O P JINDAL SCHOOL, SAVITRINAGAR

CLASS TEST & PRACTICE

ANSWER KEY

CLASS XII PHYSICS　　　　　　　　　　　　　　TOPIC : MOVING CHARGES AND MAGNETISM

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1 Why does a moving charge experience a force when placed in a magnetic field? 1

ANS: A moving charge produces a magnetic field. This magnetic field interacts with another magnetic field of a magnet and hence, it experiences force.

2 Write the expression, in a vector form, for the Lorentz magnetic force $\vec{F}$ due to a charge moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$. What is the direction of the magnetic force? 1

ANS: Lorentz magnetic force $(\vec{F_m}) = q(\vec{v} \times \vec{B})$. The direction of magnetic force is perpendicular to the plane containing velocity and magnetic field vectors.

3 Define one tesla using the expression for the magnetic force acting on a particle of charge *q* moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$. 1

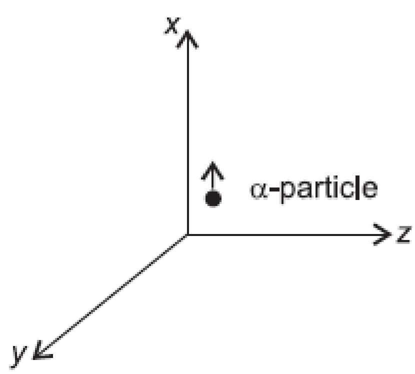
ANS:

As $F_{max} = qvB \Rightarrow B = \frac{F_{max}}{qv}$

If $F_{max} = 1\,N$, $q = +1C$ and $v = 1$ m/s and $\theta = 90°$, then $B = 1T$

Hence, one tesla is the magnetic field in which a normally entering + 1C charge, moving at 1 ms^{-1} experiences a maximum force of 1 N.

4 A beam of α-particles projected along +x-axis, experiences a force due to a magnetic field along the +y-axis. What is the direction of the magnetic field? 1



ANS:

As we know that $\vec{F} = q(\vec{v} \times \vec{B})$ here

$\vec{F} = F\hat{j};\ \vec{v} = v\hat{i},\ \therefore F\hat{j} = q(v\hat{i} \times \vec{B})$ Therefore, the direction of magnetic field is towards the negative direction of z-axis.

5 A long straight wire carries a steady current *I* along the positive y-axis in a coordinate system. A particle of charge +*Q* is moving with a velocity $\vec{v}$ along the *x*-axis. In which 1

direction will the particle experience a force?

ANS: By the right-hand thumb rule, the direction of magnetic field due to current *I* acts normally into the plane of paper. So, $\vec{B} = -B\hat{k}$, i.e. along negative z-axis. The magnetic Lorentz force is given by

$$\vec{F} = Q(\vec{v} \times \vec{B}) = Q[v\hat{i} \times (-B\hat{k})] = QvB\hat{k} \times \hat{i} = QvB\hat{j}$$

Thus, the force on charge +*Q* is along +*y* axis.

6 In a certain region of space, electric field $\vec{E}$ and magnetic field $\vec{B}$ are perpendicular to each other. An electron enters in the region perpendicular to the directions of both $\vec{E}$ and $\vec{B}$ and moves undeflected. Find the velocity of the electron. 1

ANS: $\because \quad qvB = qE \Rightarrow v = \frac{E}{B}$

7 An electron and a proton moving with the same speed enter the same magnetic field region at right angles to the direction of the field. For which of the two particles will the radius of circular path be smaller? 1

ANS: As $r = \frac{mv}{qB}$, for same v and B, $r \propto \frac{m}{q}$. Since $\frac{m}{q}$ is smaller for an electron, the radius of the circular path followed by the electron will be smaller.

8 Write the expression for the magnetic moment of a circular coil of area A carrying a current I, in a vector form. 1

ANS: $\vec{M} = I\vec{A}$, as vector $\vec{A}$ is perpendicular to the surface, the magnetic moment $\vec{M}$ will also be perpendicular to the plane of circular coil.

9 Magnetic field lines can be entirely confined within the core of a toroid, but not within a straight solenoid. Why? 1

ANS: At the edges of a solenoid, the field lines get diverged due to other fields or non-availability of dipole loops, while in a toroid, the dipoles (in loops) orient continuosly.

10 Using the concept of force between two infinitely long parallel current carrying conductors, define one ampere of current. 1

ANS: One ampere is that amount of current which when flows through two thin infinitely long straight conductors kept parallel to each other at 1 m distance produces a force per unit length of magnitude 2×10^{-7} N/m.