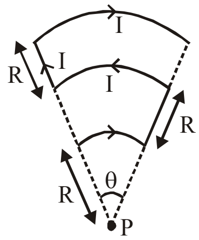
## MAGNETIC EFFECT OF CURRENT AND MAGNETISM — RACE # 01

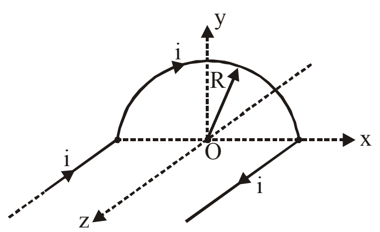
**1.** Magnetic field at P due to given structure is :-




(1) $\left(\frac{\mu_0}{4\pi}\right)\frac{I\theta}{2R}$ (2) $\frac{\mu_0}{4\pi}\frac{6I\theta}{5R}$

(3) $\left(\frac{\mu_0}{4\pi}\right)\frac{5I\theta}{6R}$ (4) $\left(\frac{\mu_0}{4\pi}\right)\frac{2I\theta}{R}$

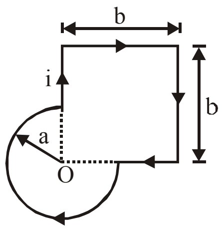
**2.** The magnetic induction at the point O, if the wire carries a current i, is :-




(1) $\frac{\mu_0 i}{2R}$ (2) $\frac{\mu_0 i}{2\pi R}$

(3) $\frac{\mu_0 i(\pi^2+4)^{1/2}}{4\pi R}$ (4) $\frac{\mu_0 i(\pi^2+4)}{4\pi R}$

**3.** The magnetic field at the point O of a loop with current i, whose shape is illustrated below is :-



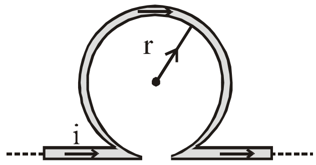

(1) $\frac{\mu_0 i}{4\pi}\left[\frac{3\pi}{2a}+\frac{\sqrt{2}}{b}\right]$

(2) $\frac{\mu_0 i}{4\pi^2}\left[\frac{2}{b}+b\right]$

(3) $\frac{\mu_0 i}{2\pi^2}\left[\frac{1}{a}+\frac{1}{b}\right]$

(4) $\frac{\mu_0 i}{4\pi}\left[\frac{1}{a}+\frac{1}{b}\right]$

**4.** 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




(1) $\frac{\mu_0 I}{2\pi r}(\pi+1)$ (2) $\frac{\mu_0 I}{2\pi r}(\pi-1)$

(3) Zero (4) Infinite

**5.** The magnetic induction at a point *P* which is distant 4 *cm* from a long current carrying wire is $10^{-8}$ Tesla. Magnetic induction at a distance 12 *cm* from the same current carrying wire would be

(1) $3.33 \times 10^{-9}$ Tesla (2) $1.11 \times 10^{-4}$ Tesla

(3) $3 \times 10^{-3}$ Tesla (4) $9\times10^{-2}$ Tesla

**6.** Two concentric circular coils of ten turns each are situated in the same plane. Their radii are 20 and 40 *cm* and they carry respectively 0.2 and 0.3 *ampere* current in opposite direction. The magnetic field in weber/m$^2$ at the centre is

(1) $\frac{35}{4}\mu_0$ (2) $\frac{\mu_0}{80}$

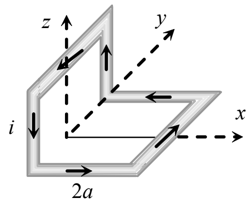
(3) $\frac{7}{80}\mu_0$ (4) $\frac{5}{4}\mu_0$

**7.** A cell is connected between two points of a uniformly thick circular conductor. The magnetic field at the centre of the loop will be (Here $i_1$ and $i_2$ are the currents flowing in the two parts of the circular conductor of radius '*a*' And $\mu_0$ has the usual meaning)

(1) Zero (2) $\frac{\mu_0}{2a}(i_1-i_2)$

(3) $\frac{\mu_0}{2a}(i_1+i_2)$ (4) $\frac{\mu_0}{a}(i_1+i_2)$

**8.** A non-planar loop of conducting wire carrying a current $I$ is placed as shown in the figure. Each of the straight sections of the loop is of length $2a$. The magnetic field due to this loop at the point $P$ $(a,0,a)$ points in the direction




(1) $\frac{1}{\sqrt{2}}\left(-\hat{j}+\hat{k}\right)$ (2) $\frac{1}{\sqrt{3}}\left(-\hat{j}+\hat{k}+\hat{i}\right)$

(3) $\frac{1}{\sqrt{3}}\left(\hat{i}+\hat{j}+\hat{k}\right)$ (4) $\frac{1}{\sqrt{2}}\left(\hat{i}+\hat{k}\right)$

**ANSWER KEY**

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Ans | 3 | 3 | 1 | 2 | 1 | 4 | 1 | 4 |

**1.** A current *i ampere* flows along the inner conductor of long coaxial cable and returns along the outer conductor of the cable, then the magnetic induction at any point outside the conductor at a distance *r metre* from the axis is

(1) $\infty$ (2) Zero

(3) $\frac{\mu_0 I}{2\pi r}$ (4) $\frac{\mu_0 I}{2r}$

**2.** There are 50 turns of a wire in every *cm* length of a long solenoid. If 4 *ampere* current is flowing in the solenoid, the approximate value of magnetic field along its axis at an internal point and at one end will be respectively

(1) $12.6 \times 10^{-3}$ Weber/m$^2$, $6.3 \times 10^{-3}$ Weber/m$^2$

(2) $12.6 \times 10^{-3}$ Weber/m$^2$, $25.1 \times 10^{-3}$ Weber/m$^2$

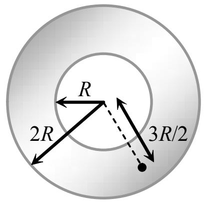
(3) $25.1 \times 10^{-3}$ Weber/m$^2$, $12.6 \times 10^{-3}$ Weber/m$^2$

(4) $25.1 \times 10^{-5}$ Weber/m$^2$, $12.6 \times 10^{-5}$ Weber/m$^2$

**3.** The current in the windings on a toroid is 2.0*A*. There are 400 turns and the mean circumferential length is 40*cm*. If the inside magnetic field is 1.0*T*, the relative permeability is near to :-

(1) 100 (2) 200 (3) 300 (4) 400

**4.** Figure shows the cross-sectional view of the hollow cylindrical conductor with inner radius '*R*' and outer radius '2*R*', cylinder carrying uniformly distributed current along it's axis. The magnetic induction at point *'P'* at a distance $\frac{3R}{2}$ from the axis of the cylinder will be




(1) Zero (2) $\frac{5\mu_0 i}{72\pi R}$

(3) $\frac{7\mu_0 i}{18\pi R}$ (4) $\frac{5\mu_0 i}{36\pi R}$

**5.** A long straight wire carries a current. Can Ampere's circuital law be used to find magnetic field on a loop that doesn't enclose the wire :-

(1) Yes, if loop is circular

(2) Yes, if loop is rectangular

(3) Yes, if loop is of irregular shape

(4) No

**ANSWER KEY**

| Que. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Ans | 2 | 3 | 4 | 4 | 4 |

**1.** A proton (mass $m$ and charge $+e$) and an $\alpha$–particle (mass $4m$ and charge $+2e$) are projected with the same kinetic energy at right angles to the uniform magnetic field. Which one of the following statements will be true

(1) The $\alpha$–particle will be bent in a circular path with a small radius that for the proton

(2) The radius of the path of the $\alpha$–particle will be greater than that of the proton

(3) The $\alpha$–particle and the proton will be bent in a circular path with the same radius

(4) The $\alpha$–particle and the proton will go through the field in a straight line

**2.** An electron is moving with a speed of $10^8\ m/\sec$ perpendicular to a uniform magnetic field of intensity $B$. Suddenly intensity of the magnetic field is reduced to $B/2$. The radius of the path becomes from the original value of $r$

(1) No change

(2) Reduces to $r/2$

(3) Increases to $2r$

(4) Stops moving

**3.** A proton and an $\alpha$–particle enter a uniform magnetic field perpendicularly with the same speed. If proton takes 25 $\mu$ sec to make 5 revolutions, then the periodic time for the $\alpha$–particle would be

(1) 50 $\mu$ sec (2) 25 $\mu$ sec

(3) 10 $\mu$ sec (4) 5 $\mu$ sec

**4.** If a particle of charge $10^{-12}$ C moving along the $\hat{x}$–direction with a velocity $10^5\ m/s$ experiences a force of $10^{-10}$ N in $\hat{y}$–direction due to magnetic field, then the minimum magnetic field is

(1) $6.25 \times 10^3$ T in $\hat{z}$–direction

(2) $10^{-15}$ T in $\hat{z}$–direction

(3) $6.25 \times 10^{-3}$ T in $\hat{z}$–direction

(4) $10^{-3}$ T in $\hat{z}$–direction

**5.** A beam of well collimated cathode rays travelling with a speed of $5\times10^6\ ms^{-1}$ enter a region of mutually perpendicular electric and magnetic fields and emerge undeviated from this region. If $|\boldsymbol{B}| = 0.02\,T$, the magnitude of the electric field is

(1) $10^5\ Vm^{-1}$

(2) $2.5\times10^8\ Vm^{-1}$

(3) $1.25\times10^{10}\ Vm^{-1}$

(4) $2\times10^3\ Vm^{-1}$

**6.** Two ions having masses in the ratio 1 : 1 and charges 1 : 2 are projected into uniform magnetic field perpendicular to the field with speeds in the ratio 2 : 3. The ratio of the radii of circular paths along which the two particles move is

(1) 4 : 3 (2) 2 : 3

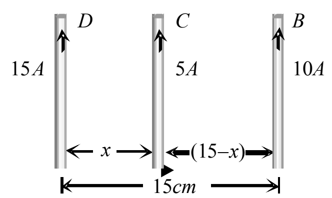
(3) 3 : 1 (4) 1 : 4

**7.** 3 $A$ of current is flowing in a linear conductor having a length of 40 $cm$. The conductor is placed in a magnetic field of strength 500 *gauss* and makes an angle of $30°$ with the direction of the field. It experiences a force of magnitude

(1) $3 \times 10^4$ N (2) $3 \times 10^2$ N

(3) $3 \times 10^{-2}$ N (4) $3 \times 10^{-4}$ N

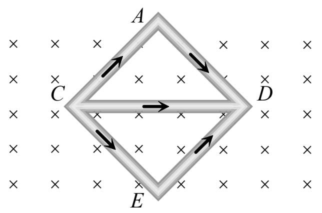
**8.** Three long, straight and parallel wires carrying currents are arranged as shown in the figure. The wire $C$ which carries a current of 5.0 *amp* is so placed that it experiences no force. The distance of wire $C$ from wire $D$ is then




(1) 9 $cm$ (2) 7 $cm$

(3) 5 $cm$ (4) 3 $cm$

**9.** 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 $B = 4T$ acting perpendicular to the plane of frame. The magnitude of magnetic force acting on the frame is




(1) 24 $N$ (2) Zero (3) 16 $N$ (4) 8 $N$

**10.** A charged particle is whirled in a horizontal circle on a frictionless table by attaching it to a string fixed at one point. If a magnetic field is switched on in the vertical direction, the tension in the string :-
(1) Will increase
(2) Will decrease
(3) Will remain the same
(4) May increase or decrease

**11.** An electron accelerated through a potential difference V enters a uniform transverse magnetic field and experiences a force F. If the accelerating potential is increased to 2V, the electron in the same magnetic field will experience a force :-
(1) F (2) $\frac{F}{2}$
(3) $\sqrt{2}F$ (4) 2 F

**12.** A proton is projected with a velocity $10^7$ m/s, at right angles to a uniform magnetic field of induction 100 mT. The time (in second) taken by the proton to traverse 90° arc is ($m_p = 1.65 \times 10^{-27}$ kg and $q_p = 1.6 \times 10^{-19}$ C) :-
(1) $0.81 \times 10^{-7}$ (2) $1.62 \times 10^{-7}$
(3) $2.43 \times 10^{-7}$ (4) $3.24 \times 10^{-7}$

**13.** If a charged particle goes unaccelerated in a region containing electric and magnetic fields, then :-
(1) $\vec{E}$ must be perpendicular to $\vec{B}$
(2) $\vec{v}$ must be perpendicular to $\vec{E}$
(3) $\vec{v}$ must be perpendicular to $\vec{B}$
(4) E must be equal to vB

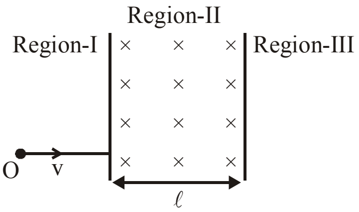
**14.** In a cyclotron, if a deuteron can gain an energy of 40 MeV, then a proton can gain an energy of :-
(1) 40 MeV (2) 80 MeV
(3) 20 MeV (4) 160 MeV

**15.** A particle with a specific charge's' is fired with a speed v towards a wall at a distance d, perpendicular to the wall. What minimum magnetic field must exist in this region for the particle not to hit the wall :-
(1) $\frac{v}{sd}$ (2) $\frac{2v}{sd}$
(3) $\frac{v}{2sd}$ (4) $\frac{v}{4sd}$

**16.** A particle of charge per unit mass $\alpha$ is projected from origin with a velocity $\vec{v} = v_0\hat{i}$ in a uniform magnetic field $\vec{B} = -B_0\hat{k}$. If the particle passes through (0, y, 0) then y is equal to :-
(1) $-\frac{2v_0}{B_0\alpha}$ (2) $\frac{v_0}{B_0\alpha}$
(3) $\frac{2v_0}{B_0\alpha}$ (4) $-\frac{v_0}{B_0\alpha}$

**17.** A charged particle enters in a magnetic field at right angles to the magnetic field. The field exists for a length equal to 1.5 times the radius of circular path of the particle. The particle will be deviated from its path by :-
(1) 90° (2) $\sin^{-1}\left(\frac{2}{3}\right)$
(3) 30° (4) 180°

**18.** A particle of mass m and charge q moving with velocity $v < \frac{qB\ell}{m}$ enters region-II normal to the boundary as shown in the figure. Region-II has a uniform magnetic field B perpendicular to the plane of paper. The particle will :-

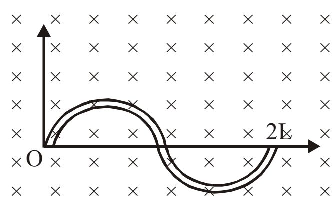



(1) Enter the region-III
(2) Not enter the region-III
(3) Complete circular motion in region-II
(4) Move undeflected in region-II

**19.** A small circular flexible loop of wire of radius R carries a current I. It is placed in a uniform magnetic field B. The tension in the loop will be doubled, if :-

(1) I is doubled (2) B is doubled
(3) R is doubled (4) All of these

**20.** A wire carrying a current *i* is placed in a uniform magnetic field 'B'. This wire is in the form of the curve $y = a\sin\left(\frac{\pi x}{L}\right)$ $0 \le x \le 2L$. Force acting on the wire is :-




(1) $\frac{iBL}{\pi}$ (2) $iBL\pi$
(3) 2iBL (4) Zero

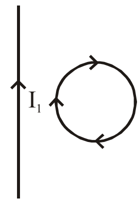
**21.** The magnetic field existing in a region is given by $\vec{B} = B_0\left(1+\frac{x}{\ell}\right)\hat{k}$. A square loop of edge $\ell$ and carrying a current i, is placed with its edge parallel to the x-y axes. Find the magnitude of the net magnetic force experienced by the square loop :-

(1) $\frac{1}{2}iB_0\ell$ (2) Zero (3) $iB_0\ell$ (4) $2iB_0\ell$

**22.** To make the magnetic field radial in a moving coil galvanometer :-

(1) The number of turns in the coil is increased
(2) Magnet is taken in the form of horse-shoe
(3) Poles are cylindrically cut
(4) Coil is wound on aluminium frame

**23.** In the given figure, the loop is fixed but straight wire can move.
The straight wire will :-




(1) Remain stationary
(2) Move towards the loop
(3) Move away from the loop
(4) Rotate about the axis

**24.** If two straight current carrying wires are kept perpendicular to each other almost touching, then the wires :-

(1) Attract each other
(2) Repel each other
(3) Remain stationary
(4) Finally become parallel to each other

**25.** Suppose an isolated north pole is kept at the centre of a circular loop carrying a electric current i. The magnetic field due to the north pole at a point on the periphery of the wire is B. The radius of the loop is a. The force on the wire is :-

(1) Nearly 2 π a i B perpendicular to the plane of loop
(2) 2 π a i B perpendicular to the plane of loop
(3) π a i B along the axis of the loop
(4) Zero

**ANSWER KEY**

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ans | 3 | 3 | 3 | 4 | 1 | 1 | 3 | 1 | 1 | 4 | 3 | 2 | 1,2 | 2 | 1 |
| Que. | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | | | | | |
| Ans | 3 | 4 | 2 | 4 | 3 | 3 | 3 | 2 | 4 | 2 | | | | | |

## MAGNETIC EFFECT OF CURRENT AND MAGNETISM RACE# 04

**1.** The magnetic moment of a current carrying loop is $2.1\times10^{-25}\, amp \times m^2$. The magnetic field at a point on its axis at a distance of $1\mathring{A}$ is

(1) $4.2\times10^{-2}\, weber/m^2$ (2) $4.2\times10^{-3}\, weber/m^2$

(3) $4.2\times10^{-4}\, weber/m^2$ (4) $4.2\times10^{-5}\, weber/m^2$

**2.** In a hydrogen atom, an electron moves in a circular orbit of radius $5.2\times10^{-11}\, m$ and produces a magnetic induction of 12.56 *T* at its nucleus. The current produced by the motion of the electron will be (Given $\mu_0 = 4\pi\times10^{-7}\, Wb/A-m$)

(1) $6.53\times10^{-3}$ ampere (2) $13.25\times10^{-10}$ ampere

(3) $9.6\times10^{6}$ ampere (4) $1.04\times10^{-3}$ ampere

**3.** The earth's magnetic induction at a certain point is $7\times10^{-5} Wb/m^2$. This is to be annulled by the magnetic induction at the centre of a circular conducting loop of radius 5 *cm*. The required current in the loop is

(1) 0.56 *A* (2) 5.6 *A*

(3) 0.28 *A* (4) 2.8 *A*

**4.** Two wires of same length are shaped into a square and a circle. If they carry same current, ratio of the magnetic moment is

(1) $2 : \pi$ (2) $\pi : 2$ (3) $\pi : 4$ (4) $4 : \pi$

**5.** A circular coil of radius 4 *cm* has 50 turns. In this coil a current of 2 *A* is flowing. It is placed in a magnetic field of 0.1 $weber/m^2$. The amount of work done in rotating it through $180°$ from its stable equilibrium position will be

(1) 0.1 *J* (2) 0.2 *J*

(3) 0.4 *J* (4) 0.8 *J*

**6.** In order to increase the sensitivity of a moving coil galvanometer, one should decrease

(1) The strength of its magnet

(2) The torsional constant of its suspension

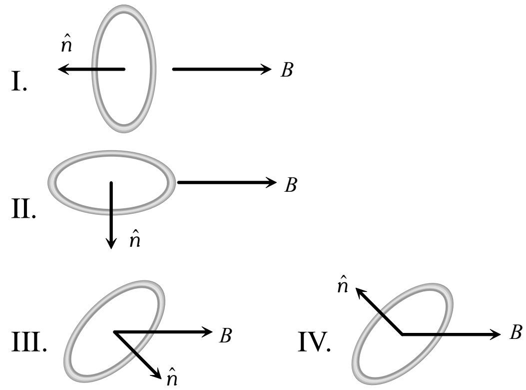
(3) The number of turns in its coil

(4) The area of its coil

**7.** Current *i* is carried in a wire of length *L*. If the wire is turned into a circular coil, the maximum magnitude of torque in a given magnetic field *B* will be

(1) $\frac{LiB^2}{2}$ (2) $\frac{Li^2B}{2}$ (3) $\frac{L^2iB}{4\pi}$ (4) $\frac{Li^2B}{4\pi}$

**8.** A current carrying loop is placed in a uniform magnetic field in four different orientations, I,II, III & IV arrange them in the decreasing order of potential Energy




(1) I > III > II > IV (2) I > II >III > IV

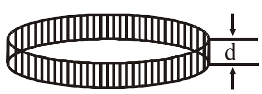
(3) I > IV > II > III (4) III > IV > I > II

**9.** A rigid circular loop of radius R and mass m lies in the x-y plane on a flat table and has a current i flowing in it. At this particular place the earth's magnetic field is $\vec{B} = B_x\hat{i} + B_z\hat{k}$. The value of i, so that the loop starts tilting is :-

(1) $\frac{mg}{\pi R\sqrt{B_x^2 + B_2^2}}$ (2) $\frac{mg}{\pi RB_x}$

(3) $\frac{mg}{\pi RB_z}$ (4) $\frac{mg}{\pi R\sqrt{B_xB_z}}$

**10.** Surface charge density on a ring of radius a and width d is σ as shown in the figure. It rotates with frequency f about its own axis. Assume that the charge is only on outer surface. The magnetic field induction at centre is (Assume that d << a) :-




(1) $\pi\ \mu_0\ f\ \sigma\ d$ (2) $\mu_0\ f\ \sigma\ d$

(3) $2\ \pi\ \mu_0\ f\ \sigma\ d$ (4) $\frac{\pi^2}{2\mu_0} f\sigma d$

**11.** Two short bar magnets of magnetic moments 'M' each are arranged at the opposite corners of a square of side 'd', such that their centres coincide with the corners and their axes are parallel to one side of the square. If the like poles are in the same direction, the magnetic induction at any of the other corners of the square is :-

(1) $\frac{\mu_0}{4\pi}\frac{M}{d^3}$ (2) $\frac{\mu_0}{4\pi}\frac{2M}{d^3}$ (3) $\frac{\mu_0}{2\pi}\frac{M}{d^3}$ (4) $\frac{\mu_0}{2\pi}\frac{2M}{d^3}$

**12.** A bar magnet of magnetic moment 2 $Am^2$ is free to rotate about a vertical axis passing through its centre. If magnet is released from rest in east west position, then kinetic energy of magnet as it takes north-south position is (horizontal component of earth's magnetic field is 25 μT):-

(1) 125 μJ (2) 200 μJ (3) 25 μJ (4) 50 μJ

**13.** At a place horizontal and vertical components of earth's magnetic field are as follows

$B_H$ = 1 G 10º west of north

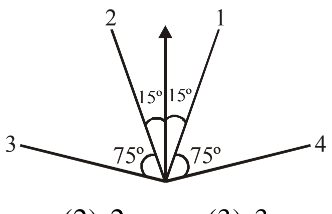
$B_V$ = 1 G vertically downward

Then dip angle and declination are respectively :-

(1) 0º, 10º W (2) 45º, 10º E

(3) 45º, 10º W (4) 10º W, 45º

**14.** If declination at a place is known to be 15º E. and a compass needle points as shown, then geographic north is represented by the direction numbered :-




(1) 1 (2) 2 (3) 3 (4) 4

**15.** A magnetising field of 1600 $Am^{-1}$ produces a magnetic flux $2.4 \times 10^{-5}$ weber in an iron bar of cross-sectional area 0.2 $cm^2$. The susceptibility of the iron bar will be :-

(1) 1788 (2) 1192 (3) 596 (4) 298

**16.** Magnetostatic screening or shielding can be created by :-

(1) Super conductor (2) Soft iron ring

(3) Both (1) & (2) (4) Neither (1) nor (2)

**17.** The angle of dip on a given meridian, making an angle 30° with the magnetic meridian is equal to 30°. The true angle of dip at the given point is :-

(1) $\tan^{-1}\left(\frac{1}{2}\right)$ (2) $\tan^{-1}(2)$

(3) $\tan^{-1}(\sqrt{2})$ (4) $\tan^{-1}\left(\frac{1}{\sqrt{2}}\right)$

**18.** If angle of dip on two perpendicular meridians are 30° and 45°, then the true angle of dip is (none of the given meridians coincide with magnetic meridian)

(1) $\tan^{-1}\frac{1}{2}$ (2) $\tan^{-1}2$

(3) $\tan^{-1}\sqrt{2}$ (4) $\tan^{-1}\frac{1}{\sqrt{2}}$

**ANSWER KEY**

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ans | 1 | 4 | 2 | 3 | 1 | 2 | 3 | 3 | 2 | 1 | 1 | 4 | 3 | 2 | 3 |
| Que. | 16 | 17 | 18 | | | | | | | | | | | | |
| Ans | 3 | 1 | 1 | | | | | | | | | | | | |

## Magnetic effect of current and Magnetism : RACE # 01 — SOLUTION

**1.** $B = \frac{\mu_0 I}{2R}\left(\frac{\theta}{2\pi}\right)\left[1-\frac{1}{2}+\frac{1}{3}\right] = \frac{5}{6}\frac{\mu_0 I}{4\pi}\left(\frac{\theta}{R}\right)$

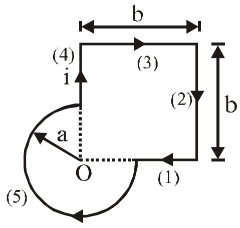
**2.** B due to straight wire portion = $2\times\frac{\mu_0 I}{4\pi R}\left(-\hat{j}\right)$

B due to semicircle = $\frac{\mu_0 I}{4R}\left(-\hat{k}\right)$

$B_{Net} = \frac{\mu_0 I}{4R}\sqrt{\frac{4}{\pi^2}+1} = \frac{\mu_0 I}{4\pi R}\sqrt{\pi^2+4}$

**3.** $B_1 = B_4 = 0$

$B_2 = B_3 = \frac{\mu_0 i}{4\pi b}\sin 45°\otimes$



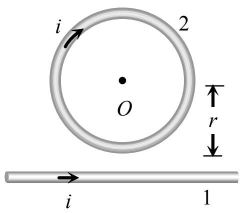

& $B_5 = \frac{\mu_0 i}{2a}\left[\frac{3}{4}\right]\otimes$

$B_{net} = B_2 + B_3 + B_5$

so $B_{Net} = \frac{\mu_0 i}{2\sqrt{2}\pi b} + \frac{3\mu_0 i}{8a}\otimes$

**4.** The given shape is equivalent to the following diagram

The field at $O$ due to straight part of conductor is $B_1 = \frac{\mu_0 I}{2\pi r}\odot$. The field at $O$ due to circular coil is $B_2 = \frac{\mu_0 I}{2r}\otimes$. $\qquad B_2 > B_1$




*i.e.* $B = B_2 - B_1 = \frac{\mu_0 I}{2\pi r}(\pi-1)$

**5.** $B = \frac{\mu_0 I}{2\pi r} \Rightarrow \frac{B_1}{B_2} = \frac{r_2}{r_1} \Rightarrow \frac{10^{-8}}{B_2} = \frac{12}{4}$

$\Rightarrow B_2 = 3.33\times10^{-9}\ Tesla$

**6.** Two coils carrying current in opposite direction, hence net magnetic field at centre will be difference of the two fields.

*i.e.*

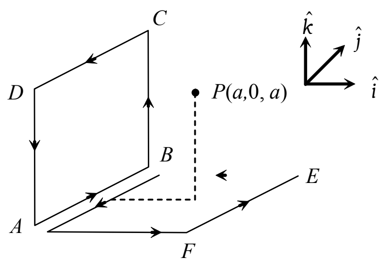
$$B_{net} = \frac{\mu_0 N}{2}\left[\frac{i_1}{r_1}-\frac{i_2}{r_2}\right] = \frac{10\mu_0}{2}\left[\frac{0.2}{0.2}-\frac{0.3}{0.4}\right] = \frac{5}{4}\mu_0$$

**7.** Magnetic field at the centre of a circuit loop will be zero, if wire is uniform.

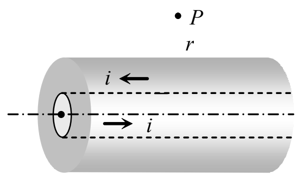
**8.** The magnetic field at $P(a, 0, a)$ due to the loop is equal to the vector sum of the magnetic fields produced by loops *ABCDA* and *AFEBA* as shown in the figure.

Magnetic field due to loop *ABCDA* will be along $\hat{i}$ and due to loop *AFEBA*, along $\hat{k}$. Magnitude of magnetic field due to both the loops will be equal.

Therefore, direction of resultant magnetic field at *P* will be $\frac{1}{\sqrt{2}}(\hat{i}+\hat{k})$.



**1.** The respective figure is shown below Magnetic field at *P* due to inner and outer conductors are equal and opposite. Hence net magnetic field at P will be zero.




**2.** The magnetic field in the solenoid along its axis

(i) At an internal point $= \mu_o ni$

$$= 4\pi \times 10^{-7} \times 5000 \times 4 = 25.1 \times 10^{-3} Wb/m^2$$

(Here $n = 50\ turns/cm = 5000\ turns/m$)

(ii) At one end

$$B_{end} = \frac{1}{2}B_{in} = \frac{\mu_0 ni}{2} = \frac{25.1\times10^{-3}}{2} = 12.6\times10^{-3} Wb/m^2$$

**3.** $B = \frac{\mu_0\mu_r Ni}{2\pi r} \Rightarrow 1 = \frac{4\pi\times10^{-7}\times\mu_r\times400\times2}{0.4}$

$\Rightarrow \mu_r \simeq 400$(appx.)

**4.** By using $B = \frac{\mu_0 i}{2\pi r}\left(\frac{r^2-a^2}{b^2-a^2}\right)$

here $r = \frac{3R}{2}$, $a = R$, $b = 2R$

$$\Rightarrow B = \frac{\mu_0 i}{2\pi\left(\frac{3R}{2}\right)} \times \left\{\frac{\left(\frac{3R}{2}\right)^2 - R^2}{(2R)^2 - R^2}\right\} = \frac{5.\mu_o i}{36\pi R}.$$

**1.** $r=\frac{\sqrt{2mK}}{qB}$ i.e. $r \propto \frac{\sqrt{m}}{q}$

Here kinetic energy $K$ and $B$ are same.

$\therefore \frac{r_p}{r_\alpha}=\frac{\sqrt{m_p}}{\sqrt{m_\alpha}}\cdot\frac{q_\alpha}{q_p}=\frac{\sqrt{m_p}}{\sqrt{4m_p}}\cdot\frac{2q_p}{q_p}=1$

**2.** $r \propto \frac{1}{B}$ i.e. $\frac{r_1}{r_2}=\frac{B_2}{B_1} \Rightarrow r_2=\frac{B_1}{B_1/2}\times r=2r$

**3.** Time period of proton $T_p=\frac{25}{5}=5\mu\,\text{sec}$

By using

$T=\frac{2\pi m}{qB} \Rightarrow \frac{T_\alpha}{T_p}=\frac{m_\alpha}{m_p}\times\frac{q_p}{q_\alpha}=\frac{4m_p}{m_p}\times\frac{q_p}{2q_p}$

$\Rightarrow T_\alpha=2T_p=10\mu$ sec.

**4.** $F=qvB\sin\theta \Rightarrow B=\frac{F}{qv\sin\theta}$

$B_{min}=\frac{F}{qv}$ (when $\theta$ = 90°)

$\therefore B_{min}=\frac{F}{qv}=\frac{10^{-10}}{10^{-12}\times 10^5}=10^{-3}$ *Tesla* in $\hat{z}$ - direction.

**5.** Using $eE = evB$

$\Rightarrow E=vB=5\times10^6\times0.02=10^5\,Vm^{-1}$

**6.** $r=\frac{mv}{qB} \Rightarrow \frac{r_1}{r_2}=\frac{m_1v_1}{m_2v_2}\times\frac{q_2}{q_1}=\frac{1\times2}{1\times3}\times\frac{2}{1}=\frac{4}{3}$

**7.** $F=Bil\sin\theta$

$=500\times10^{-4}\times3\times(40\times10^{-2})\times\frac{1}{2}=3\times10^{-2}N$

**8.** For no force on wire C, force on wire C due to wire D= force on wire C due to wire B

$\Rightarrow \frac{\mu_0}{4\pi}\times\frac{2\times15\times5}{x}\times l=\frac{\mu_0}{4\pi}\times\frac{2\times5\times10}{(15-x)}\times l \Rightarrow x=9cm.$

**9.** $\vec{F}_{CAD}=\vec{F}_{CD}=\vec{F}_{CED}$

$\therefore$ Net force on frame $=3\vec{F}_{CD}$

$=(3)(2)(1)(4)$ $(F = ilB)$

$= 24\ N$

**10.** Magnetic force will be towards or away from the centre depending upon the nature of charge and direction of magnetic field [$\otimes$ B or $\odot$ B]

**11.** $F \propto v$ & $v \propto \sqrt{V_{acc}}$

so $\frac{F_1}{F_2}=\frac{\sqrt{V}}{\sqrt{2V}}=\frac{1}{\sqrt{2}}$ so $F_2=\sqrt{2}\,F_1=\sqrt{2}F$

**12.** $T^1=\frac{T}{4}=\frac{1}{4}\left(\frac{2\pi m}{qB}\right)$

$T^1=\frac{\pi}{2}\times\frac{1.65\times10^{-27}}{1.6\times10^{-19}\times100\times10^{-3}}=1.62\times10^{-7}$

**13.** Here $\vec{F}_{net}=\vec{0} \Rightarrow q\vec{E}+q(\vec{v}\times\vec{B})=0$

$\Rightarrow \vec{E}=\vec{B}\times\vec{v}$

Therefore $\vec{E}\perp\vec{B}$ and $\vec{E}\perp\vec{v}$ .

**14.** Energy in cyclotron $E=\frac{q^2B^2r^2}{2m}$

so $E \propto \frac{q^2}{2m} \Rightarrow \frac{E_1}{E_2}=\left(\frac{q_1}{q_2}\right)^2\left(\frac{m_2}{m_1}\right)$

For proton & deutron $q_1 = q_2 = e$, $m_1$ = 1 amu, $m_2$=2 amu so $\frac{E_1}{E_2}=\frac{2}{1} \Rightarrow E_1=2E_2=80$ MeV

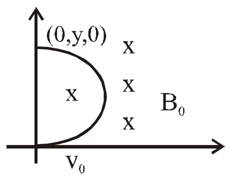
**15.** For the charge particle not to hit the wall

d = R

$\Rightarrow d=\frac{mv}{qB} \Rightarrow B=\frac{mv}{qd}=\frac{v}{\frac{q}{m}d}$

so $B=\frac{v}{sd}$

**16.** From the diagram




$y = 2R$

$y=\frac{2mv}{qB_0}$

or $y=\frac{2v_0}{\alpha B_0}$

**17.** If d > R then the particle will deviate by 180° After covering semicircle

**18.** given $v < \frac{qB\ell}{m}$

$\frac{mv}{qB} < \ell$ so $R < \ell$

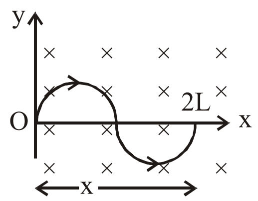
so The particle will not enter in region III

**19.** Tension generated in circular loop T = IBR

**20.** $|\vec{L}| = 2L$

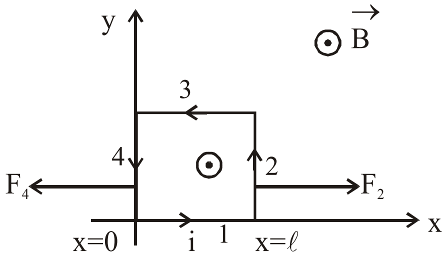
so $F = iB\,|\vec{L}|$

$F = 2iBL$




**21.** For wire 1 & 3

B is same & current is in opposite direction so forces will cancel each other



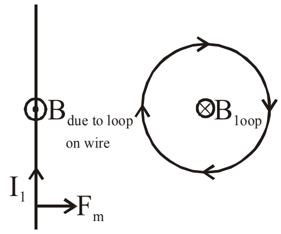

$F_{Net} = F_2 - F_4$ & $\vec{F}_1 + \vec{F}_3 = \vec{O}$

$F_{Net} = i\ B_0\ (1 + \frac{\ell}{\ell})\ \ell - i\ B_0\ (1+\frac{0}{\ell})\ell$

$F_{Net} = 2iB_0\ell - iB_0\ell$

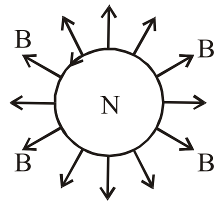
$F_{Net} = iB_0\ell$ in +x direction

**23.**




**25.** Force will be into the plane &

$F = iB \oint d\ell = iB\ (2\pi a).\ \otimes$



## Magnetic effect of current and Magnetism : RACE # 04 SOLUTION

**1.** Field at a point $x$ from the centre of a current carrying loop on the axis is

$$B=\frac{\mu_0}{4\pi}.\frac{2M}{x^3}=\frac{10^{-7}\times 2\times 2.1\times 10^{-25}}{(10^{-10})^3}$$

$$=4.2\times 10^{-32}\times 10^{30}=4.2\times 10^{-2}W/m^2$$

**2.** $B=\frac{\mu_0}{4\pi}.\frac{2\pi i}{r}\Rightarrow 12.56=10^{-7}\times\frac{2\pi\times i}{5.2\times 10^{-11}}$

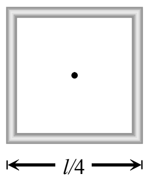
$\Rightarrow i=1.04\times 10^{-3}A$

**3.** $\frac{\mu_0 I}{2\pi r}=B_H$

$\therefore i=\frac{7\times 0.05\times 10^{-5}}{2\times 3.142\times 10^{-7}}=\frac{35}{2\times 3.142}=5.6$ *amp*

**4.** Suppose length of each wire *is l*.

$A_{square}=\left(\frac{l}{4}\right)^2=\frac{l^2}{16}$

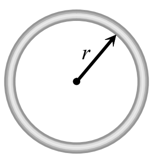



$A_{cirde}=\pi r^2=\pi\left(\frac{l}{2\pi}\right)^2=\frac{l^2}{4\pi}$

$\because$ Magnetic moment

$M=iA$

$\Rightarrow\frac{M_{square}}{M_{cirde}}=\frac{A_{square}}{A_{cirde}}$




$=\frac{l^2/16}{l^2/4\pi}=\frac{\pi}{4}$

**5.** The magnetic moment of current carrying loop

$M=niA=ni(\pi r^2)$

Hence the work done in rotating it through 180°

$W=MB(1-\cos\theta)=2MB=2(ni\pi r^2)B$

$=2\times(50\times 2\times 3.14\times 16\times 10^{-4})\times 0.1=0.1J$

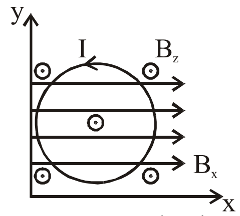
**6.** Sensitivity $=\frac{NAB}{C}$

**7.** $\tau_{max}=NiAB=1\times i\times(\pi r^2)\times B$ $\left(2\pi r=L,\Rightarrow r=\frac{L}{2\pi}\right)$

$\tau_{max}=\pi i\left(\frac{L}{2\pi}\right)^2B=\frac{L^2iB}{4\pi}$

**8.** $U=-MB\cos\theta$ ; where $\theta=$ Angle between normal to the plane of the coil and direction of magnetic field.

**9.**




Net torque on the loop must be Balance so

$i(\pi R^2)B_x=mg R$

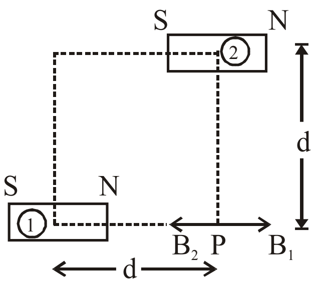
$\Rightarrow i=\frac{mg}{\pi RB_x}$

**10.** $Q=\sigma(2\pi ad)$

$I=Q.f=\sigma(2\pi ad)f$

$B=\frac{\mu_0 I}{2a}=\frac{\mu_0\sigma(2\pi ad)f}{2a}=\mu_0\sigma\pi df$

**11.**




$B_P=B_1-B_2=2\frac{KM}{d^3}-\frac{KM}{d^3}=\frac{KM}{d^3}$

where $K=\frac{\mu_0}{4\pi}$ $\therefore$ $Bp=\frac{\mu_0}{4\pi}\frac{M}{d^3}$

**12.** Apply COME LAW,

$\Delta kE=-\Delta U$

$k_f-k_i=-[U_f-U_i]$

$k_f-0=U_i-U_f$

$k_f=-MB\cos 90°-(-MB\cos 0)=MB$

**13.** For dip angle $\tan\theta=\frac{B_v}{B_H}=\frac{1}{1}$ so $\theta=45°$

& angle of declination = 10°W of N

**14.** Geographic north will be 15° west of the needle

**15.** given

$H = 1600A\ m^{-1}$ , $B_m = \dfrac{\phi}{A}$

$\Rightarrow B_m = \mu_0(H+I)$

$\Rightarrow B_m = \mu_0 H(1+\chi)$

$$\chi = \frac{B_m}{\mu_0 H} - 1 \quad \approx 596$$

**17.** $\tan\theta^1 = \dfrac{\tan\theta}{\cos\alpha}$

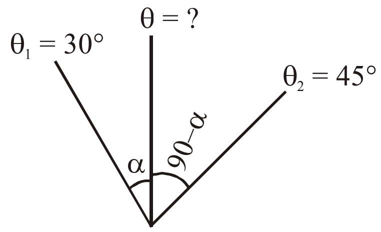
$\tan\theta = \tan\theta^1 \cos\alpha$

$= \tan30^\circ \cos30^\circ$

$$\tan\theta = \frac{1}{\sqrt{3}}\frac{\sqrt{3}}{2}$$

$$\theta = \tan^{-1}\left(\frac{1}{2}\right)$$

**18.**




$$\tan\theta_1 = \frac{\tan\theta}{\cos\alpha} \quad ...(1)$$

$$\tan\theta_2 = \frac{\tan\theta}{\cos(90-\alpha)} = \frac{\tan\theta}{\sin\alpha} \quad ...(2)$$

from equation (1) & (2)

$\cot^2\theta_1 + \cot^2\theta_2 = \cot^2\theta$

$\Rightarrow \cot^2 30 + \cot^2 45 = \cot^2\theta$

$\Rightarrow \cot\theta = 2$

$\Rightarrow \tan\theta = \dfrac{1}{2}$