LAKSHYA ADVANCED UNIT TEST (LAUT)

00 – 00		Q. Booklet Serial No: 230815 PAPER I	
Test No : 2211	3 Hrs.		

Hints & Solutions

PART A - PHYSICS

SECTION I - MULTIPLE ANSWER CORRECT TYPE

1. **a) The emf developed in the circuit is 5 volt**
   b) The induced current flow in the circuit is 0.25 ampere
   c) The electric field inside the wire AB is 27.5 V/m

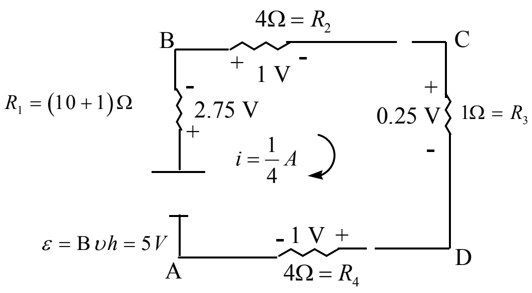
   The circuit may be simplitied as
   Here ε is the motion emf generated only in the arm AB. Whatever potential drop across the resistances is due to the electric field in wire. Hence

   Electric field in AB = $\dfrac{\text{Drop across } R_1}{h}$

   = 27.5 v/m

   Electric field in CD = $\dfrac{\text{Drop across } R_3}{h}$

   2.5 v/m



2. **b)** $\dfrac{2x^2\sqrt{Pr}}{\mu_0\, i_0\, a^2}$

   Power dissipated in the loop is

   $P = \dfrac{e^2}{r}$ ---------(1)

   where e = induced emf in the loop

   $$e = \left|\frac{d\phi}{dt}\right| = S\left|\frac{dB}{dt}\right| = (\pi a^2)\left|\frac{dB}{dt}\right|$$

   here $B(x) = \dfrac{\mu_0}{2\pi}\dfrac{i_0}{x} = B$

   $$\therefore \left(\frac{dB}{dt}\right) = -\frac{\mu_0 i_0}{2\pi x^2}\cdot\frac{dx}{dt} = -\frac{\mu_0 i_0 \upsilon}{2\pi x^2}\left(\frac{dx}{dt} = \upsilon\right)$$

   $$\therefore\ e = \frac{\pi a^2 \mu_0 i_0 \upsilon}{2\pi x^2} \ldots.(2)$$

   From equation (1) and (2)

   $$P = \frac{\pi^2 a^4 \mu_0^2 i_0^2 \upsilon^2}{2\pi x^2} \text{ or } \upsilon = \sqrt{\frac{4Px^4 r}{\mu_0^2 i_0^2 a^4}}$$

   $$\text{or } \upsilon = \frac{2x^2}{\mu_0 i_0 a^2}\sqrt{Pr}$$

3. **a) rate of energy supplied by the battery is 16 J/s**
   b) rate of heat dissipated across resistance is 8 J/s
   d) $V_a - V_b$ = 4V

4. **a) The maximum current in the circuit is $V_0\sqrt{\dfrac{C}{L}}$**
   d) Maximum energy stored in the inductor is $\dfrac{1}{2}CV_0^2$

5. **a) during $0 < t < \dfrac{\pi}{2\omega}$ a clock wise current is induced in the coil.**
   c) during $\dfrac{\pi}{2\omega} < t < \dfrac{\pi}{\omega}$ an anti clock wise current flows through it.

6. **a) If 'E' is switched off, then particle will follow a circular path**

b) If 'B' is switched off, then particle will follow a parabolic path

c) If 'E' is switched off, for a time of $\frac{\pi m}{4qB}$ and then switched on, the path of particle will not be straight line

If only magnetic field is present, the particle will follow a circular path and if only electric field is present, particle will follow a parabolic path.

7. **a) The particle suffers a deivation of 180^0**

b) The particle lies in the field for a time $t = \frac{\pi m}{BQ}$

c) The change of momentum suffered by the particle when it emerges out of the field is 2mv

It describes a semi circle in the field because 1.5 > r.

8. **a) B_4 is maximum**

b) B_3 is minimum

c) $B_4 > B_1 > B_2 > B_3$

For B_1 and B_4 the contributions due to the different sections add up. For B_2 and B_3, the contributions due to the outer sections oppose the contributions due to the inner sections. Thus, B_1 and B_4 are greater than B_2 and B_3.

For B_3 there is a section with radius < d and hence it contributes more than the semicircular section of radius b does for B_2. Thus $B_4 > B_1$.

For B_3 ,there is a section with radius > b and hence it contributes less than the samicircular section of radius b does for B_2. Thus $B_3 < B_2$.

9. **b) Magnetic field at O due to larger coil = B/2**

c) Total magnetic field at O is 3B/2

Use $B = \frac{\mu_0 i R^2}{2\left(R^2 + x^2\right)^{3/2}}$

10. **b) Electrostatic field**

d) Gravitational field

Electrostatic and gravitational fields do not make closed loops

SECTION II - MATRIX MATCH TYPE

1. **A-Q,R B – Q,R C – PR D - PR**

2. A - S ; B - R ; C - P ; D - Q

1) $\frac{\mu_0 i}{2r\pi} + \frac{\mu_0 i}{2r} = \frac{\mu_0 i}{2r}\left(1 + \frac{1}{\pi}\right) \to S$

2) $\frac{\mu_0 i}{4r} \to R$

3) $\frac{3}{4}\frac{\mu_0 i}{2r} - \frac{\mu_0 i}{4r} = \frac{\mu_0 i}{4r}\left[\frac{3}{2} - \frac{1}{\pi}\right] \to P$

4) $\frac{\mu_0 i}{4r} + 2\frac{\mu_0 i}{4\pi r} = \frac{\mu_0 i}{2r}\left[\frac{1}{2} + \frac{1}{\pi}\right] \to Q$

SECTION III - INTEGER TYPE

1. **1**

$|e_s| = N_s \frac{d\phi_s}{dt}$ and $|e_s| = M\frac{di_p}{dt}$;

$\therefore \quad N_s \frac{d\phi_s}{dt} = M\frac{di_p}{dt}$ or $M = N_s \frac{d\phi_s}{di_p} =$

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$\therefore \quad \frac{200\left(2.5\times10^{-4} - 0\right)}{(2-0)} = 2.5\times10^{-2} = 25mH$

2. 8

$q = t^2 - 4$

At t = 3 sec, q is positive

$i = \frac{dq}{dt} = 2t$ and $\frac{di}{dt} = 2$

At t = 3 sec, q = 5C, adn i = 6A

$$V_A - \frac{q}{C} - L\frac{di}{dt} - iR = V_B$$

$$V_A - V_B = \frac{q}{C} + L\frac{di}{dt} + iR = \frac{5}{5}$$

+ (0. 5)(2) + (6)(1) = 8V

3. 5

K = 5

$$B = \frac{u_o}{Y\overline{\Lambda}}\frac{q\,v\sin\theta}{r^2}$$

$$= \frac{10^{-7}\times 2\times 5\times 1/2}{10^2}$$

$= 5 \times 10^{-9}$ T K = 5

4. **3**

Flux of magnetic field at any time t is

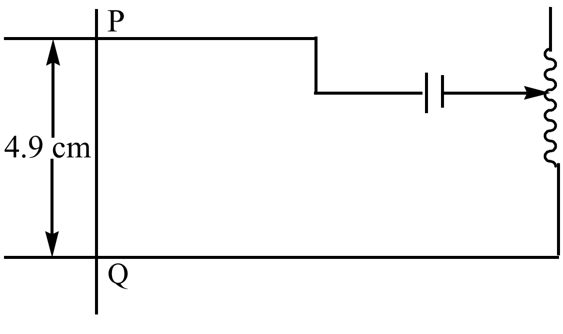
$$\phi = \int_l^{2l} \alpha x t l dt = \frac{3}{2}\alpha t l^3$$

$$\therefore |e| = \frac{3}{2}\alpha l^3$$

$\therefore$ charge on capacitor $= \frac{3}{2}C\alpha l^3$

n = 3

5. **3**



$$F = Bil = 0.8\times\frac{6}{20}\times 4.9\times 10^{-2}$$

$$= \frac{49\times 6\times 8\times 10^{-4}}{20} = \frac{48\times 49}{20}\times 10^{-4}\,N$$

Bil $= \mu mg$

$$\frac{49\times 49}{20}\times 10^{-4} = \mu\times 10\times 10^{-3}\times 9.8$$

$$\mu = \frac{48}{40}\times 10^{-1}$$

$\mu = 0.12$

6. **1**

For cylinder :

$r < R \quad B = \frac{\mu_0 ir}{2\pi R^2} \qquad r \geq R \qquad B = \frac{\mu_0 i}{2\pi r}$

we can consider the given cylinder as a combination of two cylinders. One of madius R carrying current i in one direction and other of radius $\frac{R}{2}$ carrying current $\frac{i}{3}$ in both direction

Field at A : $\left|\vec{B}_A\right| = \frac{\mu_0 i}{3\pi R}$

Field at B : $\left|\vec{B}_B\right| = \frac{\mu_0 i}{3\pi R}$

$\therefore \frac{B_A}{B_B} = 1$ (Ans : 1)

7. **1**

Power P = e^2/R

Here $e = -(d\phi/dt)$ where $(\phi = NBA)$

$\therefore$ E = -NA(dB/dt)

Also $R \propto 1/r^2$

$\therefore P \propto N^2 r^2 / l$

$$\frac{P_2}{P_1} = 1$$

8. **4**

$$\oint \vec{E}.\vec{dl} = \left|\frac{d\phi}{dt}\right|$$

$$E(4L) = L^2\frac{dB}{dt}$$

$$E = \frac{L}{4}(4t) = Lt = (2)(2) = 4V/m$$