Sample Paper 5

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

SOLUTIONS

1. **(b)** $i = \frac{E}{r} \Rightarrow 30 = \frac{1.5}{r}$

$r = 0.05\,\Omega \Rightarrow H = i^2rt = (30)^2 \times 0.05 \times 20 = 900$ J

2. **(d)**

3. **(b)**

4. **(b)** $C_{medium} = K \times C_{air}$

5. **(d)**

6. **(b)** **Given :** Dipole moment of the dipole = $\vec{p}$ and uniform electric field = $\vec{E}$. We know that dipole moment (p) = q.a (where q is the charge and a is dipole length). And when a dipole of dipole moment $\vec{p}$ is placed in uniform electric field $\vec{E}$, then Torque (τ) = Either force × perpendicular distance between the two forces = qa E sin θ or $\tau = pE \sin\theta$ or $\vec{\tau} = \vec{p} \times \vec{E}$ (vector form)

7. **(b)** In series combination of capacitors

$V_{eff} = V + V + V = 3V$

$$\frac{1}{C_{eff}} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C} \Rightarrow C_{eff} = \frac{C}{3}$$

Thus, the capacitance and breakdown voltage of the combination will be $\frac{C}{3}$ and 3V.

8. **(a)** Force on a charge q in a uniform electric field E is, F = q E, work done = force × distance = qEy.

9. **(d)** In balance condition, since no current flows through the galvanometer therefore *B* and D are at the same potential.

10. **(d)** $I = \frac{E}{R + r}$, Internal resistance (r) is zero,

$I = \frac{E}{R}$ = constant.

11. **(d)**

12. **(b)**

13. **(c)** No current flows through the resistor *R* as *P* and *Q* are at same potential. Hence current drawn from battery will remain same on closing the switch.

14. **(c)** The field due to infinite linear charge distribution

$$E = \frac{1}{4\pi\varepsilon_0}\int \frac{dq}{r} \Rightarrow E \propto \frac{1}{r}$$

So curve is hyperbolic.

15. **(d)** When $\frac{Q_1}{R_1} - \frac{Q_2}{R_2}$; current will flow in connecting wire so that energy decreases in the form of heat through the connecting wire.

16. **(a)** $e = \frac{d\phi}{dt} = \frac{d}{dt}(NBA) = NA\frac{dB}{dt} = 0.5\,V$

17. **(b)** $P = \frac{1}{2}V_0 i_0 \cos\phi \Rightarrow P = P_{peak}.\cos\phi$

$$\Rightarrow \frac{1}{2}(P_{peak}) = P_{peak}\cos\phi \Rightarrow \cos\phi = \frac{1}{2} \Rightarrow \phi = \frac{\pi}{3}$$

18. **(d)** When an ac voltage of 220 V is applied to a capacitor *C*, the charge on the plates is in phase with the applied voltage.

As the circuit is pure capacitive so, the current developed leads the applied voltage by a phase angle of 90° Hence, power delivered to the capacitor per cycle is $P = V_{rms} I_{rms} \cos 90° = 0$.

19. **(a)** r = mv/Bq is same for both.

20. **(d)** If charge is not moving then the magnetic force is zero.

Since $\vec{F}_m = q(\vec{v} \times \vec{B})$

As $\vec{v} = 0$, for stationary charge

$\therefore \quad \vec{F}_m = 0$

21. **(b)** $n = \frac{N}{\ell} = \frac{2000}{0.3} = \frac{20000}{3}$; $\xi = \frac{d}{dt}(NBA) = NA\frac{dB}{dt}$

Since $B = \mu_0 nI \Rightarrow \xi = (\mu NAn)\frac{dt}{dt} \Rightarrow \xi = 0.024\,V$

22. **(b)**

23. **(b)**

24. **(b)** $X_L = \omega L \Rightarrow X_L \propto \omega$

25. **(b)** Induction furnace is based on the heating effect of eddy current. The furnace is used to prepare alloys by melting the constituent metals. It produces very high temperature.

26. **(c)**

27. **(a)** As we know the equivalent emf (ε_{eq}) in the parallel combination

$$\varepsilon_{eq} = \frac{\varepsilon_2 r_1 + \varepsilon_1 r_2}{r_1 + r_2}$$

So according to formula the equivalent emf ε_{eq} of the two cells in parallel combination is between ε_1 and ε_2. Thus ($\varepsilon_1 < \varepsilon_{eq} < \varepsilon_2$).

28. **(a)** C = equivalent capacitance

$$\therefore \quad \frac{1}{C} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} \Rightarrow \therefore \; C = 1\mu F$$

Charge in series circuit will be same.

$$\therefore \; q = CV = (1 \times 10^{-6}) \times 10 = 10\mu C$$

$\therefore$ Charge across '$3\mu F$' capacitor will be $10\mu C$.

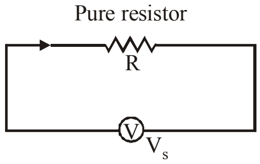
29. **(a)** In ideal condition of LC circuit $R = 0$ and LC oscillation continue indefinitely. Energy being shunted back and forth between electric field of capacitor and magnetic field of inductor. As capacitor is fully charged current in L is zero and $\frac{1}{2}\frac{q_0^2}{C}$ energy is stored in electric field. Then capacitor begins to discharge through L causing a current to flow and build up a magnetic field, around L. Therefore, energy stored.

Now in $L = \frac{1}{2}LI_0^2$ when C is fully discharged, V across the plate reduces to zero.

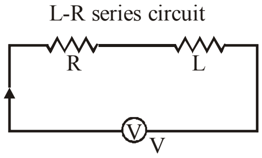
$\therefore$ Electric field energy is transferred to magnetic field and vice-versa.

30. **(d)**

Pure resistor



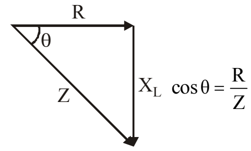
L-R series circuit



For pure resistor circuit, power

$$P = \frac{V^2}{R} \Rightarrow V^2 = PR$$

Phasor diagram



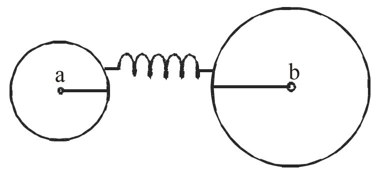
Z = impedance

For L-R series circuit, power

$$P^1 = \frac{V^2}{Z}\cos\theta = \frac{V^2}{Z}.\frac{R}{Z} = \frac{PR}{Z^2}.R = P\left(\frac{R}{Z}\right)^2$$

31. **(c)** Electric field lines are always perpendicular to equipotential surface so, they cannot be in a direction of tangent to an equipotential surface.

32. **(c)**



Let charge on each sphere $= q$

when they are connected together their potential will be equal.

Now let charge on $a = q_1$ and on $b = 2q - q_1$

$$\Rightarrow V_a = V_b \text{ or } \frac{1}{4\pi\varepsilon_o}\frac{q_1}{a} = \frac{1}{4\pi\varepsilon_o}\frac{2q - q_1}{b}$$

$$\Rightarrow \frac{q_1}{2q - q_1} = \frac{a}{b}$$

$$\frac{E_a}{E_b} = \frac{\frac{1.}{4\pi\varepsilon_o}\frac{q_1}{a^2}}{\frac{1}{4\pi\varepsilon_o}\frac{q_2}{b^2}} = \left(\frac{q_1}{2q - q_1}\right)\frac{b^2}{a^2}$$

$$= \frac{a}{b}.\frac{b^2}{a^2} = \frac{b}{a} = b : a$$

33. **(c)** The electric field lines, are directed away from positively charged source and directed toward negatively charged source. In electric field force are directly proportional to the electric field strength hence, higher the electric field strength greater the force and vice-versa. The space between the electric field lines is increasing, from left to right so strength of electric field decreases with the increase in the space between electric field lines. Then the force on charges also decreases from left to right. Thus, the force on charge $-q$ is greater than force on charge $+q$ in turn dipole will experience a force towards left.

34. **(b)** Since $\tau = pE\sin\theta$ on decreasing the distance between the two charges, and on decreasing angle θ between the dipole and electric field, $\sin\theta$ decreases therefore torque decreases.

35. **(c)** The charge on disc A is 10^{-6} μC. The charge on disc B is 10×10^{-6} μC. The total charge on both = 11 μC. When touched, this charge will be distributed equally *i.e.*, 5.5 μC on each disc.

36. **(a)** We know

$$\frac{I}{I_S}=1+\frac{G}{S} \quad \frac{750}{100}=1+\frac{13}{S} \qquad S\Rightarrow 2\Omega$$

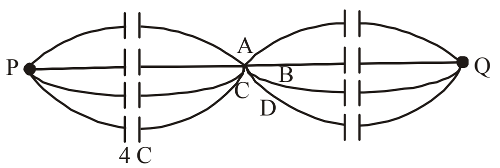
37. **(b)** If charge particle is put at rest in electric field, then it will move along line of force.

38. **(a)** $F=ma=qvB \Rightarrow a=\frac{qvB}{m}$

$$=\frac{1.6\times10^{-19}\times2\times3.4\times10^{7}}{1.67\times10^{-27}}=6.5\times10^{15}\ \text{m/sec}^2$$

39. **(b)**

40. **(a)** A, B, C and D are equipotential points (see fig.)



41. **(a)** $\frac{B_2}{B_1}=\frac{\mu_0 n_2 i_2}{\mu_0 n_1 i_1} \Rightarrow \frac{B_2}{6.28\times10^{-2}}=\frac{100\times\frac{i}{3}}{200\times i}$

$$\Rightarrow B_2=\frac{6.28\times10^{-2}}{6}=1.05\times10^{-2}\ \text{Wb/m}^2$$

42. **(b)** Given equation, $e=80\sin 100\pi t$ …(i)

Standard equation of instantaneous voltage is given by $e=e_m \sin\omega t$ …(ii)

Compare (i) and (ii), we get $e_m=80$ V

where e_m is the voltage amplitude.

Current amplitude $I_m=\frac{e_m}{Z}=80/20=4$ A.

$$I_{r.m.s}=\frac{4}{\sqrt{2}}=\frac{4\sqrt{2}}{2}=2\sqrt{2}=2.828\ \text{A}.$$

43. **(d)** No change in flux, hence no force required.

44. **(a)** Here, $B=\frac{1}{\pi}$ (Wb/m^2)

$\theta=60°$

Area normal to the plane of the disc

$$=\pi r^2\cos 60°=\frac{\pi r^2}{2}$$

Flux = B × normal area

$$=\frac{0.2\times0.2}{2}=0.02\,\text{Wb}$$

45. **(c)** Number of flux linkages with the coil is proportional to the current i, N f μ i

or $N\phi=Li$ [N is the number of turns in coils]

[N ϕ is total flux linkage]

Hence, $L=\frac{N\phi}{i}$ = co-efficient of self-inductance.

46. **(c)** In series resonance circuit,

inductive reactance is equal to capacitive reactance.

i.e. $\omega L=\frac{1}{\omega C}$

$$\therefore\ Z=\sqrt{R^2+\left(\omega L=\frac{1}{\omega C}\right)^2}=R$$

47. **(b)**

48. **(a)** A moving charge experiences a force in magnetic fields. It is because of interaction of two magnetic fields, one which is produced due to the motion of charge and other in which charge is moving.

49. **(a)** When temperature increases the random motion of electrons and vibration of ions increases which results in more frequent collisions of electrons with the ions. Due to this the average time between the successive collisions, denoted by τ, decreases which increases ρ.

50. **(c)** As we know that the relation between electric field intensity E and electric potential V is

$$E=-\frac{dV}{dr}$$

Electric field intensity E = 0 then $\frac{dV}{dr}=0$

This imply that V = constant

Thus, E = 0 inside the charged conducting sphere then the constant electrostatic potential 100V at every where inside the sphere and it verifies the shielding effect also.

51. **(a)**

52. **(d)** The strength of the earths magnetic field is not constant. It varies from one place to other place on the surface of earth. Its value being of the order of 10^{-5} T.

53. **(b)**

54. **(a)**

55. **(a)**