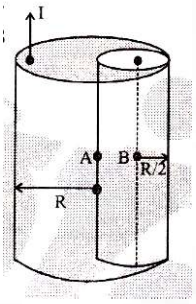
PHYSICS **Max.Marks:80**

SECTION-1
(SINGLE CORRECT CHOICE TYPE)

Section-I (Single Correct Answer Type, Total Marks: 24) contains 8 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONLY ONE is correct. For each question you will be awarded 3 marks if you darken ONLY the bubble corresponding to the correct answer and zero marks if no bubble is darkened. In all other cases, minus one (-1) mark will be awarded.

21. From a long cylinder of radius R, a cylinder of radius R/2 is removed, as shown in figure. Current flowing in the remaining cylinder is I. Magnetic field strength at B is



A) Zero B) $\frac{\mu_0 I}{4\pi R}$ C) $\frac{\mu_0 I}{3\pi R}$ D) $\frac{\mu_0 I}{2\pi R}$

22. The coil of a galvanometer consists of 100 turns and effective area of 1 square cm. The restoring couple per unit twist is $10^{-8} N m /$ radian. The magnetic field between the pole pieces is 5T. The current sensitivity of this galvanometer will be

A) $5\times10^{4}\ rad/\mu A$ B) $5\times10^{6}\ rad/A$ C) $2\times10^{-7}\ rad/A$ D) $5\ rad/\mu A$

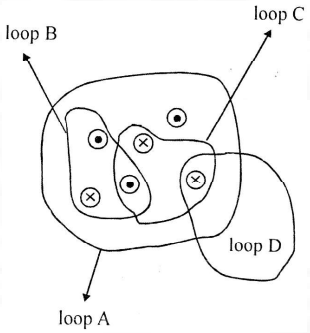
23. A small current element of length $d\ell$ and carrying current is placed at $(1,1,0)$ and is carrying a steady current in '$+z$' direction. If magnetic field at origin be $\vec{B}_1$ and at point $(2,2,0)$ be $\vec{B}_2$ then

A) $\vec{B}_1 = \vec{B}_2$ B) $|\vec{B}_1| = |2\vec{B}_2|$ C) $\vec{B}_1 = -\vec{B}_2$ D) $\vec{B}_1 = -2\vec{B}_2$

24. A long cylindrical wire of radius '*a*' carries a current *i* distributed uniformly over its cross section. If the magnetic fields at distances $r < a$ and $R > a$ from the axis have equal magnitude, then

A) $a = \frac{R+r}{2}$ B) $a = \sqrt{Rr}$ C) $a = Rr/R + r$ D) $a = R^2/r$

25. Consider six wires into or out of the page, all with the same current. Rank the line integral of the magnetic field (from most positive to most negative) taken counter clock wise around each loop shown as positive in accordance with right hand screw rule.

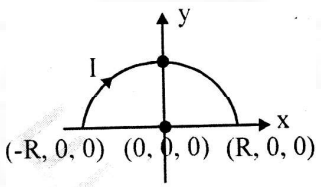


A) B>C>D>A B) B>C=D>A C) B>A>C=D D) B>C=D>A

26. A disk of radius R rotates with constant angular velocity ω about its own axis surface charge density of this disc varies as $\sigma = \alpha r^2$ where 'r' is the distance from centre of disc. Determine the magnetic field intensity at the centre of disc?

A) $\mu_0 \alpha \omega R^3$ B) $\frac{\mu_0 \alpha \omega R^3}{6}$ C) $\frac{2\mu_0 \alpha \omega R^3}{81}$ D) Zero

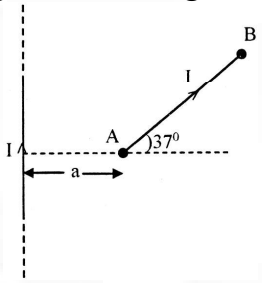
27. A semi-circular current carrying wire having radius R is placed in x-y plane with its centre at origin O. There is a position dependent non-uniform magnetic field $\vec{B} = \frac{B_0 x}{2R}\hat{k}$ (here B_0 is positive constant) existing in the region. The force due to magnetic field acting on the semi-circular wire will be along



A) negative x-axis B) positive x-axis

C) negative y-axis D) positive y-axis

28. A current carrying wire AB of length 2a is placed near to an infinite long current carrying wire as shown in figure. The magnetic force experienced by wire AB is

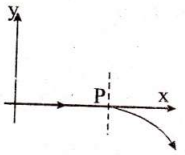


A) $\frac{\mu_0 I^2}{8\pi} l\text{n}\frac{8}{5}$ B) $\frac{5\mu_0 I^2}{8\pi} l\text{n}3$ C) $\frac{5\mu_0 I^2}{8\pi} l\text{n}\left(\frac{13}{5}\right)$ D) $\frac{\mu_0 I^2}{8\pi} l\text{n}\left(\frac{13}{5}\right)$

SECTION-2
(MORE THAN ONE TYPE)

Section - II (Multiple Correct Answers Type, Total Marks: 16) contains 4 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE or MORE may be correct. For each question you will be awarded 4 marks if you darken ALL the bubble(s) corresponding to the correct answer(s) ONLY and zero marks otherwise. There are no negative marks in this section.

29. 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) $\vec{E}=0;\vec{B}=b\hat{i}+c\hat{k}$ 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) $\vec{E}=a\hat{i}+d\hat{k}\ ;\ \vec{B}=c\hat{k}+b\hat{j}$

30. An electron of mass m is released from the origin at a place where a uniform electric field $\vec{E}$ and uniform magnetic field $\vec{B}$ exist along the negative y-axis and the negative z-axis respectively.

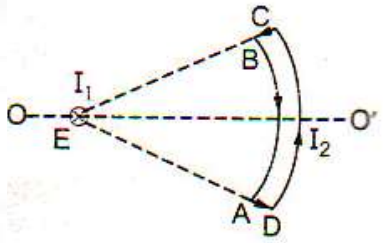
A) At time t the y-component of velocity of the electron becomes $u_y = \frac{E}{B}\sin\omega t$ where $\omega = \frac{eB}{m}$

B) At $t = \frac{\pi m}{eB}$ the electron will have only x-component of velocity

C) At $t = \frac{2\pi m}{3eB}$, the y-component of velocity becomes zero

D) The displacement along y-axis is $\frac{2Em}{eB^2}$ when the velocity of electron becomes perpendicular to the y axis

31. Which of the following statements is correct in the given figure ?



Infinitely long wire at E kept perpendicular to paper carrying current inwards:

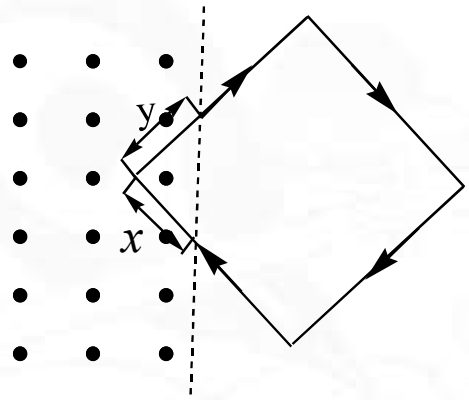
A) net force on loop is zero

B) net torque on loop is zero

C) loop will start rotating clockwise about axis OO' when seen from O

D) loop will start rotating anticlockwise about OO' when seen from O

32. On a frictionless table-top, a rigid square loop of side length l carrying an electric current is placed. A magnetic field is set as shown and then the loop is released. Considering the different lengths of the side segments x and y (x<y) shown in the figure, which of the following conclusions can be made? (plane of the loop lies on the plane of the table)



A) If $x < \frac{l}{2}$ *and* $y = \frac{l}{2}$, the loop starts rotating anticlockwise

B) If $x < \frac{l}{2}$ *and* $y < \frac{l}{2}$, the loop starts rotating anti-clockwise

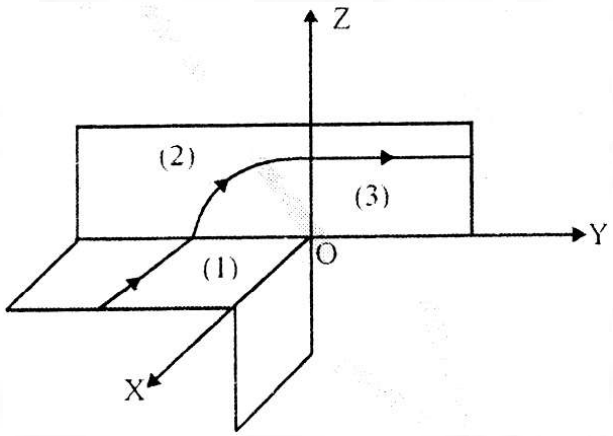
C) If $x < \frac{l}{2}$ *and* $y > \frac{l}{2}$, the loop starts rotating clockwise

D) If $x < \frac{l}{2}$ *and* $y > \frac{l}{2}$, the loop starts rotating in counter clock wise direction

SECTION-3
[INTEGER TYPE]

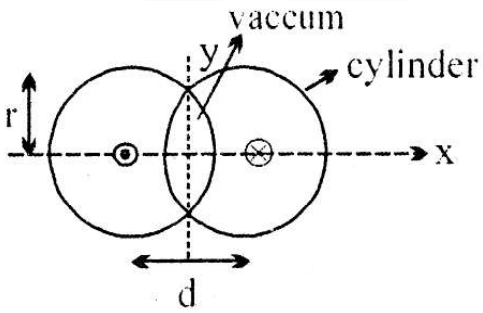
Section-III (Integer Answer Type, Total Marks: 24) contains 6 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The bubble corresponding to the correct answer is to be darkened in the ORS. For each question you will be awarded 4 marks if you darken ONLY the bubble corresponding to the correct answer and zero marks otherwise. There are no negative marks in this section.

33. Let B be the magnitude of magnetic field in SI units at O of the reference frame if the wire carrying current i = 10A has the shape shown. The radius of curved part is $R = 10\,cm$, the linear parts of the wire are very long. If the value of $10\left(B \times 10^5 - 2\right)$ is nearly $x + 0.6$, find the value of x.



34. Two long cylinders (with their axes parallel) are arranged as shown to form overlapping cylinders, each of radius r, whose centers are separated by a distance d. Current of uniform density J (Current per unit area) flows into the plane of page along the right shaded part of one cylinder and an equal current flows out of the plane of the page along the left shaded part of the other, as shown. Find the magnitude of magnetic field (in Tesla) at point O (O is the origin of shown x-y axes)

Given : $J = \frac{10^7}{\pi} A/m^2, d = 2m$

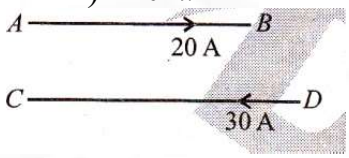


35. A large number N of closely spaced turns of fine wire are wound in a single layer upon the surface of wooden sphere of radius R with the planes of the turns perpendicular to the axis of the sphere and completely covering its surface. The magnetic field intensity at the center of the sphere is $\alpha \times \frac{\mu_0 NI}{8R}$. Determine the value of α?

36. A uniformly charged ring of radius 0.1m rotates at a frequency of 10^4 rps about its axis. The ratio of energy density of electric field to the energy density of the magnetic field at a point on the axis at distance 0.2m from the centre is in form $X\times10^9$. Find the value of X. (Use speed of light $c=3\times10^8\ m/s, \pi^2=10$)

37. The current density $\vec{J}$ inside a long, solid cylindrical wire of radius a = 12 mm is in the direction of the central axis, and its magnitude varies linearly with radial distance r from the axis according to $J=\frac{J_0 r}{a}$ where $J_0=\frac{10^5}{4\pi}\ A/m^2$. The magnitude of the magnetic field at $r=\frac{a}{2}$ in μT is $2x$. find x

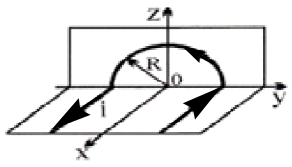
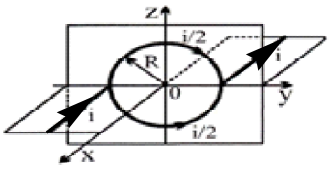
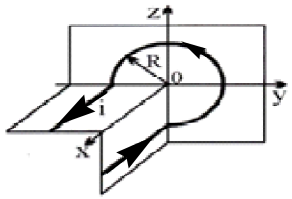
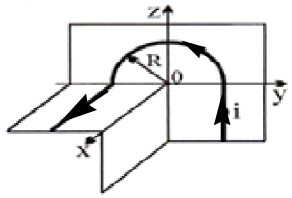
38. A long horizontal wire AB, which is free to move in a vertical plane and carries a steady current of 20A, is in equilibrium at a height of 0.01 m over another parallel long wire CD which is fixed in a horizontal plane and carries a steady current of 30A, as shown in figure. When AB is slightly depressed, then the period of oscillations (in second) is $0.1x$. Find the value of x



SECTION-4
[Matrix Matching Type]

Section-IV (Matrix-Match Type, Total Marks: 16) contains 2 questions. Each question has four statements (A, B, C and D) given in Column I and five statements (p, q, r, s and t) in Column II. Any given statement in Column I can have correct matching with ONE or MORE statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given in q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS. For each question you will be awarded 2 marks for each row in which you have darkened ALL the bubble(s) corresponding to the correct answer(s) ONLY and zero marks otherwise. Thus, each question in this section carries a maximum of 8 marks. There are no negative marks in this section.

39. Column-I shows four current configurations. Match each entry of Column-I with those axes in Column-II along which the magnetic field at origin has positive component.

Column I	Column II [+ve component (>0) of magnetic field at origin]
(A) 	(P) x
(B) 	(Q) y
(C) 	(R) z
(D) 	(S) none

40. Match the following. Consider non-relativistic analysis.

COLUMN-I	COLUMN-II
A) Magnetic force	P) Cannot perform non-zero work
B) Electrostatic force	Q) Depends on motion of the charges involved
C) Ampere force	R) Can perform non-zero work
D) Loentz force	S) Independent of motion of the charge