CLASS TEST

PHYSICS CLASS TEST # 46

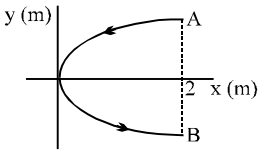
SECTION-I

Single Correct Answer Type **7 Q. [3 M (–1)]**

1. Two long concentric cylindrical conductors of radii a & b (b < a) are maintained at a potential difference V & carry equal & opposite currents I. An electron with a particular velocity "U" parallel to the axis will travel undeviated in the evacuated region between the conductors. Then U =

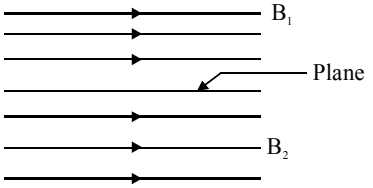
(A) $\frac{4\pi V}{\mu_0 I \ell n\left(\frac{b}{a}\right)}$ (B) $\frac{2\pi V}{\mu_0 I \ell n\left(\frac{a}{b}\right)}$ (C) $\frac{2\pi V}{\mu_0 I \ell n\left(\frac{b}{a}\right)}$ (D) $\frac{8\pi V}{\mu_0 I \ell n\left(\frac{a}{b}\right)}$

2. A conducting wire bent in the form of a parabola $y^2 = 2x$ carries a current i = 2 A as shown in figure. This wire is placed in a uniform magnetic field $\vec{B} = -4\hat{k}$ Tesla. The magnetic force on the wire is (in newton)



(A) $-16\hat{i}$ (B) $32\hat{i}$ (C) $-32\hat{i}$ (D) $16\hat{i}$

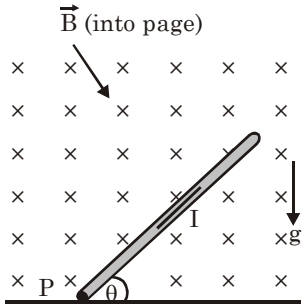
3. Two uniform magnetic fields B_1 and B_2 exist above and below the plane. The magnetic force acting on unit area of the plane is :-



(A) $\frac{B_2^2 - B_1^2}{2\mu_0} \uparrow$ (B) $\frac{|B_1 - B_2|^2}{2\mu_0} \downarrow$

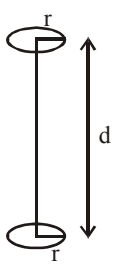
(C) $\frac{\left|\frac{B_1 + B_2}{2}\right|^2}{2\mu_0} \uparrow$ (D) None of the above

4. The drawing shows a thin, uniform rod that has a length of 0.45 m and a mass of 0.09 kg. This rod lies in the plane of the paper and is attached to the floor by a hinge at point P. A uniform magnetic field of 0.36 T is directed perpendicularly into the plane of the paper. There is a current I = 4.0 A in the rod, and rod does not rotate clockwise or counterclockwise. Find the angle θ.



(A) $\cos^{-1}(0.36)$ (B) $\cos^{-1}(0.72)$ (C) $\cos^{-1}(0.46)$ (D) $\cos^{-1}(2/3)$

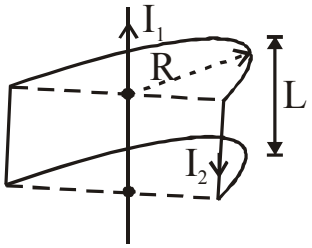
5. Two current carrying coil having radius 'r' are separated by distance 'd' as shown in diagram. If r << d. Then find the force between two ring. Current in both the ring is clockwise and equal to i.



(A) $\frac{6\mu_0}{4\pi}\frac{i^2\pi^2r^4}{d^4}$ (B) $\frac{\mu_0}{4\pi}\frac{i^2\pi^2r^4}{d^4}$

(C) $\frac{3\mu_0}{4\pi}\frac{i^2\pi^2r^4}{d^4}$ (D) $\frac{\mu_0}{2\pi}\frac{i^2\pi^2r^4}{d^4}$

6. An infinitely long straight wire carring a current I_1 is partially surrounded by a loop, as shown in figure. The loop has a length L and radius R, current I_2.The axis of loop coincider with the wire. Find force between two system



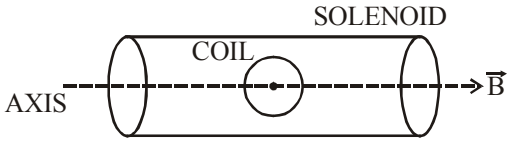
(A) zero

B) $\frac{\mu_0 I_1 II_2 L}{2\pi R}$

(C) $\frac{\mu_0 I_1 I_2 L}{\pi R}$

(D) $\frac{\mu_0 I_1 I_2 L}{R}$

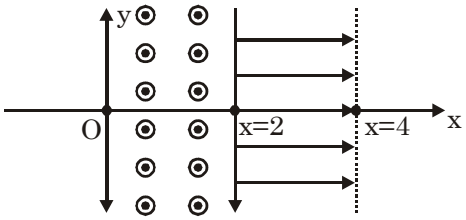
7. The torque required to hold a small circular coil of 10 turns, area 1 mm^2 and carrying a current of $\left(\frac{21}{44}\right)$A in the middle of a long solenoid of 10^3 turns/m carrying a current of 2.5A, with its axis perpendicular to the axis of the solenoid is



(A) 1.5×10^{-6} N-m (B) 1.5×10^{-8} N-m (C) $1.5 \times 10^{+6}$ N-m (D) $1.5 \times 10^{+8}$ N-m

Multiple Correct Answer Type 5 Q. [4 M (–1)]

8. There exist uniform magnetic field $\vec{B} = 5T\left(\hat{k}\right)$ from x = 0 to x = 2m. From x = 2m to x = 4m a uniform electric field $\vec{E} = 50N/C\left(\hat{i}\right)$. A point charge (q = 2C, m = 1kg) is projected from origin with velocity $\vec{V} = 20m/s\left(\hat{j}\right)$. Which of the following is/are correct :



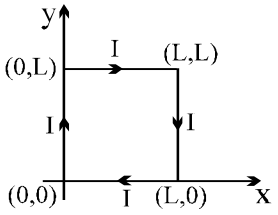
(A) Time spend by the charge particle in magnetic field is $\frac{\pi}{20}$s

(B) Time spend by the charge particle in electric field is $\frac{1}{5}$s

(C) Charge particle will leave the electric field with speed $20\sqrt{2}$ m/s

(D) Charge particle will leave the electric field with velocity $20\hat{i} + 20\hat{j}$

9. Figure shows a square loop carrying current I is present in the magnetic field which is given by $\vec{B} = \frac{B_0 z}{L}\hat{j} + \frac{B_0 y}{L}\hat{k}$ where B_0 is positive constant. Which of the following statement(s) is/are **correct**?



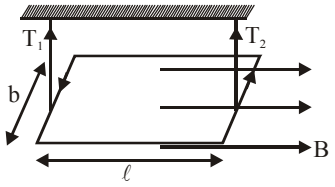
(A) force on side (0,0) to (0,L) is $\left(\frac{B_0 IL}{2}\right)\hat{i}$.

(B) force on side (0,L) to (L,L) is $-B_0 IL\,\hat{j}$.

(C) Net magnetic force on loop is zero.

(D) force on side (L,0) to (0,0) is zero.

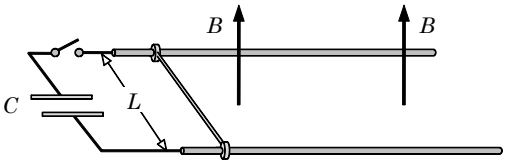
10. A uniform conducting rectangular loop of sides ℓ, b and mass m carrying current i is hanging horizontally with the help of two vertical strings. There exists a uniform horizontal magnetic field B which is parallel to the longer side of loop. Choose the **CORRECT** option(s) :-



(A) The value of $T_1 = T_2 = \dfrac{mg}{2}$ (B) The value of $T_1 = \dfrac{mg - 2ibB}{2}$

(C) The value of $T_2 = \dfrac{mg + 2ibB}{2}$ (D) The value of T_1 < value of T_2

11. In a region of space, where a uniform vertical magnetic field of induction *B* exists, a light rod of length *L* and mass *m* rigidly connected between two sleeves can slide on two horizontally fixed very long parallel conducting rails. A capacitor of capacitance *C* charged to voltage V_0 is connected through a switch to the rails as shown. Initially the switch is open and the rod is at rest. Now the switch is closed. Assume the rails to be long enough and ignoring electrical resistance and frictional forces. Which of the following conclusion can you make?



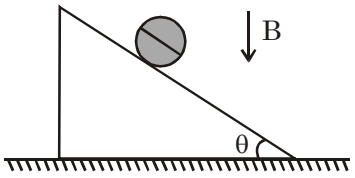
(A) The steady-state speed acquired by the rod is $\dfrac{BlCV_0}{m + CB^2L^2}$.

(B) Efficiency of conversion of electrical energy of the capacitor into mechanical energy is $\dfrac{CB^2L^2}{m + 2CB^2L^2}$.

(C) Heat released in the resistance of the jumper is $\dfrac{1}{2}CV_0^2\left(\dfrac{m}{m + CB^2L^2}\right)$.

(D) None of the above is correct.

12. In the figure shown a coil of single turn is wound on a sphere of radius R and mass M. The plane of the coil is parallel to the inclined plane and lies in the equatorial plane of the sphere. Current in the coil is i. The sphere is in equilibrium.



(A) The value of B is $\dfrac{mg\tan\theta}{\pi iR}$

(B) The current in coil is clockwise as seen from top.

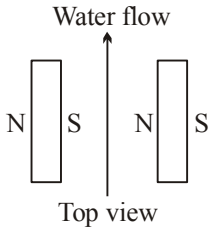
(C) Minimum friction coefficient required is tan θ.

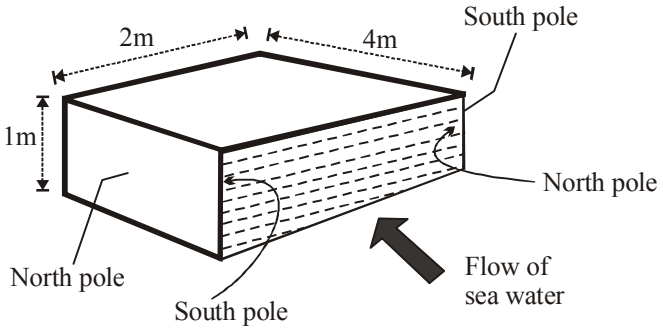
(D) If the surface is smooth, sphere will slide down without rotation.

Linked Comprehension Type (1 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

Paragraph for question nos. 13 to 15

The dead-quiet "caterpillar drive" for submarines in the movie "The Hunt for Red October" is based on a magnetohydrodynamic (MHD) drive ; as the submarines moves forward, seawater flows through multiple channels in a structure built around the rear of the hull. Figure shows the essentials of a channel. Magnets, positioned along opposite sides of the channel with opposite poles facing each other, create a magnetic field within the channel. Electrodes (not shown) create an electric field across the channel. The electric field derives a current across the channel and through the water ; the magnetic force on the current propels the water toward the rear of the channel, thus propelling the submarines forward.





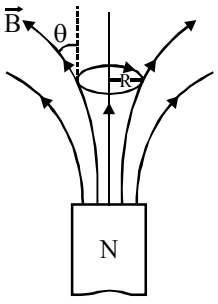
13. In figure what should be the direction of electric field ?
(A) upward (B) downward (C) left ward (D) rightward

14. If the value of magnetic field is 100T and current flowing is 50 A what is the force with which the water is pushed out through this channel?
(A) 500 N (B) 5000N (C) 10000N (D) 20000N

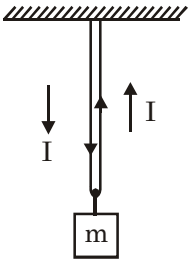
15. What should be the value of electric field to achieve the 50 A current given that resistivity of sea water is 8Ω-m.
(A) 25 V/m (B) 50 V/m (C) 100 V/m (D) 200 V/m

SECTION-III
Numerical Grid Type (Ranging from 0 to 9) 3 Q. [4 M (0)]

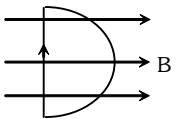
1. A superconducting current carrying ring of mass m = 40 gm and R = 2cm floats in the magnetic field of a magnet. If the field lines make an angle $\theta = 30°$ with vertical and the ring is placed co-axially, assuming i = 10A, find the magnetic field $\vec{B}$. if answer is $\frac{n}{3\pi}$. Write the value of n.



2. Consider a loop of freely deformable conducting wire with insulation of length 2ℓ, the two ends of which are fixed (permanently) to the ceiling. A load of mass 'm' is fixed to the middle of the wire (the mass of the wire in negligible). There is also a outward magnetic field of induction B; free fall acceleration is g. A current I is flowing through the wire which starts increasing slowly to value I_0. How large current I_0 is needed to lift the load by $\Delta h_0 = \ell\left(1-\frac{3}{\pi}\right)$. $m = \frac{3\sqrt{3}}{\pi}$ kg , ℓ = 2m, B = 1 tesla.



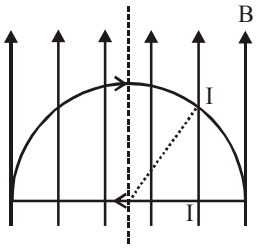
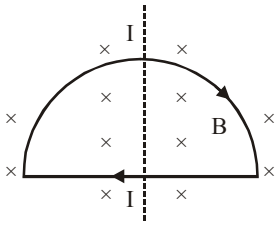
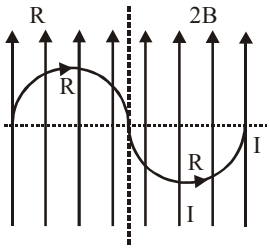
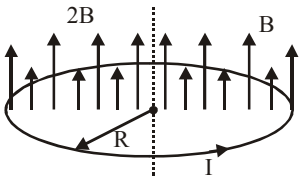
3. A semicircular loop of mass per unit length $\frac{\pi}{10}$ kg/m is placed on a surface with its plane parallel to the surface in a uniform magnetic field of magnitude 1 Tesla as shown in figure. Find the minimum amount of current (in A) that should be passed in the loop so that it just start to rotate?



SECTION-IV

Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

1. Find correct match for the figure in column I as shown with the items given in column II :
Match the following column :

Column-I		**Column-II**	
(A)		(P)	$F \neq 0$
(B)		(Q)	$F = 0, \tau \neq 0$
(C)		(R)	$F = 0, \tau = 0$
(D)		(S)	$F \neq 0, \tau = 0$
		(T)	$F \neq 0, \tau \neq 0$

CLASS TEST # 46 **ANSWER KEY**

SECTION-I

Single Correct Answer Type **7 Q. [3 M (–1)]**

1. Ans. (B) **2. Ans. (B)** **3. Ans. (A)** **4. Ans. (B)**

5. Ans. (A) **6. Ans. (C)** **7. Ans. (B)**

Multiple Correct Answer Type **5 Q. [4 M (–1)]**

8. Ans. (A,C) **9. Ans. (A,B,D)** **10. Ans. (B,C,D)** **11. Ans. (A,B,C)**

12. Ans. (B,C)

Linked Comprehension Type **(1 Para × 3Q.) [3 M (-1)]**

(Single Correct Answer Type)

13. Ans. (B) **14. Ans. (B)** **15. Ans. (B)**

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **3 Q. [4 M (0)]**

1. A ns. 6 **2. Ans. 5** **3. Ans. 4**

SECTION-IV

Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

1. Ans. (A) → (Q) ; (B) → (R) ; (C) → (P) ; (D) → (S)