WEEKLY TEST MEDICAL PLUS - 03 TEST - 26 RAJPUR SOLUTION Date 09-02-2020

[PHYSICS]

1.
2.
3.

As the electron moves from left to right, the flux linked with the loop (which is into the page) will first increase and then decrease. So, the induced current in the loop will be first anticlockwise and will change direction (*i.e.*, will become clockwise) as the electron passes by.

4.
5.

Laminations reduce energy loss due to eddy currents.

6.
7.

Initial magnetic induction,

$$B_i = 0$$

Final magnetic induction,

$$B_f = 5 \times 10^{-4} \text{ tesla}$$

Area, $A = 1 \text{ m}^2$

Number of turns, $N = 1000$

Initial flux, $\phi_i = NAB_i$

Final flux, $\phi_f = NAB_f$

$$\Delta\phi = \phi_f - \phi_i = NA(B_f - B_i)$$
$$= 1000 \times 1 \times (5 \times 10^{-4} - 0)$$
$$= 0.5 \text{ weber}$$
$$\Delta t = 0.1 \text{ sec}$$

$\therefore$
$$e = -\frac{\Delta\phi}{\Delta t}$$
$$= -\frac{5 \times 10^{-1}}{0.1} = -5 \text{ volt}$$
$$e = 5 \text{ volt (numerically)}.$$

8.

Final current, $I = (E/R)$

or $I = \frac{100}{10} = 10$ ampere.

Energy stored in the magnetic field,

$$U = \frac{1}{2} LI^2$$
$$= \frac{1}{2} \times 5 \times (10)^2 = 250 \text{ J}.$$

9.

$$L = \frac{\mu_0 N^2 \pi r}{2}$$

When the number of turns in a coil is doubled without changing the length of the coil, the radius of the coil is reduced to half. Hence,

$$L' = \frac{\mu_0 (2N)^2 \times \pi (r/2)}{2}$$
$$= 2\left[\frac{\mu_0 N^2 \pi r}{2}\right] = 2L.$$

10.

$$e = \frac{d\phi}{dt} = \frac{dB}{dt} A = A_0 \frac{dB}{dt}$$
$$= A_0 \left[\frac{4B_0 - B_0}{t}\right] = \frac{3A_0 B_0}{t}.$$

11.

Here, the bulb B_1 will die out promptly but B_2 with some delay. The reason is that the branch of bulb B_2 contains inductance. Due to the effect of inductance, the current in this branch continues to flow for some time even when the switch S is turned off.

12.

The induced emf will oppose the motion of the magnet. Applying the right hand rule, the direction of induced current will be clockwise.

13.

We know that, the magnetic flux associated with coil Y is directly proportional to current flowing in X coil.

i.e., $\phi_Y \propto I_X$

Here, ϕ_Y = change in magnetic flux in coil Y,

I_X = change in current in coil X,

M = mutual inductance

or $\phi_Y = MI_X$ ...(i)

Now, given that,

$I_X = 4$ A

$\phi_Y = 0.4$ Wb

14. Let I be the current through coil of radius R_1. If B_1 is the magnetic induction at the centre of the coil, then B_1 is given by:

$$B_1 = \left(\frac{\mu_0}{4\pi}\right)\left(\frac{2\pi N_1 I}{R_1}\right)$$

Magnetic flux linked with the coil of radius R_2 is given by:

$$\phi = B_1 \pi R_2^2 N_2 = \frac{\mu_0}{4\pi}\left(\frac{2\pi N_1 I}{R_1}\right)\pi R_2^2 N_2$$

at $\phi = MI$

$$\therefore \quad M = \left(\frac{\mu_0}{4\pi}\right)\left(\frac{2\pi N_1}{R_1}\right)\pi R_2^2 N_2 = \mu_0 \frac{\pi R_2^2 N_1 N_2}{2R_1}.$$

15.

16. We know from the Faraday's law of electromagnetic induction that an emf and thereby a current is induced in a coil whenever the magnetic flux linked with a circuit changes. Since, the coil remains stationary, there is no change in flux. Therefore, neither emf nor current is induced in the coil.

17. $$|e_s| = N_s \frac{d\phi_s}{dt}$$

and $$|e_s| = M\frac{dI_p}{dt}$$

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

$$\therefore \quad M = N_s \frac{d\phi_s}{dI_p} = \frac{600 \times 9.00 \times 10^{-5}}{3.0} = 1800 \times 10^{-5} = 1.8 \times 10^{-2}\,\text{H}.$$

18. $$\eta = \frac{E_s I_s}{E_p I_p} \times 100\% = \frac{11 \times 90}{220 \times 5} \times 100\% = 90\%.$$

19. $$E = Blv$$

$$I = \frac{E}{r} = \frac{Blv}{R}$$

$$P = I^2 R = \frac{B^2 l^2 v^2}{R}$$

i.e., $P \propto v^2$.

20. If the equilibrium current is I_0, then current at any time in transient state is given as:

$$I = I_0[1 - e^{-t/\tau}]$$

where, $\tau = L/R$

Putting $t = 0, I = 0$

The voltage drop across the inductor is E' that opposes the applied emf E.

$$E' = E \text{ (numerically)}$$

Since, the circuit current is zero, the heat loss that is proportional to I_0^2 will be zero.

21. $$E = \frac{d\phi}{dt}$$

$$\int_{\phi_1}^{\phi_2} d\phi = \Delta\phi = \int E\,dt$$

The total charge flown in the loop

$$q = \int I\,dt$$

or $$q = \int \frac{E}{R}dt = \frac{\Delta\phi}{R} = \frac{B\pi r^2}{R}$$

i.e., $q \propto B$, $q \propto r^2$

and $q \propto \frac{1}{R}$.

22. $$\phi = 10t^2 - 50t + 250$$

Induced emf $= -\frac{d\phi}{dt} = -\frac{d}{dt}(10t^2 - 50t + 250) = -(20t - 50)$

The induced emf at $t = 3$ sec

$$e = -(20 \times 3 - 50) = -(60 - 50) = -10\text{ V}.$$

23.

$$e = -N\frac{d\phi}{dt} = -NA\frac{dB}{dt} = -80 \times \frac{22}{7} \times (0.1)^2\left(\frac{2.0}{0.4}\right)$$

$$I = \frac{e}{R} = 80 \times \frac{22}{7} \times \frac{(0.1)^2 \times 5}{11} = \frac{8}{7}\text{ A}.$$

24.

$$e_{ind} = \frac{1}{2}B\omega l^2 = \frac{1}{2} \times (0.2 \times 10^{-4}) \times 5 \times (1)^2 = 5 \times 10^{-5}\text{ V} = 50\,\mu\text{V}.$$

25.

The charging of inductance is given by:

$$I = I_0[1 - e^{-Rt/L}]$$

$$\therefore \quad \frac{I_0}{2} = I_0[1 - e^{-Rt/L}]$$

or $$e^{-Rt/L} = \frac{1}{2}$$

or $$\frac{Rt}{L} = \log 2$$

or $$t = \frac{0.693 \times 300 \times 10^{-3}}{2} = 0.1\text{ s}.$$

26.

As, $E_P I_P = P_i$ (Input Power)

or $$I_P = \frac{P_i}{E_P} = \frac{4000}{100} = 40\text{ amp}.$$

27. Induced emf across the radius of disc is:

$$|e| = \frac{B\omega r^2}{2} = B\pi r^2 \nu$$

$$= 0.1 \times \pi \times (0.1)^2 \times 20$$

$$= 20\pi \times 10^{-3} \text{ volt}$$

$$= 20\pi \text{ milli volt.}$$

28. Mutual inductance of the system, $M = \mu_0 n_1 n_2 A_2 l$

where A_2 is the area of inner solenoid $n_1 = 10 \text{ cm}^{-1} = 1000 \text{ m}^{-1}$; $n_2 = 40 \text{ cm}^{-1} = 4000 \text{ m}^{-1}$; $l = 30 \text{ cm} = 30 \times 10^{-2}$ m; $A_2 = 20 \text{ cm}^2 = 20 \times 10^{-4} \text{ m}^2$.

$$\therefore \quad M = 4\pi \times 10^{-7} \times 4000 \times 1000 \times 20 \times 10^{-4} \times 30 \times 10^{-2}$$

$$= 301.44 \times 10^{-5} = 3 \text{ mH.}$$

29. $$i = \frac{e}{R} = \frac{N}{R}\left[\frac{d\phi}{dt}\right] = \frac{N}{R}\left[\frac{\phi + (\phi)}{dt}\right]$$

$$= \frac{2N\phi}{R(dt)} = \frac{2N(BA)}{R(dt)}$$

$$= \frac{2(1200)(4 \times 10^{-4})(500 \times 10^{-4})}{20(10^{-1})}$$

$$= 24 \times 10^{-3} \text{ A} = 24 \text{ mA.}$$

30. **Given:** No. of turns across primary coil, $N_p = 50$

Number of turns across secondary coil, $N_s = 1500$

Magnetic flux linked with primary coil, $\phi = \phi_0 + 4t$

$\therefore$ Voltage across the primary coil,

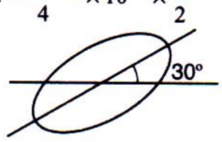
$$V_p = \frac{d\phi}{dt} = \frac{d}{dt}(\phi_0 + 4t) = 4 \text{ volt}$$

Also, $$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

$$\therefore \quad V_s = \left(\frac{1500}{50}\right) \times 4 = 120 \text{ V.}$$

31. Flux $= B \times A = BA \sin 30°$

$$= 10^{-4} \times \pi \times \frac{21 \times 21}{4} \times 10^{-4} \times \frac{1}{2}$$



$$= 173.18 \times 10^{-8} \text{ Wb}$$

$$= 1.732 \times 10^{-6} \text{ Wb.}$$

32. The net magnetic flux through a closed surface, will be zero.

$\oint B ds = 0$ because there are no magnetic monopoles.

33. The induced emf e in the secondary coil is given by:

$$e = -\frac{d\phi}{dt} = -M\frac{dI}{dt}$$

or $$|e| = M\frac{dI}{dt}$$

$$\therefore \quad |e| = 5 \times \frac{10}{5 \times 10^{-4}} = 1 \times 10^5 \text{ V.}$$

34. By Lenz's law, the direction of induced current in the ring is such as to oppose the falling of N-pole of the magnet.

So, the direction of induced current will be anticlockwise, because the induced current makes the ring a magnetic dipole, with its N-pole upward which opposes (repel) the N-pole of falling magnet. Hence, the direction of the current in the ring will be anticlockwise.

35. **(c)** The current at time t is given by

$$i = i_0(1 - e^{-t/\tau})$$

Here $i_0 = E/R$ and $\tau = \frac{L}{R}$

$$\therefore \quad q = \int_0^\tau i\,dt = \int_0^\tau i_0(1 - e^{-t/\tau})\,dt$$

$$= \frac{i_0 \tau}{e} = \frac{\left(\frac{E}{R}\right)\left(\frac{L}{R}\right)}{e} = \frac{EL}{eR^2}$$

36.

(b) If resistance is constant (10Ω) then steady current in the circuit $i = \frac{5}{10} = 0.5\,A$. But resistance is increasing it means current through the circuit start decreasing. Hence inductance comes in picture which induces a current in the circuit in the same direction of main current. So $i > 0.5\,A$.

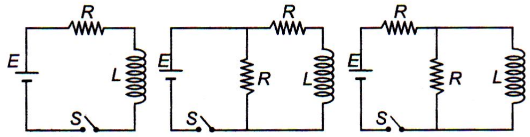
37. **(a)** Steady-state current in $L = I_0 = \frac{E}{R_1}$

Energy stored in L

$$= \frac{1}{2}LI_0^2 = \frac{1}{2}L\left(\frac{E^2}{R_1^2}\right)$$

= heat produced in R_2 during discharge.

38. **(b)** At $t = 0$ current through L is zero so it acts as open circuit. The given figures can be redrawn as follows.



(i) (ii) (iii)

$$i_1 = 0;\ i_2 = \frac{E}{R}\ i_3 = \frac{E}{2R}$$

Hence $i_2 > i_3 > i_1$.

39. **(c)** At the time $t = 0$, e is max and is equal to E, but current i is zero.

As the time passes, current through the circuit increases but induced elf decreases.

40. **(b)** At $t = 0$, inductor behave as open circuit so i_1

$$= \frac{10}{10} = 1\,A$$

At $t = \infty$, inductor behave as short circuit, so i_2

$$= \frac{10}{8} = \frac{5}{4}A$$

Hence, $\frac{i_1}{i_2} = \frac{1}{5/4} = \frac{4}{5} = 0.8$

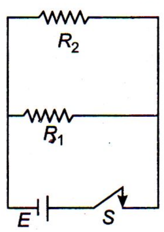
41. **(b)** Since resistance of the circuit is increasing and hence current in the circuit is decreasing so $\frac{di}{dt}$ is negative.

Current in the circuit is given by $i = \dfrac{6 - L\frac{di}{dt}}{12}$

Since $\frac{di}{dt}$ is negative so the value of numerator will be more than 6V and hence current in the circuit at that instant will be more than 0.5 A.

42. **(d)** After a long time, steady current flows, so no emf is induced across inductor. Hence circuit reduces like shown.

So, current flowing $i = \dfrac{E(R_1 + R_2)}{R_1 R_2}$



43. **(b)** Hot wire ammeter is not based on the phenomenon of electromagnetic induction.

44. **(c)** $i = \dfrac{|e|}{R} = \dfrac{N}{R} \cdot \dfrac{\Delta B}{\Delta t} A\cos\theta$

$$= \frac{20}{100} \times 1000 \times (25 \times 10^{-4}) \cos 0°$$

$\Rightarrow i = 0.5$ A

45. **(b)** By using $e = \dfrac{-NBA(\cos\theta_2 - \cos\theta_1)}{\Delta t}$

$$e = -\frac{1000 \times 2 \times 10^{-5} \times 500 \times 10^{-4}(\cos 180° - \cos 0°)}{0.2}$$

$= 10^{-2}$ volt $= 10$ mV

[CHEMISTRY]

53. **(a)** $n = 4 \therefore Fe^{2+}$

If BM $= \sqrt{24} = \sqrt{4(4+2)}$

number of unpaired e = 4

Then Fe must have +2 charge

57. **(d)** Ni^{2+} and Ti^{3+} ions are coloured in aqueous solution because they contain unpaired electrons.

58. **(b)** $_{30}Zn$ $[Ar]^{18}$ $3d^{10}$, so $n = 0$; Fe^{2+} $[Ar]^{18}$ $3d^6$, so $n = 4$; Ni^{2+} $[Ar]^{18}$ $3d^8$, so $n = 2$; Cu^{2+} [Ar]18 $3d^9$, so $n = 1$.

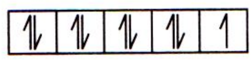
72. **(d)** Cuprous ion (Cu^+) $3d^{10}$ Completely filled d subshell

$3d^{10}$

No. unpaired $d - e^{-1}$

Cupric ion Cu^{+2}

$3d^9$



1. unpaired $d - e^{-1}$

73. **(c)** The ability of d-block element to form is due to the small and highly charged ions and vacant low energy orbital to accept lone pair electrons from ligands