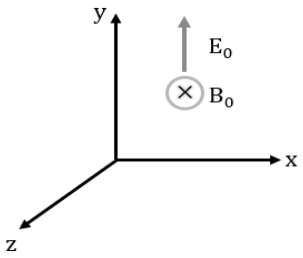
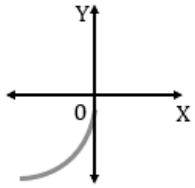
Chapter 4

Magnetism

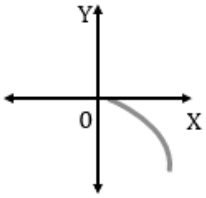
Exercise

Q.1 In a region, a uniform electric field is present as $\vec{E} = E_0\,\hat{j}$ and a uniform magnetic field is present as $\vec{B} = -B_0\,\hat{k}$. An electron is released from rest at origin. Which of the following best represents the path followed by an electron after release.

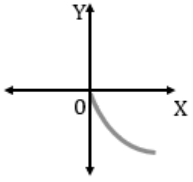




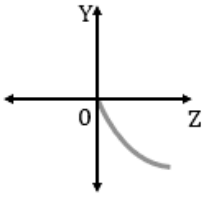
(A)



(B)

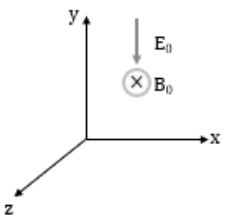


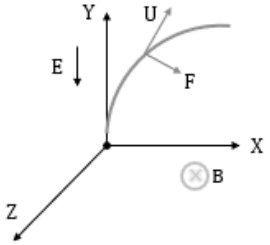
(C)



(D)

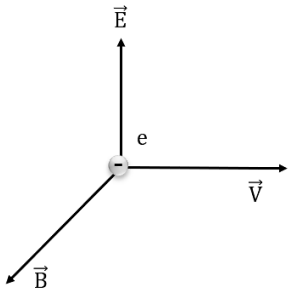
Q.2 An electron is released from the origin at a place where a uniform electric field E and a uniform magnetic field B exist along the negative y −axis and the negative z −axis respectively. Find the displacement of the electron along the y −axis when its velocity becomes perpendicular to the electric field for the first time. (Take $E = 20$ V/m and $B = 0.5$ mT, charge of electron $e = 1.6 \times 10^{-19}$ C , Mass of electron $m = 10^{-30}$ kg).





(A) 0.5 mm **(B)** 1 mm **(C)** 2 mm **(D)** 5 mm

Q.3 A beam of electrons passes, undeflected through mutually perpendicular electric and magnetic fields. If the electric field is switched off, and the same magnetic field is maintained, the electrons move.



(A) In a circular orbit **(B)** Along a parabolic path
(C) Along a straight line **(D)** In an elliptical orbit

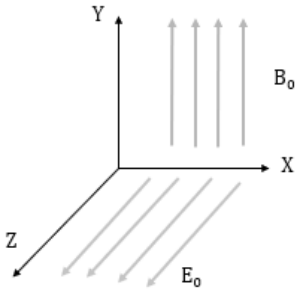
Q.4 A charged particle is released from rest in a region of steady and uniform electric and magnetic fields, where the magnetic field and electric field are parallel. The particle will follow -

(A) Straight line path **(B)** Circular path **(C)** Elliptical path **(D)** Helical path

Q.5 In a certain region, uniform electric field $\vec{E} = -E_0\hat{k}$ and uniform magnetic field $\vec{B} = -B_0\hat{k}$ are present. At time $t = 0$, a particle of mass m and charge q is given a velocity $v = v_0\hat{j} + v_0\hat{k}$. Find the time when the speed of the particle is minimum.

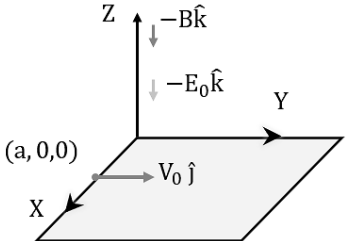
(A) $\frac{4mv_0}{qE_0}$ **(B)** $\frac{3mv_0}{qE_0}$ **(C)** $\frac{2mv_0}{qE_0}$ **(D)** $\frac{mv_0}{qE_0}$

Q.6 A particle having m and charge q which is initially at rest is released from the origin in a region in which electric and magnetic fields are given by $\vec{B} = B_0\hat{j}$ and $\vec{E} = E_0\hat{k}$. Find the speed of the particle as a function of its z −coordinate.



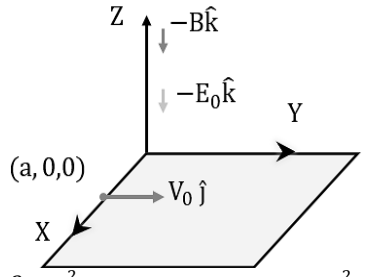
(A) $\sqrt{\frac{qE_0z}{m}}$ **(B)** $\sqrt{\frac{2(qvB_0+qE_0)2z}{m}}$ **(C)** $\sqrt{\frac{(-qvB_0+qE_0)2z}{m}}$ **(D)** $\sqrt{\frac{2qE_0z}{m}}$

Q.7 A charged particle of mass m and charge q is projected on a rough horizontal xy-plane surface with z-axis in the vertically upward direction. Both electric and magnetic fields are acting in the region given by $\vec{E} = -E_0\hat{k}$ and $\vec{B} = -B_0\hat{k}$ respectively. The particle enters the field at (a, 0,0) with velocity $\vec{v} = v_0\hat{j}$. The particle starts moving into a circular path on the plane. If the coefficient of friction between the particle and the plane is μ.
Then calculate the time when the particle will come to rest?



(A) $\frac{2mv_0}{\mu(mg+qE_0)}$ **(B)** $\frac{mv_0}{\mu(mg+qE_0)}$ **(C)** $\frac{3mv_0}{\mu(mg+qE_0)}$ **(D)** $\frac{4mv_0}{\mu(mg+qE_0)}$

Q.8 A charged particle of mass m and charge q is projected on a rough horizontal xy-plane surface with z-axis in the vertically upward direction. Both electric and magnetic fields are acting in the region is given by $\vec{E} = -E_0\hat{k}$ and $\vec{B} = -B_0\hat{k}$ respectively. The particle enters the field at (a, 0,0) with velocity $\vec{v} = v_0\hat{j}$. The particle starts moving into a circular path on the plane. If the coefficient of friction between the particle and the plane is
μ then calculate the distance travelled by the particle before it comes to rest.



(A) $\frac{3mv_0^2}{2\mu(mg+qE_0)}$ **(B)** $\frac{2mv_0^2}{2\mu(mg+qE_0)}$ **(C)** $\frac{mv_0^2}{\mu(mg+qE_0)}$ **(D)** $\frac{mv_0^2}{2\mu(mg+qE_0)}$

Q.9 A particle of charge q and mass m starts moving from the origin under the action of electric field $\vec{E} = E_0\,\hat{i}$ and $\vec{B} = B_0\,\hat{i}$ with velocity $\vec{V} = V_0\,\hat{j}$. 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.10 A particle of specific charge (charge/mass) α starts moving from the origin from rest under the action of an electric field $\vec{E} = E_0\,\hat{i}$ and magnetic field $\vec{B} = B_0\,\hat{k}$. Its velocity at $(x_0, y_0, 0)$ is $(4\hat{i} - 3\hat{j})$. The value of x_0 is: (All parameters are in SI units).

(A) $\frac{13\alpha E_0}{2B_0}$ **(B)** $\frac{16\alpha B_0}{E_0}$ **(C)** $\frac{25}{2\alpha E_0}$ **(D)** $\frac{5\alpha}{2B_0}$

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(C)	(B)	(A)	(A)	(D)	(D)	(B)	(D)	(D)	(C)