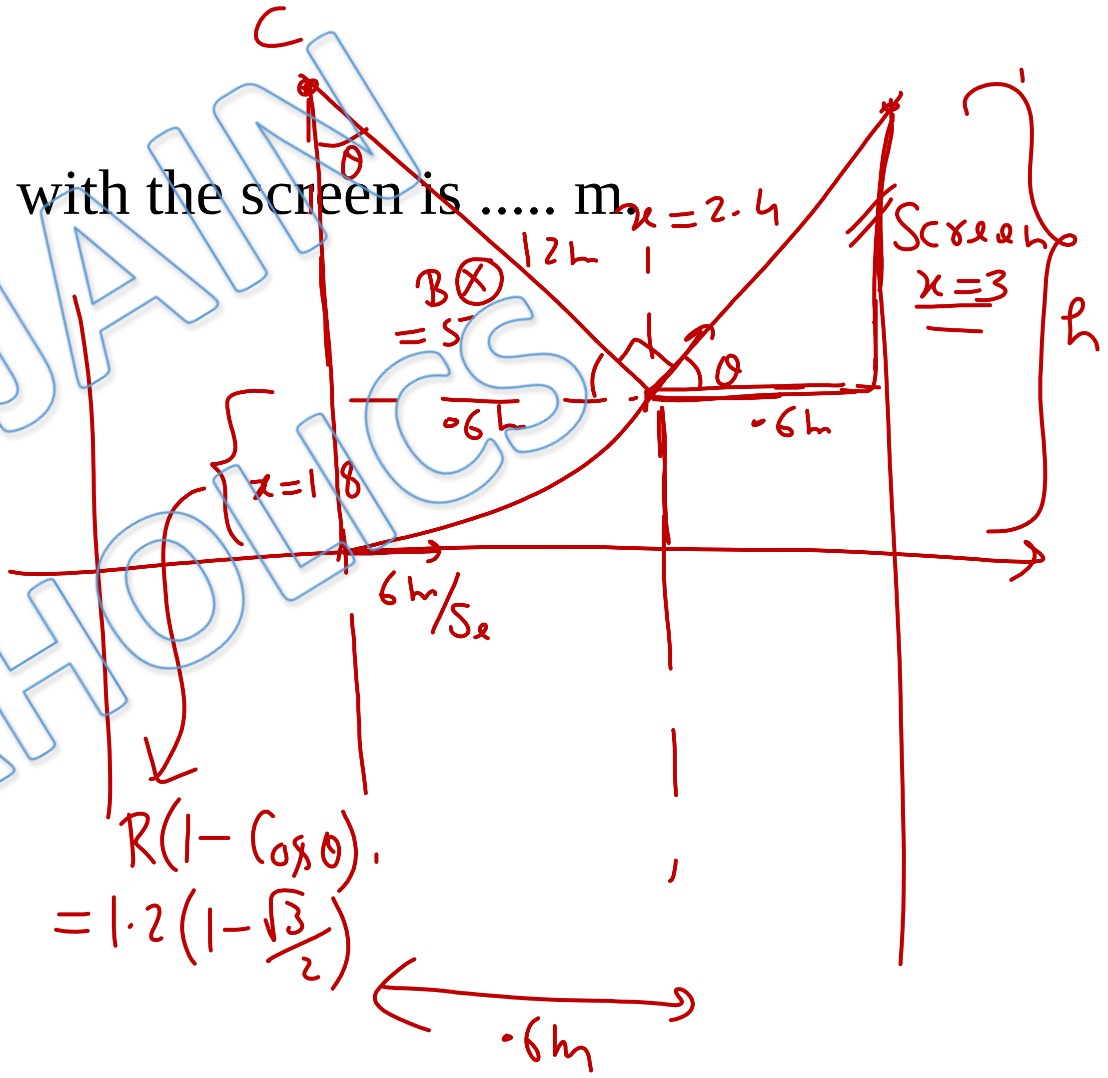
$\theta = 30^\circ$

(a) $\frac{0.6(\sqrt{3}-1)}{\sqrt{3}}$

(b) $\frac{0.6(\sqrt{3}+1)}{\sqrt{3}}$

(c) $1.2(\sqrt{3}+1)$

(d) $\frac{1.2(\sqrt{3}-1)}{\sqrt{3}}$



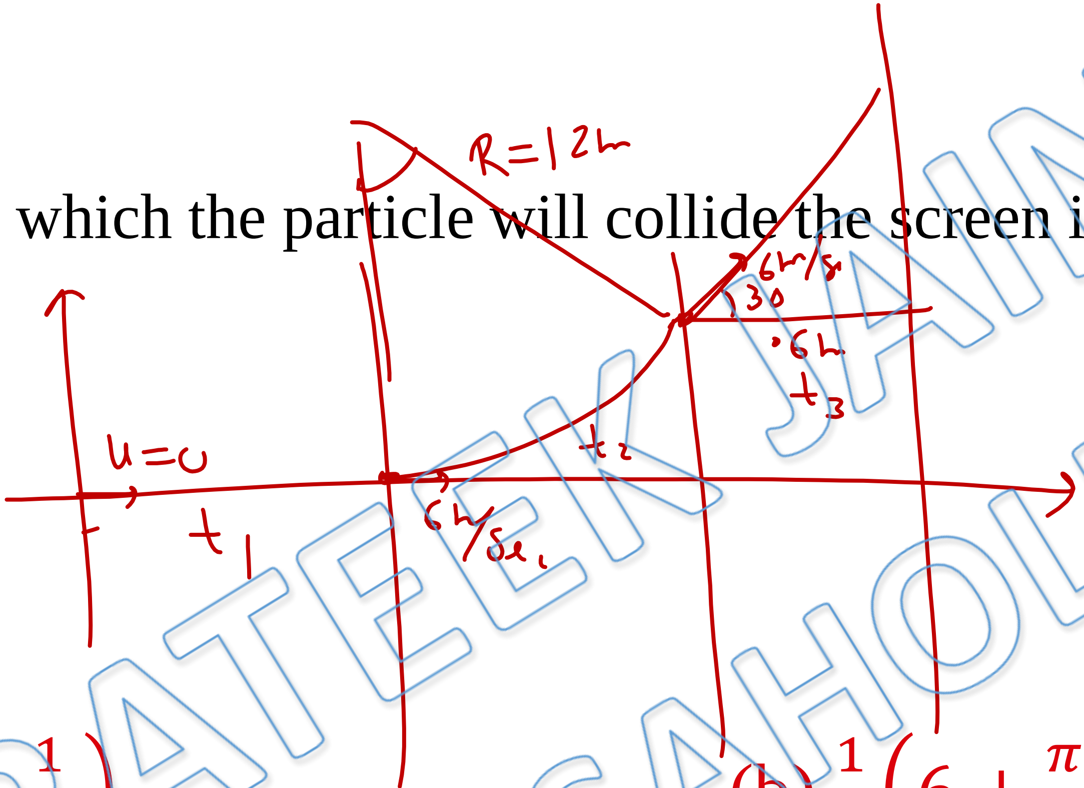
$\tan\theta = \frac{h - 1.2(1 - \frac{\sqrt{3}}{2})}{.6} = \frac{1}{\sqrt{3}}$

$h - 1.2 + .6\sqrt{3} = \frac{.6}{\sqrt{3}}$

$h = 1.2 + \frac{.6}{\sqrt{3}} - .6\sqrt{3} = 1.2 + .6\left(\frac{1-3}{\sqrt{3}}\right)$

$= 1.2 - \frac{1.2}{\sqrt{3}}$

Q.11) Time after which the particle will collide the screen is ...... second –



$x = \frac{u+v}{2}t$

$18 = \frac{6}{2} \times t_1$

$t_1 = .6\ Sec$

$t_3 = \frac{.6}{6\cos 30} = \frac{.6}{3\sqrt{3}} = \frac{1}{5\sqrt{3}}$

(a) $\frac{1}{5}\left(3 + \frac{\pi}{6} + \frac{1}{\sqrt{3}}\right)$ ✓

(b) $\frac{1}{5}\left(6 + \frac{\pi}{3} + \sqrt{3}\right)$

(c) $\frac{1}{3}\left(5 + \frac{\pi}{6} + \frac{1}{\sqrt{3}}\right)$

(d) $\frac{1}{3}\left(6 + \frac{\pi}{18} + \sqrt{3}\right)$

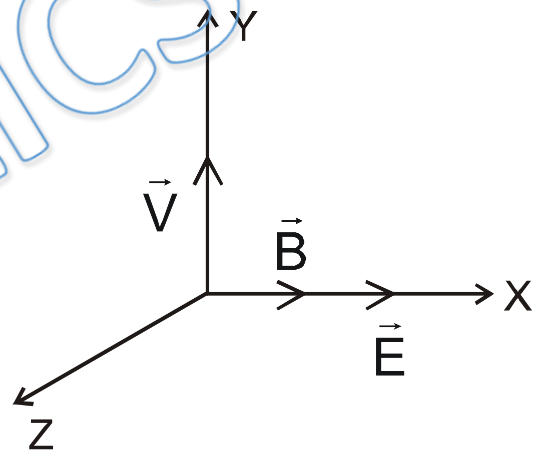
$t_2 = \frac{1.2 \times \pi/6}{6} = \frac{.2\pi}{60} = \frac{\pi}{30}$

$T = \frac{3}{5} + \frac{\pi}{30} + \frac{1}{5\sqrt{3}}$

Q.12) Column I lists the field in a region and Column II lists the path of a charge q and mass m on which the particle can move. Match the appropriate entries of Column II with entries of Column I. [Consider all fields to be uniform]

Column I		Column II
(A) Only uniform electric field $\vec{E}$ is present	(p)	The particle can move on a straight line
(B) Only uniform magnetic field $\vec{B}$ is present	(q)	The particle can move on a circle
(C) Only uniform gravitational field $\vec{g}$ is present	(r)	The particle can move on parabolic path
(D) Both uniform $\vec{E}$ and uniform $\vec{B}$ are present	(s)	The particle can remain in rest
	(t)	The particle can move in a helical path of constant pitch

Q.13) A particle of charge = 1μC and mass m = 1 gm starts moving from origin at t = 0 under an electric field of 10^3 N/C along x-axis and magnetic field of 10 tesla along the same axis with the velocity of $\vec{v} = 20\hat{j}$ m/sec as shown, the speed of the particle at the time of $20\sqrt{3}$ sec will be :

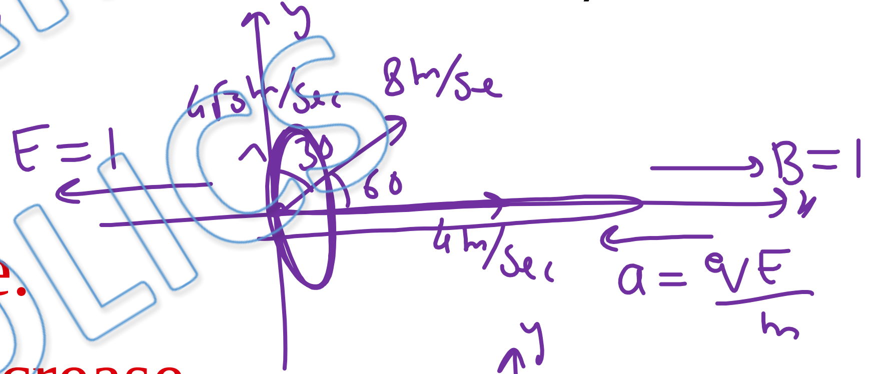


(a) 20 m/sec (b) 40 m/sec (c) 10 m/sec (d) None

Q.14) A positively charge particle is projected from origin with speed 8m/sec at an angle π/3 with + x axis and π/6 with +y axis. There are unifom electric and magnetic field along -x axis and + x axis respectively. If B= 1T and E = 1N/c and π = 22/7

time of returing in st line motion $\frac{2 \times 4\, m}{q E} = n \left(\frac{2\pi m}{q B}\right)$ → time period of circular motion

n ↓ integer (no of rounds)

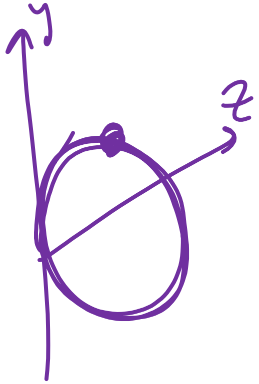


(a) Charge will return to origin after some time.

(b) Its kinetic energy will first decrease then increase.

(c) charge will cross yz plane with positive y coordinate.

(d) Nothing can be said as charge and mass are not given



$$n = \frac{8B}{2\pi E} = \frac{4B}{\pi E} = \frac{4 \times 1}{\pi \times 1} = \frac{4}{\pi} \neq \text{Integer}$$

$$= \frac{4 \times 7}{22} = \frac{14}{11} = 1.27$$

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Chalo Niklo