Sample Paper 8

ANSWER KEYS																	
1	(a)	**7**	(d)	**13**	(b)	**19**	(c)	**25**	(d)	**31**	(c)	**37**	(b)	**43**	(a)	**49**	(d)
2	(c)	**8**	(c)	**14**	(c)	**20**	(a)	**26**	(b)	**32**	(a)	**38**	(c)	**44**	(c)	**50**	(d)
3	(d)	**9**	(d)	**15**	(c)	**21**	(b)	**27**	(d)	**33**	(b)	**39**	(a)	**45**	(d)	**51**	(c)
4	(a)	**10**	(b)	**16**	(a)	**22**	(a)	**28**	(d)	**34**	(b)	**40**	(b)	**46**	(a)	**52**	(b)
5	(b)	**11**	(c)	**17**	(d)	**23**	(b)	**29**	(d)	**35**	(a)	**41**	(d)	**47**	(a)	**53**	(a)
6	(c)	**12**	(b)	**18**	(a)	**24**	(d)	**30**	(c)	**36**	(c)	**42**	(a)	**48**	(b)	**54**	(a)

55	(d)

SOLUTIONS

1. **(a)** $V = 120 \sin 100\pi t \cos 100\pi t \Rightarrow V = 60 \sin 200\pi t$

   $V_{max} = 60V$ and $v = 100Hz$

2. **(c)** Electric field between the sheets

   $$= \frac{(\sigma_1 - \sigma_2)}{2\epsilon_0} \text{ (from Gauss's theorem)}$$

   Here, $\sigma_1 = \sigma_2$ $E = 0$

3. **(d)** $I = \frac{E}{Z} = \frac{E}{R} = \frac{100}{10} = 10$ ampere

   potential across capacitor $C = (I) \times (x_c) = 10 \times 40$
   $= 400$ volt

4. **(a)**

5. **(b)** Any body, having the electrons and protons is equal numbers, is said to be in its neutral configiration. When we say that a body is charged, it means either the body is having excess of electrons (negatively charged) or is of deficient of electrons (positively charged).

6. **(c)** The electric field will be different at the location of the two charges. Therefore the force on two charges will be unequal. This will result in a force as well as torque.

7. **(d)**

8. **(c)** The resistivity of semiconductor decreases with increase in temperature.

9. **(d)**

10. **(b)** Energy consumed per day = P × t = 60 × 8 = 480 watt hour = 480/1000 = 0.48 kWh or unit of electricity.

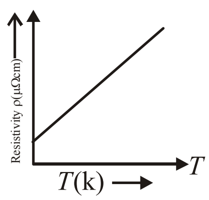
    Hence the cost = 0.48 × 1.25 = ₹ 0.60.

11. **(c)** Heat supplied $= \frac{V^2}{R} \times t$

    $$\Rightarrow \frac{t_1}{R_1} = \frac{t_2}{R_2} \Rightarrow \frac{6}{R_1} = \frac{8}{R_2} \Rightarrow \frac{R_1}{R_2} = \frac{3}{4}$$

12. **(b)**

13. **(b)** These materials exhibit a very weak dependence of resistivity on temperature. Their resistance values would be changed very little with temperature as shown in figure.



    Hence these materials are widely used as heating element.

14. **(c)** Current, $I = \frac{\text{Charge}}{\text{Time}}$; as charge $q = n \times 1.6 \times 10^{-19}$

    $$10^{-3} \text{ amp} = \frac{n \times 1.6 \times 10^{-19}}{1 \text{ sec}} \Rightarrow n = 6.25 \times 10^{15}.$$

15. **(c)** An α-particle is a doubly ionised helium nucleus having a charge +2e and a mass 4u (4 amu), while a deutron is the nucleus of a deuterium (an isotope of hydrogen, usually found in sea water) having a charge +e and a mass of about 2u.

    The radius R of circular path is given by

    $$r = \frac{mv}{qB} \Rightarrow \frac{r_1}{r_2} = \frac{m_1 v_1}{q_1} \times \frac{q_2}{m_2 v_2} \quad (\because \text{ B is same})$$

    $$= \frac{q_2}{q_1} \times \frac{m_1}{m_2} \times \sqrt{\frac{m_2}{m_1}}$$

    $$\left[\because \frac{1}{2} m_1 v_1^2 = \frac{1}{2} m_2 v_2^2 \Rightarrow \frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}}\right]$$

    $$\therefore \frac{r_1}{r_2} = \frac{+e}{+2e} \times \frac{4u}{2u} \times \sqrt{\frac{2u}{4u}} = 1 : \sqrt{2}$$

16. **(a)** $B = \frac{\mu_0 i}{2\pi r}$ or $B \propto \frac{1}{r}$

When r is doubled, the magnetic field becomes half, i.e., now the magnetic field will be 0.2 T.

17. **(d)** $\tau = NiAB \sin\theta$

$$A = \frac{\sqrt{3}}{4} l^2, [\theta = 90°, N = 1]$$

$$\tau = \frac{\sqrt{3}}{4} l^2 BI$$

18. **(a)**

19. **(c)** Let the actual angle of dip (in the magnetic meridian) be θ. If B_H and B_v be the horizontal and vertical component of the earth's magnetic field respectively, then

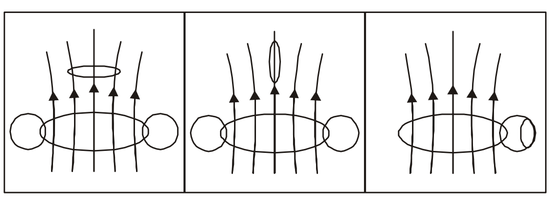
$$\tan\theta = \left(\frac{B_v}{B_H}\right)$$

In the plane situated at 30° with the magnetic meridian, the horizontal component of the earth's magnetic field will be $B_H \cos 30^o$ while the vertical component will be Bv. The angle of dip in this plane is,

$$\tan 45^o = \frac{B_v}{B_H \cos 30^o}$$

$$\frac{\tan\theta}{\tan 45^o} = \cos 30^o \Rightarrow \theta = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$$

20. **(a)** Clearly the flux linkage is maximum in case (a) due to the spatial arrangement of the two loops.



21. **(b)** $L = \mu_0 nI$

$\therefore \quad \frac{L_2}{L_1} = \frac{\mu}{\mu_0}$ ----($\because$ n and I are same)

$\therefore \quad L_2 = \mu_r L_1 = 900 \times 0.18 = 162$ mH

22. **(a)** Induced electric field is non conservative in nature

$$\xi = \frac{W}{Q} \Rightarrow V = \frac{W}{Q} \Rightarrow W = QV$$

23. **(b)**

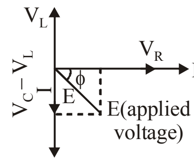
24. **(d)** At resonance, $\omega L = \frac{1}{\omega C}$. The circuit behaves as if it contains R only. So, phase difference = 0

At resonance, impedance is minimum $Z_{min} = R$ and current is maximum, given by $\mathbf{I}_{max} = \frac{E}{Z_{min}} = \frac{E}{R}$

It is interesting to note that before resonance the current leads the applied emf, at resonance it is in phase, and after resonance it lags behind the emf. LCR series circuit is also called as acceptor circuit and parallel LCR circuit is called rejector circuit.

25. **(d)** $\tan\phi = \frac{V_C - V_L}{V_R}$ (if $V_C > V_L$)

$$= \frac{V_L - V_C}{V_R} \text{ (if } V_L > V_C)$$



where φ is phase between current & applied voltage.

26. **(b)** Electric field at any point of the close surface is due to all the charges enclosed by the surface. So it is

$$\oint(\vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \vec{E}_4).d\vec{A} = \frac{q_1 + q_2 + q_3}{\epsilon_0}.$$

27. **(d)** Torque, $\vec{\tau} = \vec{p} \times \vec{E} = pE \sin\theta$

$4 = p \times 2 \times 10^5 \times \sin 30°$

or, $p = \frac{4}{2 \times 10^5 \times \sin 30°} = 4 \times 10^{-5}$ Cm

Dipole moment, $p = q \times l$

$$q = \frac{p}{l} = \frac{4 \times 10^{-5}}{0.02} = 2 \times 10^{-3} C = 2mC$$

28. **(d)**

29. **(d)** $E = -\frac{dV}{dx} = -(2x - 2)$

Now, E [at x = 1] = –(2×1 – 2) = 0

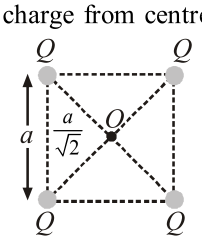
30. **(c)** Potential at centre O of the square

$$V_0 = 4\left(\frac{Q}{4\pi\varepsilon_0(a/\sqrt{2})}\right)$$

Work done in shifting (–Q) charge from centre to infinity

$$W = -Q(V_\infty - V_0) = QV_0$$

$$= \frac{4\sqrt{2}Q^2}{4\pi\varepsilon_0 a} = \frac{\sqrt{2}Q^2}{\pi\varepsilon_0 a}$$



31. **(c)** The circuit will have inductive nature if

$$\omega > \frac{1}{\sqrt{LC}} \quad \left(\omega L > \frac{1}{\sqrt{LC}}\right)$$

Hence (a) is false. Also if circuit has inductive nature the current will lag behind voltage. Hence (d) is also false.

If $\omega = \frac{1}{\sqrt{LC}}\left(\omega L = \frac{1}{\omega C}\right)$ the circuit will have resistance nature. Hence (b) is false.

Power factor

$$\cos\phi = \frac{R}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}} = 1 \text{ if } \omega L = \frac{1}{\omega C}$$

32. **(a)** The charging of inductance given by,

$$i = i_0\left(1 - e^{-\frac{Rt}{L}}\right)$$

$$\frac{i_0}{2} = i_0(1 - e^{-\frac{Rt}{L}}) \Rightarrow e^{-\frac{Rt}{L}} = \frac{1}{2}$$

Taking log on both the sides, $-\frac{Rt}{L} = \log 1 - \log 2$

$$\Rightarrow t = \frac{L}{R}\log 2 = \frac{300 \times 10^{-3}}{2} \times 0.69 = 0.1 \text{ sec.}$$

33. **(b)**

34. **(b)** $I = \frac{E}{R + r} \Rightarrow V = \frac{E}{R + r}R. \quad [\because V = IR]$

$$\Rightarrow r = \frac{(E - V)}{V}R.$$

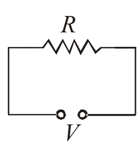
35. **(a)**

36. **(c)** Charge = area under the current – time graph

$$q_1 = 2 \times 1 = 2,\ q_2 = 1 \times 2 = 2, \text{ and } q_3 = \frac{1}{2} \times 2 \times 2 = 2$$

$$q_1 : q_2 : q_3 = 2 : 2 : 2 = 1 : 1 : 1$$

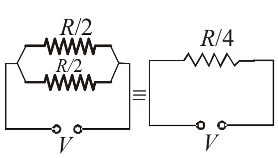
37. **(b)** Case 1 $P_1 = \frac{V^2}{R}$



Case 2

The wire is cut into two equal pieces. Therefore, the resistance of the individual wire is $\frac{R}{2}$. These are connected in parallel

$$\therefore R_{eq} = \frac{R/2}{2} = \frac{R}{4}$$



$$\therefore P_2 = \frac{V^2}{R/4} = 4\left(\frac{V^2}{R}\right) = 4P_1$$

38. **(c)** $L = n_1 2\pi r_1 = n_2 2\pi r_2$

$$\Rightarrow n_1 r_1 = n_2 r_2 \Rightarrow \frac{r_1}{r_2} = \frac{n_2}{n_1};\ B = \frac{\mu_0 n i}{2r}$$

$$\Rightarrow \frac{B_1}{B_2} = \frac{\mu_0 n_1 i / 2r_1}{\mu_0 n_2 i / 2r_2} = \frac{n_1}{n_2} \cdot \frac{r_2}{r_1} = \left(\frac{n_1}{n_2}\right)^2 = \frac{4}{1}$$

39. **(a)** For conversion of a Galvanometer to a voltmeter, we connect a large resistance R in series with the Galvanometer.

40. **(b)** $\tan\theta = \frac{B_V}{B_H} = 1, B_V = B_H$

$$\theta = \tan^{-1}(1) = 45°$$

41. **(d)** $\Delta I = 6A,\ \Delta t = 0.3s,\ E = 30V$

$$E = L\frac{dI}{dt} \quad \therefore L = \frac{30 \times 0.3}{6} = 1.5 \text{ H.}$$

42. **(a)** Here, $C = 100\ \mu F = 100 \times 10^{-6} F, R = 40\ \Omega$, $V_{rms} = 200\ V$, $f = 60\ Hz$

Peak voltage, $V_0 = \sqrt{2}\ .\ V_{rms} = 200\sqrt{2}$

Circuit impedance,

$$Z = \sqrt{R^2 + \frac{1}{\omega^2 C^2}}$$

$$= \sqrt{40^2 + \frac{1}{(2 \times \pi \times 60 \times 100 \times 10^{-6})^2}} = 48\ \Omega$$

hence, maximum current in coil,

$$I_0 = \frac{V_0}{Z} = \frac{200\sqrt{2}}{48} = 5.89 \text{ A}$$

43. **(a)** Emf induced $|e| = B\ell v$

$$I = \frac{B\ell v}{r}$$

Force act on the rod due to magnetic field in opposite direction of velocity

$$F = BI\ell = \frac{B^2\ell^2 v}{r}$$

Therefore, an equal force must be provided to move the rod with velocity v.

44. **(c)** If the current increases with time in loop A, then magnetic flux in B will increase. According to Lenz's law, loop -B is repelled by loop -A because current in loop B will be antiparallel to that in A.

45. **(d)** The magnetic force acts on moving electrons, and so net force on the conductor is non-zero.

46. **(a)** In the battery connected capacitor *V* remains constant while *C* increases with the introduction of dielectric.

47. **(a)** In the given case, there is no component of velocity in perpendicular to the magnetic field and so $e = Bv\ell \sin 0°$.

48. **(b)** If $\vec{F} \perp \vec{V}$ at all instants then motion will be circular

49. **(d)** **50.** **(d)**

51. **(c)** Since $V = \frac{W}{Q}$, more work will be done for a positive charge of two units as compared to positive charge of one unit, but the ratio $\frac{W}{Q}$ is same. Therefore potential difference is same.

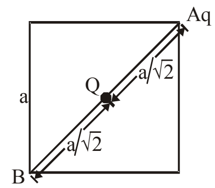
52. **(b)** When the charge is released to move freely, the work done by electric field is equal to change in kinetic energy

$\therefore W_{EF} = \Delta KE$

$-q\,\Delta V = \Delta KE$

$KE = -3 \times 10^{-6}(1-5) = 12 \times 10^{-6}$ J

53. **(a)** Here, $V_A = V_B = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{a/\sqrt{2}}$



Hence, $V_A - V_B = 0$

Work done, $W = q(V_A - V_B) = 0$

54. **(a)** **55.** **(d)**