Sample Paper 3

ANSWER KEYS																			
1	(a)	**7**	(b)	**13**	(c)	**19**	(b)	**25**	(a)	**31**	(b)	**37**	(c)	**43**	(a)	**49**	(b)	**55**	(c)
2	(b)	**8**	(b)	**14**	(c)	**20**	(b)	**26**	(a)	**32**	(a)	**38**	(a)	**44**	(d)	**50**	(a)		
3	(c)	**9**	(d)	**15**	(d)	**21**	(b)	**27**	(a)	**33**	(c)	**39**	(a)	**45**	(c)	**51**	(d)		
4	(a)	**10**	(b)	**16**	(d)	**22**	(b)	**28**	(a)	**34**	(b)	**40**	(c)	**46**	(c)	**52**	(b)		
5	(a)	**11**	(d)	**17**	(c)	**23**	(b)	**29**	(a)	**35**	(a)	**41**	(a)	**47**	(a)	**53**	(b)		
6	(b)	**12**	(c)	**18**	(d)	**24**	(d)	**30**	(b)	**36**	(d)	**42**	(d)	**48**	(a)	**54**	(c)		

SOLUTIONS

1. **(a)** $J = \sigma E \Rightarrow J\rho = E$
J is current density, E is electric field
so B = ρ = resistivity.

2. **(b)** $P_1 = \dfrac{V^2}{R_1}$ and $P_2 = \dfrac{V^2}{R_2}$ $\therefore \dfrac{P_1}{P_2} = \dfrac{R^2}{R_1} = \dfrac{6}{4} = \dfrac{3}{2}$

3. **(c)** $B = \mu_0 N_0 i;\ B_1 = (\mu_0)\left(\dfrac{N_0}{2}\right)(2\,i) = \mu_0 N_0 i = B$
$\Rightarrow B_1 = B$

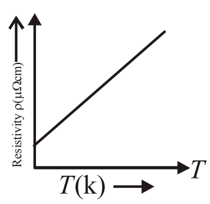
4. **(a)** The force acting on a charged particle in magnetic field is given by $\vec{F} = q(\vec{v} \times \vec{B})$ or $F = qvB \sin\theta$,
When angle between v and B is 180°, $F = 0$

5. **(a)**

6. **(b)** The figure is showing $I - V$ characteristics of non ohmic or non linear conductors.

7. **(b)**

8. **(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.

9. **(d)** $Q_1 + Q_2 = Q$ … (i) and $F = k\dfrac{Q_1 Q_2}{r^2}$ … (ii)

From (i) and (ii) $F = \dfrac{kQ_1(Q - Q_1)}{r^2}$

For F to be maximum $\dfrac{dF}{dQ_1} = 0 \Rightarrow Q_1 = Q_2 = \dfrac{Q}{2}$

10. **(b)** Potential at the centre of the triangle,
$V = \dfrac{\Sigma q}{4\pi\varepsilon_0 r} = \dfrac{2q - q - q}{4\pi\varepsilon_0 r} = 0$
Obviously, $E \neq 0$

11. **(d)** **By Gauss's law :** The total of the electric flux out of a closed surface is equal to the charge enclosed devided by the permittivity i.e., $\phi = \dfrac{Q}{\varepsilon_0}$.
Thus, electric flux through a surface doesn't depend on the shape, size or area of a surface but it depends on the number of charges enclosed by the surface. So all the given figures have same electric flux as all of them also has same single positive charge.

12. **(c)** Since $W_{A \to B} = q(V_B - V_A)$

$\Rightarrow V_B - V_A = \dfrac{16}{4} = 4V$

13. **(c)**

14. **(c)** As the capacitor remains connected to the battery, the potential difference provided by the battery remains constant.

15. **(d)** As capacitor offers infinite resistance in dc-circuit.
So, current flows through 2Ω resistance from left to right, given by

$$I = \frac{V}{R + r} = \frac{2.5V}{2 + 0.5} = \frac{2.5}{2.5} = 1\text{ A}$$

So, the potential difference across 2Ω resistance
$V = IR = 1 \times 2 = 2$ volt.
Since, capacitor is in parallel with 2Ω resistance, so it also has 2V potential difference across it.
As current does not flow through capacitor branch so no potential drop will be accross 10Ω resistance. The charge on capacitor
$q = CV = (4\,\mu F) \times 2V = 8\,\mu C$

16. **(d)**

17. (c) When the capacitor is completely charged, the total energy in the L.C circuit is with the capacitor and that energy is $E=\frac{1}{2}\frac{Q^2}{C}$

When half energy is with the capacitor in the form of electric field between the plates of the capacitor we get $\frac{E}{2}=\frac{1}{2}\frac{Q'^2}{C}$ where Q' is the charge on one plate of the capacitor

$$\therefore \frac{1}{2}\times\frac{1}{2}\frac{Q^2}{C}=\frac{1}{2}\frac{Q'^2}{C} \Rightarrow Q'=\frac{Q}{\sqrt{2}}$$

18. (d) $\eta=\frac{E_s I_s}{E_p I_p}=\frac{11\times 90}{220\times 5}=0.9\times 100\%=90\%$

19. (b) Inductive reactance,

$X_L=\omega L=2\pi f L$

$\Rightarrow X_L \propto f$

Hence, inductive reactance increases linearly with frequency.

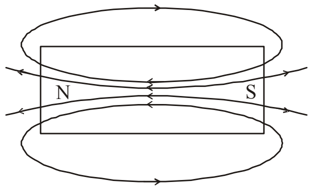
20. (b) $F=Bi\ell=2\times 1.2\times 0.5=1.2\,N$

21. (b) Length of conductor (l) = 0.4 m; Speed (v) = 7 m/s and magnetic field (B) = 0.9 Wb/ m^2. Induced e.m.f. $(\varepsilon)=Blv\cos\theta=0.9\times 0.4\times 7\times\cos 0^\circ=2.52$ V.

22. (b)

23. (b) Induced of e.m.f., $e=-\frac{d\phi}{dt}$

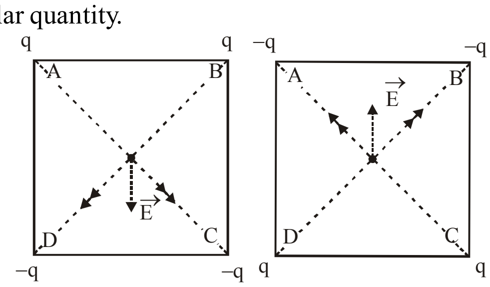
24. (d) As shown in the figure, the magnetic lines of force are directed from south to north inside a bar magnet.



25. (a)

26. (a) Since $V=\frac{1}{4\pi\varepsilon_0}\frac{q}{r}$, for a given point charge, q is constant, therefore V depends only on r. Hence V is a function of distance.

27. (a) As shown in the figure, the resultant electric fields before and after interchanging the charges will have the same magnitude, but opposite directions.
Also, the potential will be same in both cases as it is a scalar quantity.



28. (a) $E=8\sin\omega t+6\sin 2\omega t$

$$\Rightarrow E_{peak}=\sqrt{8^2+6^2}=10\text{ V} \Rightarrow E_{rms}=\frac{10}{\sqrt{2}}=5\sqrt{2}\text{ V}$$

29. (a) The current and potential difference are in phase with the resistance. So, the time taken would be same as time for voltage to change from (t = 0) that is peak value to rms value.

Time taken by voltage to achieve its rms value of $\frac{200}{\sqrt{2}}$.

$$\frac{200}{\sqrt{2}}=200\cos(100\pi t)$$

$$\Rightarrow \cos(100\pi t)=\frac{1}{\sqrt{2}}=\cos\left(\frac{\pi}{4}\right)$$

$$t=\frac{1}{400}\text{ second}=2.5\times 10^{-3}\text{ sec.}$$

30. (b) $\vec{E}=\frac{\partial v}{\partial x}\hat{i}+\frac{\partial v}{\partial y}\hat{j}$ $\therefore |\vec{E}|=k(\sqrt{x^2+y^2})=kr$

Given $v=-kxy$ $\quad E\propto r$

$\therefore \vec{E}=ky\hat{i}+kx\hat{j}$

31. (b)

32. (a) $H=I^2Rt$. Here $R_1=\rho\frac{\ell}{\pi r^2}$ and $R_2=\rho\frac{\ell}{\pi(2r)^2}$.

That is, $R_1=4R_2$. Hence, $\frac{H_1}{H_2}=4$.

33. (c) Internal resistance = r, External resistance = nr.
Let terminal voltage = V

then $V=E-Ir \Rightarrow V=E-\frac{Er}{(n+1)r}$

$$V=\frac{nE}{n+1}\Rightarrow\frac{V}{E}=\frac{n}{n+1}$$

34. (b) This is a balanced wheatstone bridge condition,

$$\frac{5}{R}=\frac{\ell_1}{100-\ell_1}\text{ and }\frac{5}{R/2}=\frac{1.6\ell_1}{100-1.6\ell_1}\Rightarrow R=15\,\Omega$$

35. (a) $\frac{F}{\ell}=\frac{\mu_0 i^2}{2\pi d}=9.8\times 4\times 10^{-6}$

$$\Rightarrow i=\sqrt{\frac{4\times 10^{-6}\times 9.8\times 0.12}{2\times 10^{-7}}}=4.85\,A$$

36. (d) $r=\frac{mv}{qB}\Rightarrow r\propto\frac{v}{B}$

37. (c) **38. (a)**

39. (a) The reactance of inductor, $X_L=\omega L$

The reactance of capacitor, $X_C=\frac{1}{\omega C}$

where $\omega=2\pi n$ & n is the frequency of A.C source.

40. **(c)** $\frac{\Delta\phi}{\Delta t} = \varepsilon = iR \Rightarrow \Delta\phi = (i\Delta t)R = QR \quad \Rightarrow Q = \frac{\Delta\phi}{R}$

41. **(a)** According to Faraday's law of electro-magnetic inductions,

$$e = \left|L\frac{dI}{dt}\right| \Rightarrow 2 = L\frac{(8-2)}{3\times10^{-2}} \Rightarrow L = 10\,mH$$

42. **(d)** **43.** **(a)**

44. **(d)** The value of H is fairly uniform.

45. **(c)** The magnetic field of two equal halfs of the loop is equal and opposite and so $\vec{B} = 0$.

46. **(c)**

47. **(a)** DC is a constant current but AC varies sinusoidally.

48. **(a)** As $(V_B - V_A) = \frac{W_{AB}}{q} = -\int_A^B \vec{E}.\overrightarrow{d\ell}$

$$= kq\left[\frac{1}{r_A} - \frac{1}{r_B}\right]$$

Which depends on the initial and final position.

49. **(b)** In case of inductive circuit emf leads current by π/2 rad

50. **(a)** $\frac{E_s}{E_p} = \frac{n_s}{n_p}$ or $E_s = E_p \times \left(\frac{n_s}{n_p}\right)$

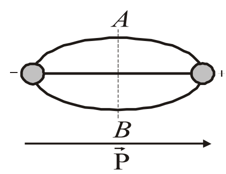
$$\therefore\ E_s = 120 \times \left(\frac{200}{100}\right) = 240\,V$$

$$\frac{\mathbf{I}_p}{\mathbf{I}_s} = \frac{n_s}{n_p} \text{ or } \mathbf{I}_s = \mathbf{I}_p\left(\frac{n_p}{n_s}\right) \ \therefore\ \mathbf{I}_s = 10\left(\frac{100}{200}\right) = 5\text{ amp}$$

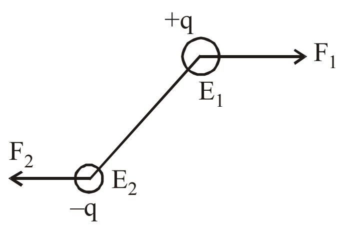
51. **(d)** Option (d) is false because the reason why the voltage leads the current is because $\frac{1}{C\omega} > L\omega$ and if the voltage lags, the inductive reactance is greater than the capacitive reactance.

52. **(b)**

53. **(b)** The direction of electric field at equatorial point *A* or *B* will be in opposite direction, as that of direction of dipole moment.



54. **(c)**



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

55. **(c)** Intensity of electric field due to a Dipole

$$E = \frac{p}{4\pi\varepsilon_0 r^3}\sqrt{3\cos^2\theta + 1} \Rightarrow E \propto \frac{1}{r^3}$$