Sample Paper 7

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

SOLUTIONS

1. **(a)** Current flowing through the conductor, I = n e v A. Hence

$$\frac{4}{1}=\frac{nev_{d_1}\pi(1)^2}{nev_{d_2}\pi(2)^2} \text{ or } \frac{v_{d_1}}{v_{d_2}}=\frac{4\times 1}{1}=\frac{16}{1}.$$

2. **(b)** Because as temperature increases, the resistivity increases and hence the relaxation time decreases for conductors $\left(\tau \propto \frac{1}{\rho}\right)$

3. **(d)** The total volume remains the same before and after stretching.

Therefore $A\times\ell = A'\times\ell'$

Here $\ell' = 2\ell$

$$\therefore \quad A' = \frac{A\times\ell}{\ell'}=\frac{A\times\ell}{2\ell}=\frac{A}{2}$$

Percentage change in resistance

$$=\frac{R_f-R_i}{R_i}\times 100=\frac{\rho\left(\frac{\ell'}{A'}-\frac{\ell}{A}\right)}{\rho\frac{\ell}{A}}\times 100$$

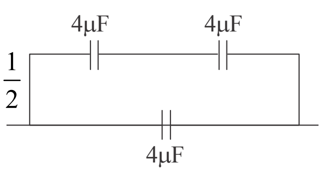
$$=\left[\left(\frac{2\ell}{A/2}\times\frac{A}{\ell}\right)-1\right]\times 100=300\%$$

4. **(b)** **5.** **(b)** **6.** **(a)**

7. **(d)** To get effective capacitance of 6 μF two capacitors of 4 μF each connected in sereies and one of 4 μF capacitor in parallel with them.

Two capacitors in series

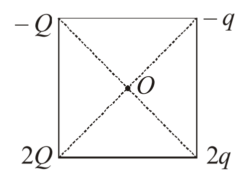
$$\therefore \frac{1}{C}=\frac{1}{C_1}+\frac{1}{C_2}=\frac{1}{4}+\frac{1}{4}=\frac{1}{2}$$



1 capacitor in parallel

$$\therefore C_{eq}=C_3+C=4+2=6\,\mu F$$

8. **(a)** Let the side length of square be 'a' then potential at centre O is



$$V=\frac{k(-Q)}{\left(\frac{a}{\sqrt{2}}\right)}+\frac{k(-q)}{\frac{a}{\sqrt{2}}}+\frac{k(2q)}{\frac{a}{\sqrt{2}}}+\frac{k(2Q)}{\frac{a}{\sqrt{2}}}=0 \quad \text{(Given)}$$

$$=-Q-q+2q+2Q=0=Q+q=0\Rightarrow Q=-q$$

9. **(d)** From Coulomb's law $F=\frac{Kq_1q_2}{r^2}$ i.e., $F\propto\frac{1}{r^2}$ which is correctly shown by graph (d).

10. **(a)** Here, $V(x)=\frac{20}{x^2-4}$ volt

We know that $E=-\frac{dV}{dx}=-\frac{d}{dx}\left(\frac{20}{x^2-4}\right)$

or, $E=+\frac{40x}{(x^2-4)^2}$

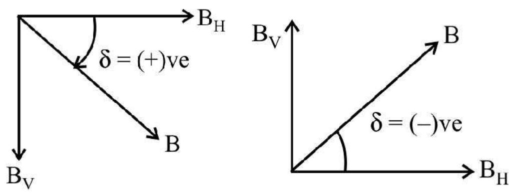
At x = 4 μm,

$$E=+\frac{40\times 4}{(4^2-4)^2}=+\frac{160}{144}=+\frac{10}{9}\text{ volt}/\mu\text{m}.$$

Positive sign indicates that $\vec{E}$ is in +ve x-direction.

11. **(d)**

12. **(c)** As we know that the angle of dip is the angle between earth's resultant magnetic field from horizontal.



At equator, dip is zero. At Northern hemisphere, dip is positive. At southern hemisphere, dip is negative.

13. **(c)** Net magnetic dipole moment = $2\,M\cos\frac{\theta}{2}$

As value of $\cos\frac{\theta}{2}$ is maximum in case (c) hence net magnetic dipole moment is maximum for option (c).

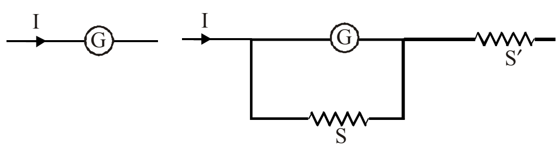
14. **(c)** Force, $\vec{F}_B = q(\vec{V}\times\vec{B})$

which gives direction of force towards centre.

15. **(d)** According to Ampere's circuital law $\oint \vec{B}.\vec{dl} = \mu_o I$

16. **(c)** To keep the main current in the circuit unchanged, the resistance of the galvanometer should be equal to the net resistance.

$$\therefore G = \left(\frac{GS}{G+S}\right) + S' \;\Rightarrow G - \frac{GS}{G+S} = S' \qquad \therefore S' = \frac{G^2}{G+S}.$$



17. **(c)** When current flows through a conductor electrons start moving in the opposite direction of current and collide with the metal atoms or ions in the conductor.

18. **(c)** r = E / I = 1.5 / 3 = 0.5 ohm.

19. **(b)** F = qE = mg (q = 6e = 6 × 1.6 × 10^{-19})

Density (d)

$$\frac{\text{mass}}{\text{volume}} = \frac{m}{\frac{4}{3}\pi r^3} \text{ or } r^3 = \frac{m}{\frac{4}{3}\pi d}$$

Putting the value of v and m (= 2E/g) and solving we get r = 7.8 × 10^{-7} m

20. **(b)** **21.** **(a)**

22. **(c)** Across resistor, $I = \frac{V}{R} = \frac{100}{1000} = 0.1$ A

At resonance,

$$X_L = X_C = \frac{1}{\omega C} = \frac{1}{200\times 2\times 10^{-6}} = 2500$$

Voltage across L is

$IX_L = 0.1 \times 2500 = 250$ V

23. **(c)** $P = V_{r.m.s}\times I_{r.m.s}\times\cos\phi = \frac{1}{2}V_0\,I_0\cos\phi$

$$= \frac{1}{2}\times 100\times(100\times 10^{-3})\cos\pi/3 = 2.5\text{ W}$$

24. **(c)** The magnitude of induced e.m.f. is given by

$|e| = Blv$

v = 300 m/min = 5m/s

$\therefore\; B = \frac{|e|}{lv} = \frac{2}{0.5\times 5} = 0.8$ tesla

25. **(a)** The mutual inductance between two planar concentric rings of radii r_1 and r_2 ($r_1 > r_2$) is given by

$$M = \frac{\mu_0\pi r_2^2}{2r_1}$$

26. **(b)** Reading of potentiometer is accurate because during taking reading it does not draw any current from the circuit.

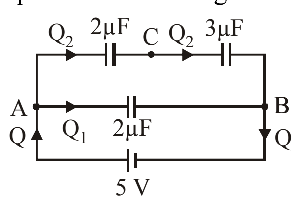
27. **(a)** Given,

Drift velocity of charged particle, $V_d = 7.5\times 10^{-4}$ m/s

Electric field, $E = 3\times 10^{-10}$ Vm^{-1}

Mobility, $\mu = \frac{V_d}{E} = \frac{7.5\times 10^{-4}}{3\times 10^{-10}} = 2.5\times 10^6\ m^2V^{-1}s^{-1}$

28. **(a)** The equivalent circuit diagram as shown in the figure.



The equivalent capacitance between A and B is

$$C_{eq} = \frac{2\mu F\times 3\mu F}{2\mu F + 3\mu F} + 2\mu F = \frac{16}{5}\mu F$$

Total charge of the given circuit is

$$Q = \frac{16}{5}\mu F\times 5V = 16\mu C$$

$$Q_1 = (2\mu F)\times 5V = 10\mu C$$

$\therefore\; Q_2 = Q - Q_1 = 16\ \mu C - 10\ \mu C = 6\ \mu C$

$\therefore$ Voltage between B and C is

$$V_{BC} = \frac{Q_2}{3\mu F} = \frac{6\mu C}{3\mu F} = 2\text{ V}$$

29. **(d)** $V = \frac{V_0}{T/4}t \;\Rightarrow\; V = \frac{4V_0}{T}t$

$$\Rightarrow V_{rms} = \sqrt{<V^2>} = \frac{4V_0}{T}\sqrt{<t^2>} = \frac{4V_0}{T}\left\{\frac{\int_0^{T/4} t^2 dt}{\int_0^{T/4} dt}\right\}^{1/2} = \frac{V_0}{\sqrt{3}}$$

30. **(d)** At resonance ωL = 1/ωC

and i = E/R , So power dissipated in circuit is $P = i^2R$.

31. **(b)** $W_{AB.} = W_{AC} + W_{CB}$

W_{CB} should be zero, because in moving from C to B, we always move perpendicular to field. Hence, force applied by field and displacement will be at 90°.

$W_{AC} = -e(V_C - V_A)$

$V_C - V_A = -E \times AC = -10 \times 4 = -40$

$\therefore \quad W_{AC} = -e \times (-40) = 40e$

So $\quad W_{AB} = 40e\,J = 40\,eV$

32. **(b)** Area of plate $= \pi r^2 = \pi \times (8 \times 10^{-2})^2 = 0.0201\ m^2$

and $d = 1mm = 1 \times 10^{-3}\ m$

Capacity of capacitor

$$C = \frac{\varepsilon_0 \varepsilon_r A}{d} = \frac{8.85 \times 10^{-12} \times 6 \times 0.0201}{1 \times 10^{-3}} = 1.068 \times 10^{-9}\ F$$

Potential difference, V = 150 volt

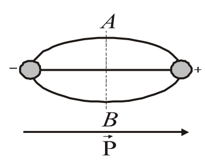
Energy stored,

$$U = \frac{1}{2}CV^2 = \frac{1}{2} \times (1.068 \times 10^{-9}) \times (150)^2$$
$$= 1.2 \times 10^{-5}\ J$$

33. **(a)** $\phi = \vec{E}.\vec{A} = 4\hat{i}.(2\hat{i} + 3\hat{j}) = 8$ V-m

34. **(b)** Electric field is directly proportional to the magnitude of charge and inversely proportional to the square of the distance from the charge. Therefore charge $+Q$ produce a comparatively stronger electric field than $+q$ which get at cancelled with each other at a point closer to $+q$.

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



36. **(a)** Change in flux = 2 B A N

$$\therefore \text{Induced e.m.f.} = \frac{2 \times 0.3 \times 200 \times 70 \times 10^{-4}}{0.1}$$

37. **(a)** Vel. of coil $= \frac{1}{0.5} = 2\,m/s$

velocity of magnet $= \frac{2}{1} = 2\,m/s.$

As they are made to move in the same direction, their relative velocity is zero. Therefore, induced e.m.f. = 0.

38. **(b)**

39. **(d)** $M = \frac{\mu_0 N_1 N_2 A}{\ell} = \frac{4\pi \times 10^{-7} \times 300 \times 400 \times 100 \times 10^{-4}}{0.2}$

$= 2.4\pi \times 10^{-4}$ H

40. **(c)**

41. **(c)** $B = \frac{\mu_0 i\, a^2}{2(x^2 + a^2)^{3/2}}$

$$B' = \frac{\mu_0 i}{2a} = \frac{\mu_0 i\, a^2}{2a(x^2 + a^2)^{3/2}} \left(\frac{(x^2 + a^2)^{3/2}}{a^2} \right)$$

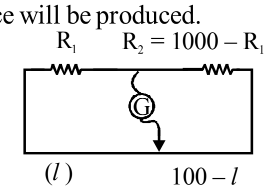
$$B' = \frac{B.(x^2 + a^2)^{3/2}}{a^3}$$

Put $x = 4$ & $a = 3 \Rightarrow B' = \frac{54(5^3)}{3 \times 3 \times 3} = 250\mu T$

42. **(a)** Due to flow of current in same direction at adjacent side, an attractive magnetic force will be produced.

43. **(c)** $R_1 + R_2 = 1000$

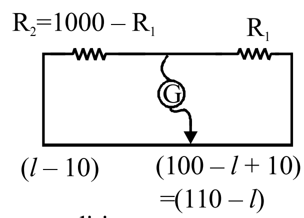
$\Rightarrow R_2 = 1000 - R_1$



On balancing condition

$R_1(100 - l) = (1000 - R_1)l$ ...(i)

On Interchanging resistance balance point shifts left by 10 cm



On balancing condition

$(1000 - R_1)(110 - l)$

$= R_1(l - 10)$

or, $R_1(l - 10)$

$= (1000 - R_1)(110 - l)$ ...(ii)

Dividing eqn (i) by (ii)

$$\frac{100 - l}{l - 10} = \frac{l}{110 - l}$$

$\Rightarrow \quad (100 - l)(110 - l) = l(l - 10)$

$\Rightarrow \quad 11000 = 200l \quad$ or, $\quad l = 55$

Putting the value of 'l' in eqn (i)

$R_1(100 - 55) = (1000 - R_1)\,55$

$\Rightarrow \ R_1(45) = (1000 - R_1)\,55$

$\Rightarrow \ 20R_1 = 11000 \quad \therefore \quad R_1 = 550K\Omega$

44. **(c)** Total power consumed by electrical appliances in the building, $P_{total} = 2500$ W

Watt = Volt × ampere

$\Rightarrow \quad 2500 = V \times I \Rightarrow 2500 = 220\,I \quad \Rightarrow \quad I \approx 12\,A$

(Minimum capacity of main fuse)

45. **(d)** Large eddy currents are produced in non-laminated iron core of the transformer by the induced emf, as the resistance of bulk iron core is very small. By using thin iron sheets as core the resistance is increased. Laminating the core substantially reduces the eddy currents. Eddy current heats up the core of the transformer. More the eddy currents greater is the loss of energy and the efficiency goes down.

46. **(a)**

47. **(c)** In an atom, electrons revolve around the nuclear and such the circular orbits of electrons may be considered as the small current loops. In addition to orbital motion, an electron has got spin motion also. So the total magnetic moment of electron is the vector sum of its magnetic charge moments due to orbital and spin motion. Particles at rest do not produce magnetic field.

48. **(a)** **49.** **(c)**

50. **(c)** Here, $\ell = 2.4\ m,\ r = 4.6\ mm = 4.6 \times 10^{-3}\ m$

$q = -4.2 \times 10^{-7}$ C

Linear charge density, $\lambda = \dfrac{q}{\ell}$

$= \dfrac{-4.2 \times 10^{-7}}{2.4} = -1.75 \times 10^{-7}\ \text{C m}^{-1}$

Electric field, $E = \dfrac{\lambda}{2\pi\varepsilon_0 r}$

$= \dfrac{-1.75 \times 10^{-7}}{2 \times 3.14 \times 8.854 \times 10^{-12} \times 4.6 \times 10^{-3}}$

$= -6.7 \times 10^{5}\ \text{N C}^{-1}$

51. **(d)** In an external electric field, the positive and negative charges of a non-polar molecule are displaced in opposite directions. The displacement stops when the external force on the constituent charges of the molecule is balanced by the restoring force (due to internal fields in the molecule). The non-polar molecule thus develops an induced dipole moment. The dielectric is said to be polarised by the external field.

Sol. (52-55):

We know that

$$r = \frac{mV}{qB} \quad \therefore \quad V > \frac{qBl}{m}$$

52. **(a)** If $r > l$ then particle enter the III region $\dfrac{mV}{qB} > l$

53. **(c)** If $V = \dfrac{qBl}{m}$ then particle will cover semi circular path in this condition the path length of the particle in region II is maximum.

54. **(d)** Time spent in region II, $T = \dfrac{\pi m}{qB}$

It does not depends upon the velocity.

55. **(d)** $F = q(\vec{V} \times \vec{B})$ if $V \parallel B$, then $\vec{F} = 0$