CHAPTER 04

MAGNETIC EFFECT OF CURRENT AND MAGNETISM

Magnetic lines of force convey a far better and purer idea than the phrase magnetic current or magnetic flood: it avoids the assumption of a current or of two currents and also of fluids or a fluid, yet conveys a full and useful pictorial idea to the mind.

"MICHAEL FARADAY"

INTRODUCTION

Magnets are familiar objects. The word magnetism is derived from the province of Magnesia where the ancient Greek mine magnetic, also known as lodestone, a mineral composed of iron oxide which attracts iron.

If you ask the average person what "magnetism" is, you will probably be told about the magnets those are used to hold notes on refrigerator door, or keeping paper clips in a holder or may be about lead stone (naturally occurring magnet).

Scholars still dispute about the origin of magnetism. It is believed that magnetism was originally used, not for navigation, but for geomancy ("foresight by earth") and fortune-telling by the Chinese. Chinese fortune tellers used lodestones to construct their fortune telling boards.

From Chinese text, it is known that magnetic compass (used for navigational purpose) is an old Chinese invention. An old Indian literature dates it to as back as 4th century. The compass was used in India was known as the matsya yantra, because of the placement of a metallic fish in a cup of oil.

ETOOS KEY POINTS

(i) $\vec{F} \perp \vec{v}$ and also $\vec{F} \perp \vec{B}$

(ii) $\because$ $\vec{F} \perp \vec{v}$ $\therefore$ power due to magnetic force on a charged particle is zero. (use the formula of power $P = \vec{F}.\vec{v}$ for its proof).

(iii) Since the $\vec{F} \perp \vec{B}$ so work done by magnetic force is zero in every part of the motion. The magnetic force cannot increase or decrease the speed (or kinetic energy) of a charged particle. Its can only change the direction of velocity.

(iv) On a stationary charged particle, magnetic force is zero.

(v) If $\vec{V} \,||\, \vec{B}$, then also magnetic force on charged particle is zero. It moves along a straight line if only magnetic field is acting.

Ex. A charged particle of mass 5 mg and charge q = +2μC has velocity $\vec{v} = 2\hat{i} - 3\hat{j} + 4\hat{k}$. Find out the magnetic force on the charged particle and its acceleration at this instant due to magnetic field $\vec{B} = 3\hat{j} - 2\hat{k}$. $\vec{v}$ and $\vec{B}$ are in m/s and Wb/m^2 respectively.

Sol. $\vec{F} = q\vec{v} \times \vec{B} = 2 \times 10^{-6}(2\hat{i} - 3\hat{j} \times 4\hat{k}) \times (3\hat{j} - 2\hat{k}) = 2 \times 10^{-6}[-6\hat{i} + 4\hat{j} + 6\hat{k}]$ N

By Newton's Law $\vec{a} = \frac{\vec{F}}{m} = \frac{2 \times 10^{-6}}{5 \times 10^{-6}}(-6\hat{i} + 4\hat{j} + 6\hat{k}) = 0.8(-3\hat{i} + 2\hat{j} + 3\hat{k})$ m/s^2

Motion of charged particles under the effect of magnetic force

- Particle released if v = 0 then $f_m = 0$

  $\therefore$ particle will remain at rest

- $\vec{V} \,||\, \vec{B}$ here θ = 0 or θ = 180º

  $\therefore$ $F_m = 0$ $\therefore$ $\vec{a} = 0$ $\therefore$ $\vec{V}$ = const.

  $\therefore$ particle will move in a straight line with constant velocity

- Initial velocity $\vec{u} \perp \vec{B}$ and $\vec{B}$ = uniform

  In this case $\because$ B is in z direction so the magnetic force in z-direction will be zero $\left(\because \overrightarrow{F_m} \perp \vec{B}\right)$.

  Now there is no initial velocity in z-direction.

  $\therefore$ particle will always move in xy plane.

  $\therefore$ velocity vector is always $\perp \vec{B}$ $\therefore$ F_m = quB = constant

  Now quB = $\frac{mu^2}{R}$ $\Rightarrow$ R = $\frac{mu}{qB}$ = constant.

  The particle moves in a curved path whose radius of curvature is same every where, such curve in a plane is only a circle.

  $\therefore$ path of the particle is circular.

  $$R = \frac{mu}{qB} = \frac{p}{qB} = \frac{\sqrt{2mk}}{qB}$$

Etoos Tips & Formulas

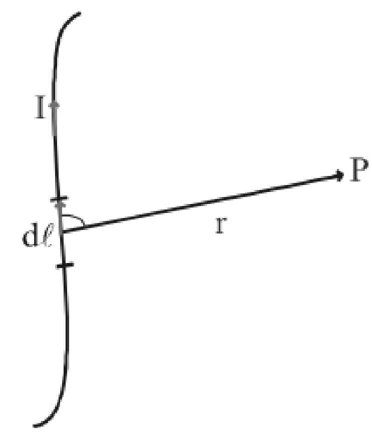
A static charge produced only electric field and only electric field can exert a force on it. A moving charge produced both electric field and magnetic field can exert force on it. A current carrying conductor produces only magnetic field and only magnetic field can exert a force on it.

Magnetic charge (i.e. current), produces a magnetic field. It can not produce electric field as net charge on a current carrying conductor is zero. A magnetic field is detected by its action current carrying conductors (or moving charges) and magnetic needles (compass). The vector quantity $\vec{B}$ known as **MAGNETIC INDUCTION** is introduced to characterise a magnetic field. It is a vector quantity which may be defined is term of the force it produces on electric currents. Lines of magnetic induction may be drawn in the same way as lines of electric field. The number of line per unit area crossing a small area perpendicular to the direction of the induction bring numerically equal to $\vec{B}$. The number of lines of $\vec{B}$ crossing a given area is referred to as the **magnetic flux** linked with that area. For this reason $\vec{B}$ is also called **magnetic flux density.**

1. Magnetic Induction Produced by a Current (Biot-Savart Law) :

The magnetic induction dB produced by an element d*l* carrying a current I are a distance r is given by :

$$dB = \frac{\mu_0\mu_r}{4\pi}\frac{Id\ell\sin\theta}{r^2} \Rightarrow \overrightarrow{dB} = \frac{\mu_0\mu_r}{4\pi}\frac{I\left(d\vec{\ell}\times\vec{r}\right)}{r^3}$$



here the quantity $Id\ell$ is called as current element strength.

μ = permeability of the medium = $\mu_0\mu_r$

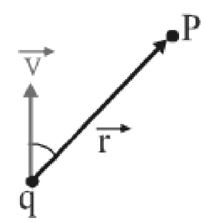
μ_0 = permeability of free space

μ_r = relative permeability of the medium (Dimensionless quantity).

Unit of μ_0 & μ is NA^{-2} or Hm^{-1} ;

$\mu_0 = 4\pi\times10^{-7}\,Hm^{-1}$

2. Magnetic Induction Due to a Moving Charge :

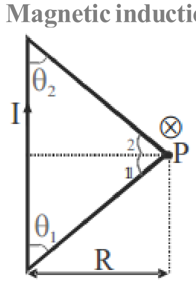


$$dB_p = \frac{\mu_0 qv\sin\theta}{4\pi r^2}$$

In vector form it can be written as $\overrightarrow{dB} = \frac{\mu_0}{4\pi}\frac{q\left(\vec{v}\times\vec{r}\right)}{r^3}$

3. Magnetic Induction Due to a Current Carrying Straight Conductor

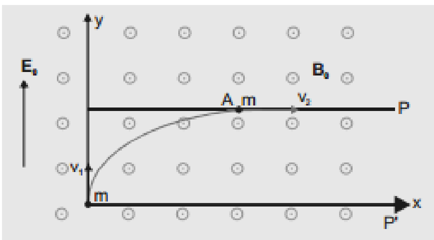
(a) Magnetic induction due to a current carrying straight wire



$$B = \frac{\mu_0 I}{4\pi R}\left(\cos\theta_1 + \cos\theta_2\right) = \frac{\mu_0 I}{4\pi R}\left(\sin\alpha_1 + \sin\alpha_2\right)$$

SOLVED EXAMPLE

Ex.1 There are constant electric field $E_0\hat{j}$ & magnetic field $B\hat{k}$ present between plates P and P'. A particle of mass m is projected from plate P' along y axis with velocity v_1. After moving on the curved path, it passes through point A just grazing the plate P with velocity v_2. The magnitude of impulse (i.e. $\vec{F}\Delta t = \Delta\vec{p}$) provided by magnetic force during the motion of particle from origin to point A is :–

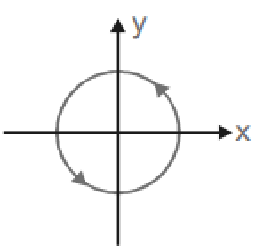


(A) $m|v_2 - v_1|$ (B) $m\sqrt{v_1^2 + v_2^2}$

(C) mv_1 (D) mv_2

Sol. Electric force is only responsible for the change in momentum along y–axis. Therefore impulse provide by magnetic force is $J_B = mv_2$.

Ex.2 Current i = 2.5 A flows along the circle $x^2 + y^2 = 9\ cm^2$ (here x & y in cm) as shown. Magnetic field at point (0, 0, 4 cm) is



(A) $(36\pi \times 10^{-7}\,T)\hat{k}$

(B) $(36\pi \times 10^{-7}\,T)(-\hat{k})$

(C) $\left(\frac{9\pi}{5} \times 10^{-7}\,T\right)\hat{k}$

(D) $\left(\frac{9\pi}{5} \times 10^{-7}\,T\right)(-\hat{k})$

Sol. Magnetic field on the axis of a circular loop

$$B = \left(\frac{\mu_0}{4\pi}\right) \times \frac{2\pi i R^2}{(R^2 + z^2)^{3/2}}$$

$$= 10^{-7} \times \frac{2\pi \times 2.5 \times 3^2 \times 10^{-4}}{125 \times 10^{-6}}\hat{k}$$

$$= \left(\frac{9\pi}{25} \times 10^{-5}\,T\right)\hat{k} = (36\pi \times 10^{-7}\,T)\hat{k}$$

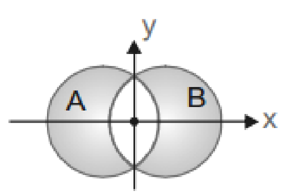
Ex.3 Three identical charge particles A, B and C are projected perpendicular to the uniform magnetic field with velocities v_1, v_2 and v_3 ($v_1 < v_2 < v_3$) respectively such that T_1, T_2 and T_3 are their respective time period of revolution and r_1, r_2 and r_3 are respective radii of circular path described. Then

(A) $\frac{r_1}{T_1} > \frac{r_2}{T_2} > \frac{r_3}{T_3}$ (B) $T_1 < T_2 < T_3$

(C) $\frac{r_1}{T_1} < \frac{r_2}{T_2} < \frac{r_3}{T_3}$ (D) $r_1 = r_2 = r_3$

Sol. $T = \frac{2\pi m}{qB}$ & $r = \frac{mv}{qB} \Rightarrow \frac{r}{T} \propto v$

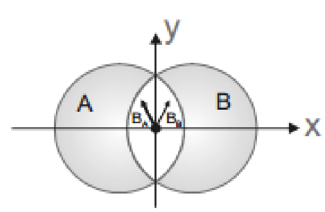
Ex.4 Two cylindrical straight and very long non magnetic conductors A and B, insulated from each other, carry a current I in the positive and the negative z–direction respectively. The direction of magnetic field at origin is



(A) $-\hat{i}$ (B) $+\hat{i}$

(C) $\hat{j}$ (D) $-\hat{j}$

Sol.



Exercise # 1 — SINGLE OBJECTIVE — NEET LEVEL

1. A length L of wire carries a steady current I. It is bent first to form a circular plane coil of one turn. The same length is now bent more sharply to give a double loop of smaller radius. The magnetic field at the centre caused by the same current is
(A) A quarter of its first value
(B) Unaltered
(C) Four times of its first value
(D) A half of its first value

2. A vertical straight conductor carries a current vertically upwards. A point P lies to the east of it at a small distance and another point Q lies to the west at the same distance. The magnetic field at P is
(A) Greater than at Q
(B) Same as at Q
(C) Less than at Q
(D) Greater or less than at Q depending upon the strength of the current

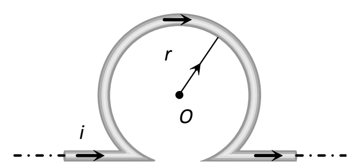
3. If a copper rod carries a direct current, the magnetic field associated with the current will be
(A) Only inside the rod
(B) Only outside the rod
(C) Both inside and outside the rod
(D) Neither inside nor outside the rod

4. If a long hollow copper pipe carries a direct current, the magnetic field associated with the current will be
(A) Only inside the pipe
(B) Only outside the pipe
(C) Neither inside nor outside the pipe
(D) Both inside and outside the pipe

5. The magnetic field $d\vec{B}$ due to a small current element $d\vec{l}$ at a distance $\vec{r}$ and element carrying current i is, or Vector form of Biot-savart's law is
(A) $d\vec{B} = \frac{\mu_0}{4\pi} i \left(\frac{d\vec{l} \times \vec{r}}{r}\right)$ (B) $d\vec{B} = \frac{\mu_0}{4\pi} i^2 \left(\frac{d\vec{l} \times \vec{r}}{r}\right)$
(C) $d\vec{B} = \frac{\mu_0}{4\pi} i^2 \left(\frac{d\vec{l} \times \vec{r}}{r^2}\right)$ (D) $d\vec{B} = \frac{\mu_0}{4\pi} i \left(\frac{d\vec{l} \times \vec{r}}{r^3}\right)$

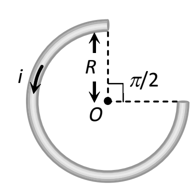
6. A charge q *coulomb* moves in a circle at n revolutions per second and the radius of the circle is r *metre*. Then magnetic field at the centre of the circle is
(A) $\frac{2\pi q}{nr} \times 10^{-7}$ *N/amp/metre*
(B) $\frac{2\pi q}{r} \times 10^{-7}$ *N/amp/metre*
(C) $\frac{2\pi nq}{r} \times 10^{-7}$ *N/amp/metre*
(D) $\frac{2\pi q}{r}$ *N/amp/metre*

7. An infinitely long straight conductor is bent into the shape as shown in the figure. It carries a current of i *ampere* and the radius of the circular loop is r *metre*. Then the magnetic induction at its centre will be



(A) $\frac{\mu_0}{4\pi}\frac{2i}{r}(\pi + 1)$
(B) $\frac{\mu_0}{4\pi}\frac{2i}{r}(\pi - 1)$
(C) Zero
(D) Infinite

8. A current i *ampere* flows in a circular arc of wire whose radius is R, which subtend an angle $3\pi/2$ radian at its centre. The magnetic induction B at the centre is



(A) $\frac{\mu_0 i}{R}$ (B) $\frac{\mu_0 i}{2R}$
(C) $\frac{2\mu_0 i}{R}$ (D) $\frac{3\mu_0 i}{8R}$

Exercise # 2 SINGLE OBJECTIVE AIIMS LEVEL

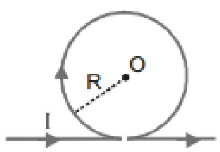
1. Two concentric coils each of radius equal to 2π cm are placed at right angles to each other. 3A and 4A are the currents flowing in each coil respectively. The magnetic induction in Wb/m^2 at the centre of the coils will be : –

($\mu_0 = 4\pi \times 10^{-7}$ Wb/Am)

(A) 12×10^{-5} **(B)** 10^{-5}

(C) 5×10^{-5} **(D)** 7×10^{-5}

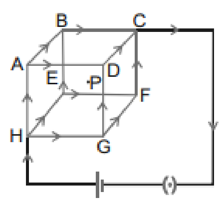
2. An infinitely long straight conductor is bent into the shape as shown in figure. It carries a current I ampere and the radius of the circular loop is r meter. Then the magnetic induction at the centre of the circular part is :–



(A) Zero **(B)** ∞

(C) $\frac{\mu_0}{4\pi}\frac{2I}{r}(\pi+1)$ **(D)** $\frac{\mu_0}{4\pi}\frac{2I}{r}(\pi-1)$

3. A steady current is set up in a cubic network composed of wires of equal resistance and length d as shown in figure. What is the magnetic field at the centre P due to the cubic network ?



(A) $\frac{\mu_0}{4\pi}.\frac{2I}{d}$ **(B)** $\frac{\mu_0}{4\pi}.\frac{3I}{\sqrt{2}d}$

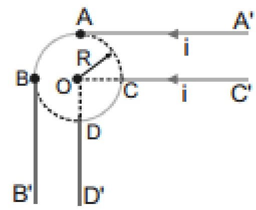
(C) 0 **(D)** $\frac{\mu_0}{4\pi}.\frac{8\pi I}{d}$

4. If the intensity of magnetic field at a point on the axis of current coil is half of that at the centre of the coil, then the distance of that point from the centre of the coil will be :–

(A) $\frac{R}{2}$ **(B)** R

(C) $\frac{3R}{2}$ **(D)** 0.766R

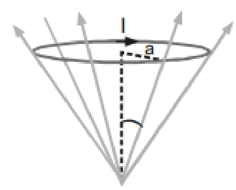
5. All straight wires are very long. Both AB and CD are arcs of the same circle, both subtending right angles at the centre O. Then the magnetic field at O is–



(A) $\frac{\mu_0 i}{4\pi R}$ **(B)** $\frac{\mu_0 i}{4\pi R}\sqrt{2}$

(C) $\frac{\mu_0 i}{2\pi R}$ **(D)** $\frac{\mu_0 i}{2\pi R}(\pi+1)$

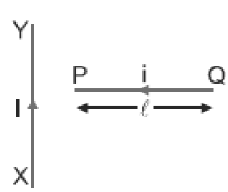
6. A circular current loop of radius a is placed in a radial field B as shown. The net force acting on the loop is



(A) zero **(B)** $2\pi BaI\cos\theta$

(C) $2\pi aIB\sin\theta$ **(D)** None

7. A conductor PQ carries a current 'i' is placed perpendicular to a long conductor XY carrying a current I. The direction of force on PQ will be :–



(A) towards right

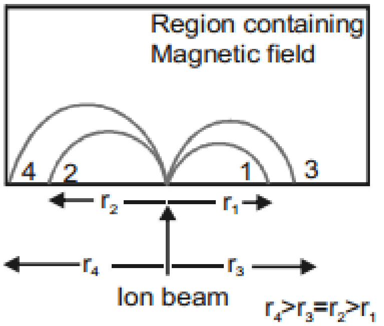
(B) towards left

(C) upwards

(D) downwards

Exercise # 3 PART - 1 MATRIX MATCH COLUMN

1. A beam consisting of four types of ions A, B, C and D enters a region that contains a uniform magnetic field as shown. The field is perpendicular to the plane of the paper, but its precise direction is not given.



ION	MASS	CHARGE
A	2m	e
B	4m	–e
C	2m	–e
D	m	+e

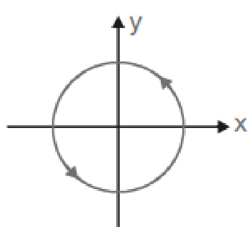
All ions in the beam travel with the same speed. The table below gives the masses and charges of the ions. The ions fall at different positions 1, 2, 3 and 4, as shown. Correctly match the ions with respective falling positions.

Table–I	Table–II
(A) A	(P) 1
(B) B	(Q) 2
(C) C	(R) 3
(D) D	(S) 4

2. A charged particle is moving in a circular path in uniform magnetic field. Match the following :

Table–I	Table–II
(A) Equivalent current due to motion of charge particle	(P) is proportional to v
(B) Magnetic moment	(Q) is proportional to v^2
(C) Magnetic field at centre of circle due to motion of charged particle	(R) is proportional to v^0
	(S) None

3. A circular current carrying loop is placed in x–y plane as shown in figure. A uniform magnetic field $\vec{B} = B_0\hat{k}$ is present in the region. Match the following :



Table–I	Table–II
(A) Magnetic moment of the loop	(P) zero
(B) Torque on the loop	(Q) maximum
(C) Potential energy of the loop	(R) along positive z–axis
(D) Equilibrium of the loop	(S) stable
	(T) None

Exercise # 4 PART - 1 PREVIOUS YEAR (NEET/AIPMT)

MAGNETIC EFFECT OF CURRENT

1. Two wires are held perpendicular to the plane of paper and are 5 m apart. They carry currents of 2.5 A and 5 A in same direction. Then, the magnetic field strength (B) at a point midway between the wires will be [CBSE AIPMT 2001]

(A) $\frac{\mu_0}{4\pi}$ T (B) $\frac{\mu_0}{2\pi}$ T

(C) $\frac{3\mu_0}{2\pi}$ T (D) $\frac{3\mu_0}{4\pi}$ T

2. Current is flowing in a coil of area A and number of turns N, then magnetic moment of the coil, M is equal to [CBSE AIPMT 2001]

(A) NiA (B) $\frac{Ni}{A}$

(C) $\frac{Ni}{\sqrt{A}}$ (D) N^2Ai

3. A charged particle of charge q and mass m enters perpendicularly in a magnetic field B Kinetic energy of the particle is E, then frequency of rotation is [CBSE AIPMT 2001]

(A) $\frac{qB}{m\pi}$ (B) $\frac{qB}{2\pi m}$

(C) $\frac{qBE}{2\pi m}$ (D) $\frac{qB}{2\pi E}$

4. The magnetic field of a given length of wire carrying a current for a single turn circular coil at centre is B, then its value for two turns for the same wire when same current passing through it is [CBSE AIPMT 2002]

(A) $\frac{B}{4}$ (B) $\frac{B}{2}$

(C) 2 B (D) 4 B

5. A charge q moves in a region where electric field E and magnetic field B both exist, then the force on it is [CBSE AIPMT 2002]

(A) $q(v \times B)$ (B) $qE + q(v \times B)$

(C) $qB + q(B \times v)$ (D) $qB + q(E \times v)$

6. A charged particle moves through a magnetic field in a direction perpendicular to it. Then, the [CBSE AIPMT 2003]

(A) acceleration remains unchanged

(B) velocity remains unchanged

(C) speed of the particle remains unchanged

(D) direction of the particle remains unchanged

7. A long solenoid carrying a current produces a magnetic field B along its axis. If the current is doubled and the number of turns per cm is halved, the new value of the magnetic field is [CBSE AIPMT 2003]

(A) 2B (B) 4 B

(C) $\frac{B}{2}$ (D) B

8. A coil in the shape of an equilateral triangle of side l is suspended between the pole pieces of a permanent magnet such that B is in plane of the coil. If due to a current i in the triangle a torque τ acts on it, the side l of the triangle is [CBSE AIPMT 2005]

(A) $\frac{2}{\sqrt{3}}\left(\frac{\tau}{Bi}\right)^{1/2}$ (B) $\frac{2}{\sqrt{3}}\left(\frac{\tau}{Bi}\right)$

(C) $2\left(\frac{\tau}{\sqrt{3}Bi}\right)^{1/2}$ (D) $\frac{1}{\sqrt{3}}\frac{\tau}{Bi}$

9. An electron moves in a circular orbit with a uniform speed v. It produces a magnetic field B at the centre of the circle. The radius of the circle is proportional to [CBSE AIPMT 2005]

(A) $\frac{B}{v}$ (B) $\frac{v}{B}$

(C) $\sqrt{\frac{v}{B}}$ (D) $\sqrt{\frac{B}{v}}$

10. When a charged particle moving with velocity v is subjected to a magnetic field of induction B, the force on it is non-zero. This implies that

(A) angle between v and B is necessarily 90°

(B) angle between v and B can have any value other than 90°

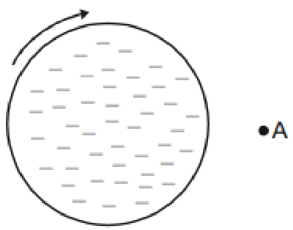
(C) angle between v and B can have any value other than zero and 180°

(D) angle between v and B is either zero or 180°

MOCK TEST

STRAIGHT OBJECTIVE TYPE

1. The negatively and uniformly charged nonconducting disc as shown in the figure is rotated clockwise with great angular speed. The direction of the magnetic field at point A in the plane of the disc is



(A) into the page (B) out of the page (C) up the page (D) down the page

2. A particle is moving with velocity $\vec{v} = \hat{i} + 3\hat{j}$ and it produces an electric field at a point given by $\vec{E} = 2\hat{k}$. It will produce magnetic field at that point equal to (all quantities are in S.I. units)

(A) $\frac{6\hat{i} - 2\hat{j}}{c^2}$ (B) $\frac{6\hat{i} + 2\hat{j}}{c^2}$ (C) zero

(D) can not be determined from the given data

3. Two observers moving with different velocities see that a point charge produces same magnetic field at the same point A . Their relative velocity must be parallel to $\vec{r}$, where $\vec{r}$ is the position vector of point A with respect to point charge. This statement is :

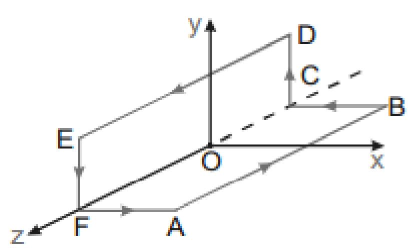
(A) true

(B) false

(C) nothing can be said

(D) true only if the charge is moving perpendicular to the $\vec{r}$

4. In the figure shown A B C D E F A was a square loop of side ℓ , but is folded in two equal parts so that half of it lies in x z plane and the other half lies in the yz plane. The origin 'O' is centre of the frame also. The loop carries current ' i '. The magnetic field at the centre is:



(A) $\frac{\mu_0 i}{2\sqrt{2}\pi\ell}(\hat{i} - \hat{j})$ (B) $\frac{\mu_0 i}{4\pi\ell}(-\hat{i} + \hat{j})$ (C) $\frac{\sqrt{2}\mu_0 i}{\pi\ell}(\hat{i} + \hat{j})$ (D) $\frac{\mu_0 i}{\sqrt{2}\pi\ell}(\hat{i} + \hat{j})$

11th Class Modules Chapter Details

Physics
5
Modules

Chemistry
5
Modules

Mathematics
5
Modules

PHYSICS

Module-1

1. Physical World & Measurements
2. Basic Maths & Vector
3. Kinematics

Module-2

1. Law of Motion & Friction
2. Work, Energy & Power

Module-3

1. Motion of system of particles & Rigid Body
2. Gravitation

Module-4

1. Mechanical Properties of Matter
2. Thermal Properties of Matter

Module-5

1. Oscillations
2. Waves

CHEMISTRY

Module-1(PC)

1. Some Basic Conceps of Chemistry
2. Atomic Structure
3. Chemical Equilibrium
4. Ionic Equilibrium

Module-2(PC)

1. Thermodynamics & Thermochemistry
2. Redox Reaction
3. States Of Matter (Gaseous & Liquid)

Module-3(IC)

1. Periodic Table
2. Chemical Bonding
3. Hydrogen & Its Compounds
4. S-Block

Module-4(OC)

1. Nomenclature of Organic Compounds
2. Isomerism
3. General Organic Chemistry

Module-5(OC)

1. Reaction Mechanism
2. Hydrocarbon
3. Aromatic Hydrocarbon
4. Environmental Chemistry & Analysis Of Organic Compounds

BIOLOGY

Module-1

1. Diversity in the Living World
2. Plant Kingdom
3. Animal Kingdom

Module-2

1. Morphology in Flowering Plants
2. Anatomy of Flowering Plants
3. Structural Organization in Animals

Module-3

1. Cell: The Unit of Life
2. Biomolecules
3. Cell Cycle & Cell Division
4. Transport in Plants
5. Mineral Nutrition

Module-4

1. Photosynthesis in Higher Plants
2. Respiration in Plants
3. Plant Growth and Development
4. Digestion & Absorption
5. Breathing & Exchange of Gases

Module-5

1. Body Fluids & Its Circulation
2. Excretory Products & Their Elimination
3. Locomotion & Its Movement
4. Neural Control & Coordination
5. Chemical Coordination and Integration

12th Class Modules Chapter Details

Physics
5
Modules

Chemistry
5
Modules

Mathematics
5
Modules

PHYSICS

Module-1
1. Electrostatics
2. Capacitance

Module-2
1. Current Electricity
2. Magnetic Effect of Current and Magnetism

Module-3
1. Electromagnetic Induction
2. Alternating Current

Module-4
1. Geometrical Optics
2. Wave Optics

Module-5
1. Modern Physics
2. Nuclear Physics
3. Solids & Semiconductor Devices
4. Electromagnetic Waves

CHEMISTRY

Module-1(PC)
1. Solid State
2. Chemical Kinetics
3. Solutions and Colligative Properties

Module-2(PC)
1. Electrochemistry
2. Surface Chemistry

Module-3(IC)
1. P-Block Elements
2. Transition Elements (d & f block)
3. Co-ordination Compound
4. Metallurgy

Module-4(OC)
1. HaloAlkanes & HaloArenes
2. Alcohol, Phenol & Ether
3. Aldehyde, Ketone & Carboxylic Acid

Module-5(OC)
1. Nitrogen & Its Derivatives
2. Biomolecules & Polymers
3. Chemistry in Everyday Life

BIOLOGY

Module-1
1. Reproduction in Organisms
2. Sexual Reproduction in Flowering Plants
3. Human Reproduction
4. Reproductive Health

Module-2
1. Principles of Inheritance and Variation
2. Molecular Basis of Inheritance
3. Evolution

Module-3
1. Human Health and Disease
2. Strategies for Enhancement in Food Production
3. Microbes in Human Welfare

Module-4
1. Biotechnology: Principles and Processes
2. Biotechnology and Its Applications
3. Organisms and Populations

Module-5
1. Ecosystem
2. Biodiversity and Conservation
3. Environmental Issues