Sample Paper 10

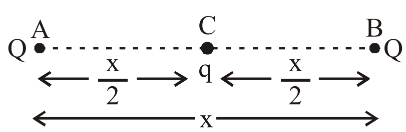
ANSWER KEYS																			
1	(d)	**7**	(c)	**13**	(c)	**19**	(b)	**25**	(c)	**31**	(c)	**37**	(a)	**43**	(d)	**49**	(c)	**55**	(a)
2	(d)	**8**	(d)	**14**	(a)	**20**	(c)	**26**	(b)	**32**	(a)	**38**	(b)	**44**	(d)	**50**	(c)		
3	(b)	**9**	(d)	**15**	(b)	**21**	(d)	**27**	(b)	**33**	(c)	**39**	(c)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

SOLUTIONS

1. **(d)** $V = k\frac{\vec{p}.\vec{r}}{r^3} = \frac{k\, pr\cos\theta}{r^3}$

$= k\frac{p\cos\theta}{r^2}$.

2. **(d)** Let q charge is situated at the mid position of the line AB. The distance between AB is x. A and B be the positions of charges Q and Q respectively.



Let $AC = \frac{x}{2}$, $BC = \frac{x}{2}$

The force on A due to charge q at C,

$\vec{F}_{CA} = \frac{1}{4\pi\varepsilon_0}.\frac{Q.q}{(x/2)^2}$ along $\overrightarrow{AC}$

The force on A due to charge Q at B

$\vec{F}_{AB} = \frac{1}{4\pi\varepsilon_0}.\frac{Q^2}{x^2}$ along $\overrightarrow{BA}$

The system is in equilibrium, then two oppositely directed force must be equal, i.e., total force on A is equal to zero.

$\vec{F}_{CA} + \vec{F}_{AB} = 0 \Rightarrow \vec{F}_{CA} = -\vec{F}_{AB}$

$\frac{1}{4\pi\varepsilon_0}.\frac{4Q.q}{x^2} = \frac{-1}{4\pi\varepsilon_0}.\frac{Q^2}{x^2} \Rightarrow q = -\frac{Q}{4}$

3. **(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 θ decreases therefore torque decreases.

4. **(d)** Since, electric potential is constant throughout the volume, hence electric field, $E = -\frac{dV}{dr} = 0$.

5. **(a)** For the curved surface, θ = 90º

$\therefore\ \phi = E\, ds\cos 90^\circ = 0$.

6. **(c)**

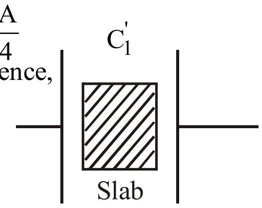
7. **(c)** Before introducing a slab capacitance of plates

$C_1 = \frac{\varepsilon_0 A}{3}$

If a slab of dielectric constant K is introduced between plates then

$C = \frac{K\varepsilon_0 A}{d}$ then $C_1' = \frac{\varepsilon_0 A}{2.4}$

C_1 and C_1' are in series hence,



$\frac{\varepsilon_0 A}{3} = \frac{k\frac{\varepsilon_0 A}{3}\cdot\frac{\varepsilon_0 A}{2.4}}{k\frac{\varepsilon_0 A}{3} + \frac{\varepsilon_0 A}{2.4}}$

$3k = 2.4k + 3 \Rightarrow 0.6k = 3$

Hence, the dielectric constant of slap is given by,

$k = \frac{30}{6} = 5$

8. **(d)**

9. **(d)** $I = neAv_d = 2\times10^{21}\times1.6\times10^{-19}\times10\times0.25\times10^{-3}$

$= 2\times1.6\times0.25 = \frac{8}{10} = 0.8\text{ A}$

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

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

11. **(b)** $H = I^2Rt$ or $R = \frac{H}{(I^2t)} = \frac{80}{(2^2 \times 10)} = 2\Omega$

12. **(b)** The working principle of meter bridge is

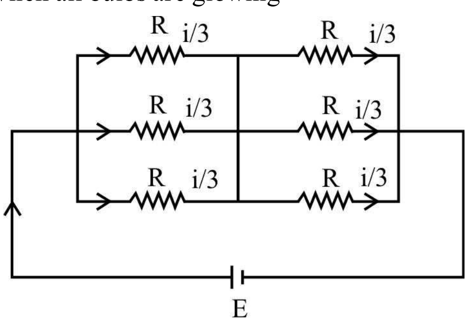
$$\frac{R}{S} = \frac{l}{100 - l} \quad \ldots\text{(i)}$$

When S' is connected in parallel with S we obtain equivalent resistance S_{eq} of S and S' which is less than S. Thus if the value of denominator of L.H.S. of eq. (i) decreases then value of denominator of R.H.S. of eq. (i) also decreases. For this to happen the null point shifts to the right of D.

13. **(c)**

14. **(a)** Potential gradient $= \frac{\text{Pot. Difference}}{\text{length of wire}} = \frac{V_A - V_B}{\ell}$

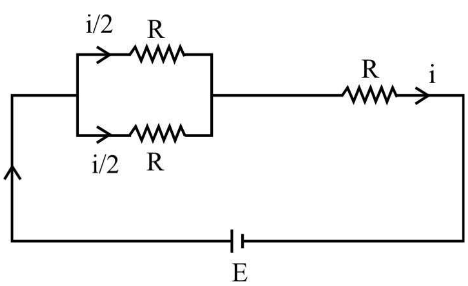
15. **(b)** When all bulbs are glowing



$$R_{eq} = \frac{R}{3} + \frac{R}{3} = \frac{2R}{3}$$

$$\text{Power } (P_i) = \frac{E^2}{R_{eq}} = \frac{3E^2}{2R} \quad \ldots\text{(i)}$$

When two from section A and one from section B are glowing, then



$$R_{eq} = \frac{R}{2} + R = \frac{3R}{2}$$

$$\text{Power } (P_f) = \frac{2E^2}{3R} \quad \ldots\text{(ii)}$$

Dividing equation (i) by (ii) we get

$$\frac{P_i}{P_f} = \frac{3E^2 3R}{2R\, 2E^2} = 9:4$$

16. **(c)** Here, $n = \frac{600}{0.6} = 1000$ turns / m $I = \mu A$

$I = 0.6\ m$, $r = 0.02\ m$ $\because \frac{1}{r} = 30$ *i.e.* $I >> r$

Hence, we can use long solenoid formula, them

$\therefore\ B = \mu_0 nI = 4 \times 10^{-7} \times 10^3 \times 4$

$= 50.24 \times 10^{-4} = 5.024 \times 10^{-3}$ T

17. **(c)** $B_{axis} = \left(\frac{\mu_0 NI}{2x^3}\right)R^2$

$B \propto R^2$

So, when radius is tripled, magnetic field becomes 9 times.

18. **(d)** **19.** **(b)**

20. **(c)** The magnetic moment of a bar magnet is thus equal to the magnetic moment of an equivalent solenoid that produces the same magnetic field.

21. **(d)**

22. **(a)** Induced e.m.f. $\varepsilon = \frac{d\phi}{dt} = \frac{dBA}{dt} = A_0 \frac{dB}{dt}$

$$= A_0\left(\frac{4B_0 - B_0}{t}\right) = 3A_0 B_0 / t$$

23. **(b)** We know that $\mathbf{I}_{rms} = \mathbf{I}_0/\sqrt{2}$ and $\mathbf{I}_m = 2\mathbf{I}_0/\pi$

$$\therefore\ \frac{\mathbf{I}_m}{\mathbf{I}_{rms}} = \frac{2\sqrt{2}}{\pi}$$

24. **(b)** In an inductor voltage leads the current by $\frac{\pi}{2}$ or current lags the voltage by $\frac{\pi}{2}$.

25. **(c)** $i = 3 \sin \omega t + 4 \cos \omega t$

$$= 5\left[\frac{3}{5}\sin \omega t + \frac{4}{5}\cos \omega t\right] = 5\,[\sin(\omega t + \delta)] \quad \ldots(1)$$

$$\Rightarrow \text{ rms value} = \frac{5}{\sqrt{2}} \Rightarrow \text{mean value} = \frac{\int_{T_1}^{T_2} i\, dt}{\int_{T_1}^{T_2} dt}$$

$\therefore$ initial value is not given hence the mean value will be difference for various time intervals.

If voltage applied is $V = V_m \sin \omega t$ then i given by eq. (1) indicates that it is ahead of V by δ where $0 < \delta < 90°$ which indicates that the circuit contains R and C.

26. **(b)** Here $q_1 = q_2 = 3.2 \times 10^{-7}$ C, $r = 60$ cm $= 0.6\ m$

Electrostatic force, $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$

$$= \frac{9 \times 10^9 (3.2 \times 10^{-7})^2}{(0.6)^2} = 2.56 \times 10^{-3}\ N$$

27. **(b)** Capacitance of a parallel plate capacitor with air is

$$C = \frac{\varepsilon_0 A}{d} \qquad \ldots \text{(i)}$$

Here, A = area of plates of capacitor,
d = distance between the plates

Capacitance of a same parallel plate capacitor with introduction of dielectric medium of dielectric constant K is

$$C' = \frac{K\varepsilon_0 A}{d} \qquad \ldots \text{(ii)}$$

Dividing (ii) by (i)

$$\Rightarrow \frac{C'}{C} = K \Rightarrow \frac{30}{6} = K \Rightarrow K = 5$$

$$\Rightarrow K = \frac{\varepsilon}{\varepsilon_0}$$

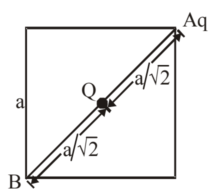
$$\Rightarrow \varepsilon = K\varepsilon_0 = 5 \times 8.85 \times 10^{-12}$$

$$= 0.44 \times 10^{-10}\ C^2N^{-1}m^{-2}$$

28. **(b)** On touching the metal knob with a positively charged rod some electrons from the gold leaves get transferred to the rod making gold leaves positively charged and they get separated. When a negatively charged rod is touched with metal knob some negative charge flows to the gold leaves lessening the positive charge there and the separation between the leaves decreases.

29. **(d)** Unit positive charge at O will be repelled equally by three charges at the three corners of triangle. By symmetry, resultant $\vec{E}$ at O would be zero.

30. **(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, $W = q(V_A - V_B) = 0$

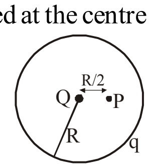
31. **(c)** $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$

Here R = 100 W, L = 0.5 henry, C = 10 × 10^6 farad

ω = 2 p π = 100 π.

32. **(a)**

33. **(c)** Electric potential due to charge Q placed at the centre of the spherical shell at point P is



$$V_1 = \frac{1}{4\pi\varepsilon_o}\frac{Q}{R/2} = \frac{1}{4\pi\varepsilon_o}\frac{2Q}{R}$$

Electric potential due to charge q on the surface of the spherical shell at any point inside the shell is

$$V_2 = \frac{1}{4\pi\varepsilon_o}\frac{q}{R}$$

∴ The net electric potential at point P is

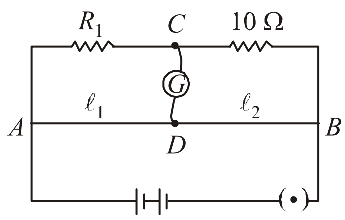
$$V = V_1 + V_2 = \frac{1}{4\pi\varepsilon_o}\frac{2Q}{R} + \frac{1}{4\pi\varepsilon_o}\frac{q}{R}$$

34. **(c)** For metals temperature coefficient of resistance is positive while for insulators and semiconductors, temperature coefficient of resistance is negative.

35. **(c)**

36. **(d)** Fuse is an safety device that operates to provide over current protection of an electrical circuit. A fuse is mainly a metal wire that melts when too much current flows through it due to low melting point and protects electric appliances.

37. **(a)** Let R_1 be the resistance of resistance wire.



From the balancing condition of metre bridge,

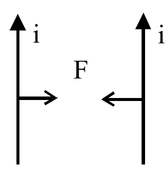
$$\frac{R_1}{10} = \frac{\ell_1}{\ell_2} = \frac{3}{2} \Rightarrow R_1 = \frac{30}{2} = 15\Omega$$

Length of 15Ω resistance wire is 1.5 m.

∴ Length of 1 Ω resistance wire

$$= \frac{1.5}{15} = 0.1 \text{ m} = 1.0 \times 10^{-1} \text{ m}$$

38. **(b)** $\frac{F}{\ell} = \frac{\mu_0 i_1 i_2}{2\pi d} = \frac{\mu_0 i^2}{2\pi d}$



(attractive as current is in the same direction)

39. **(c)** $M = NiA \Rightarrow M \propto A$

$\Rightarrow M \propto r^2$ [As $\ell = 2\pi r \Rightarrow \ell \propto r$]

$\Rightarrow M \propto \ell^2$

40. **(a)** $\tan\theta = \frac{V}{H}, \tan\theta' = \frac{V}{H\cos x}$

$$\frac{\tan\theta'}{\tan\theta} = \frac{1}{\cos x}$$

41. **(d)** According to Lenz's law

42. **(d)** Power in primary of transformer is

$P_P = V_p . I_P = 220 \times 0.5$

$= 110$ W

But power in secondary of transformer is

$Ps = 100$ W

$\therefore \quad \eta = \frac{100}{110} = 0.9 = 90\%$

43. **(d)** According to Faraday's law of electromagnetic induction,

Induced emf, $e = \frac{Ldi}{dt}$

$$50 = L\left(\frac{5-2}{0.1\text{sec}}\right)$$

$$\Rightarrow \quad L = \frac{50 \times 0.1}{3} = \frac{5}{3} = 1.67 \text{ H}$$

44. **(d)** Given : $M = 0.75$ H and $\frac{dI}{dt} = \frac{0.5-0}{0.01} = 50$ A / s

$\therefore$ Average induced e.m.f. in secondary coil

$$e = M\frac{dI}{dt} = 0.75 \times 50 = 37.5 \text{ V}$$

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

46. **(a)**

47. **(b)** In both the cases, the magnetic flux will change, and so there is an induced current.

48. **(c)** An ammeter should have a low resistance which we get when we connect low resistance in parallel with galvanometer.

49. **(c)** The electric field will increase if positive charge is brought in an electric field.

50. **(c)** $I_g = 10 \times 10^{-3}/5 = 2 \times 10^{-3}$ A;

$$R = \frac{V}{I_g} - R_g = \frac{1}{2\times10^{-3}} - 5 = 495\Omega.$$

51. **(b)**

52. **(c)** Av. electric field energy $= \left(\frac{1}{2}CV_{rms}^2\right) = 25 \times 10^{-3}$ J

$\therefore \quad \frac{1}{2}C \times (I_{rms}X_C)$

$\therefore \quad \frac{1}{2} \times C.I^2_{rms} \times \frac{1}{4\pi^2 v^2 c^2} = 25 \times 10^{-3}$ J

$\therefore \quad C = 20\mu F$

53. **(c)** Av. magnetic energy $\left(\frac{1}{2}LI_{rms}^2\right)$

$\therefore \quad L = \frac{2 \times 5 \times 10^{-3}}{(.10)^2} \Rightarrow L = 1$ henry

54. **(d)** The sum for rms voltage across C, rms voltage across R and rms voltage across L is not equal to rms voltage across ideal ac source.

55. **(a)** At resonance, $\omega L = \frac{1}{\omega C}$

Hence the impedance of the circuit would be just equal to R (minimum). In other words, the LCR-series circuit will behave as a purely resistive circuit. Due to this the current is maximum. This condition is known as resonance

$\therefore \quad Z = R, \quad \text{Current} = \frac{V}{R}$