Sample Paper 7

Time : 90 Minutes **Max. Marks : 35**

General Instructions

1. *The Question Paper contains three sections.*
2. *Section A has **25** questions. Attempt any **20** questions.*
3. *Section B has **24** questions. Attempt any **20** questions.*
4. *Section C has **6** questions. Attempt any **5** questions.*
5. *All questions carry equal marks.*
6. *There is no negative marking.*

SECTION-A

*This section consists of 25 multiple choice questions with overall choice to attempt **any 20** questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.*

1. Two wires A and B of the same material, having radii in the ratio 1 : 2 and carry currents in the ratio 4 : 1. The ratio of drift speed of electrons in A and B is

(a) 16 : 1 (b) 1 : 16 (c) 1 : 4 (d) 4 : 1

2. The relaxation time in conductors

(a) increases with the increases of temperature (b) decreases with the increases of temperature

(c) it does not depends on temperature (d) all of sudden changes at 400 K

3. The length of a given cylindrical wire is increased by 100%. Due to the consequent decrease in diameter the change in the resistance of the wire will be

(a) 200% (b) 100% (c) 50% (d) 300%

4. A unit charge moves on an equipotential surface from a point A to point B, then

(a) $V_A - V_B = +$ ve (b) $V_A - V_B = 0$ (c) $V_A - V_B = -$ ve (d) it is stationary

5. When a body is charged by induction, then the body

(a) becomes neutral (b) does not lose any charge

(c) loses whole of the charge on it (d) loses part of the charge on it

6. When an electric dipole $\vec{P}$ is placed in a uniform electric field $\vec{E}$ then at what angle between $\vec{P}$ and $\vec{E}$ the value of torque will be maximum?

(a) 90° (b) 0° (c) 180° (d) 45°

7. Three capacitors each of 4 μF are to be connected in such a way that the effective capacitance is 6μF. This can be done by connecting them :

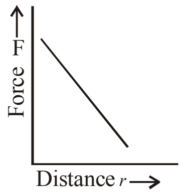
(a) all in series (b) all in parallel

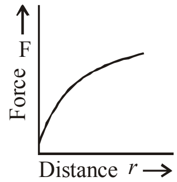
(c) two in parallel and one in series (d) two in series and one in parallel

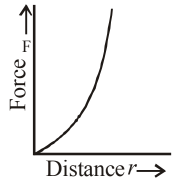
8. Four point charges $-Q$, $-q$, $2q$ and $2Q$ are placed, one at each corner of the square. The relation between Q and q for which the potential at the centre of the square is zero is

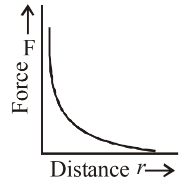
(a) $Q = -q$ (b) $Q = -\frac{1}{q}$ (c) $Q = q$ (d) $Q = \frac{1}{q}$

9. Which of the following graphs shows the correct variation of force when the distance r between two charges varies?

(a) 

(b) 

(c) 

(d) 

10. The potential at a point x (measured in μm) due to some charges situated on the x-axis is given by $V(x) = 20/(x^2 - 4)$ volt. The electric field E at $x = 4$ μm is given by

(a) (10/9) volt/μm and in the +ve x direction
(b) (5/3) volt/μm and in the –ve x direction
(c) (5/3) volt/μm and in the +ve x direction
(d) (10/9) volt/μm and in the –ve x direction

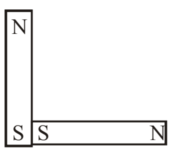
11. The self inductance associated with a coil is independent of

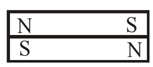
(a) current
(b) time
(c) induced voltage
(d) resistance of coil

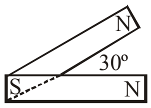
12. At a point A on the earth's surface the angle of dip, $d = +25°$. At a point B on the earth's surface the angle of dip, $d = -25°$. We can interpret that:

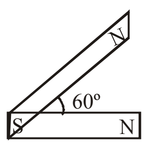
(a) A and B are both located in the northern hemisphere.
(b) A is located in the southern hemisphere and B is located in the northern hemisphere.
(c) A is located in the northern hemisphere and B is located in the southern hemisphere.
(d) A and B are both located in the southern hemisphere.

13. Following figures show the arrangement of bar magnets in different configurations. Each magnet has magnet ic dipole moment $\vec{m}$. Which configuration has highest net magnetic dipole moment?

A. 

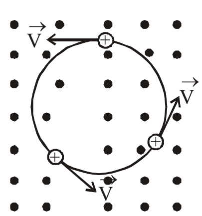
B. 

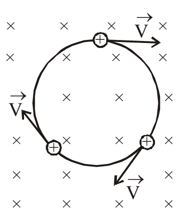
C. 

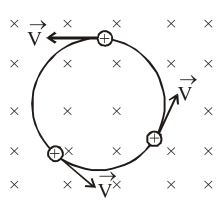
D. 

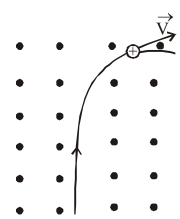
(a) A
(b) B
(c) C
(d) D

14. A positively charged particle enters in a uniform magnetic field with velocity perpendicular to the magnetic field. Which of the following figures shows the correct motion of charged particle?

(a) 

(b) 

(c) 

(d) 

15. Ampere's circuital law states that

(a) the surface integral of magnetic field over the open surface is equal to μ_0 times the total current passing through the surface.
(b) the surface integral of magnetic field over the open surface is equal to μ_0 times the total current passing near the surface.
(c) the line integral of magnetic field along the boundary of the open surface is equal to μ_0 times the total current passing near the surface.
(d) the line integral of magnetic field along the boundary of the open surface is equal to μ_0 times the total current passing through the surface.

16. A galvanometer of resistance, G is shunted by a resistance S ohm. To keep the main current in the circuit unchanged, the resistance to be put in series with the galvanometer is

(a) $\frac{S^2}{(S+G)}$ (b) $\frac{SG}{(S+G)}$ (c) $\frac{G^2}{(S+G)}$ (d) $\frac{G}{(S+G)}$

17. The cause of heat production in a current carrying conductor is

(a) collisions of free electrons with one another

(b) high drift speed of free electrons

(c) collisions of free electrons with atoms or ions of the conductor

(d) high resistance value

18. A primary cell has an e.m.f. of 1.5 volt. When short-circuited it gives a current of 3 ampere. The internal resistance of the cell is

(a) 4.5 ohm (b) 2 ohm (c) 0.5 ohm (d) (1/4.5) ohm

19. A liquied drop having 6 excess electrons is kept stationary under a uniform electric field of 25.5 KVm^{-1}. The density of liquid is 1.26×10^3 kg m^{-3}. The radius of the drop is (neglect buoyany)

(a) 4.3×10^{-7} m (b) 7.3×10^{-7} m (c) 0.078×10^{-7} m (d) 3.4×10^{-7} m

20. Two capacitors of capacitances 3μF and 6μF are charged to a potential of 12V each. They are now connected to each other, with the positive plate of each joined to the negative plate of the other. The potential difference across each will be

(a) zero (b) 4 *V* (c) 6 *V* (d) 12 *V*

21. An ac voltage is represented by

$$E = 220\sqrt{2}\cos(50\pi)t$$

How many times will the current become zero in 1 s?

(a) 50 times (b) 100 times (c) 30 times (d) 25 times

22. In a series resonant LCR circuit, the voltage across R is 100 volts and R = 1 kΩ with C = 2μF. The resonant frequency ω is 200 rad/s. At resonance the voltage across L is

(a) 2.5×10^{-2} V (b) 40 V (c) 250 V (d) 4×10^{-3} V

23. In an a.c. circuit V and **I** are given by

$V = 100 \sin(100\,t)$ volts

$\mathbf{I} = 100 \sin(100\,t + \pi/3)$ mA

the power dissipated in the circuit is

(a) 10^4 watt (b) 10 watt (c) 2.5 watt (d) 5.0 watt

24. A wire of length 50 cm moves with a velocity of 300 m/min, perpendicular to a magnetic field. If the e.m.f. induced in the wire is 2 V, the magnitude of the field in tesla is

(a) 2 (b) 5 (c) 0.8 (d) 2.5

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

(a) $\frac{\mu_0 \pi r_2^2}{2r_1}$ (b) $\frac{\mu_0 \pi r_1^2}{2r_2}$ (c) $\frac{\mu_0 \pi (r_1 + r_2)^2}{2r_1}$ (d) $\frac{\mu_0 \pi (r_1 + r_2)^2}{2r_2}$

SECTION-B

This section consists of 24 multiple choice questions with overall choice to attempt ***any 20*** *questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.*

26. A potentiometer is an accurate and versatile device to make electrical measurements of E.M.F. because the method involves

(a) Potential gradients

(b) A condition of no current flow through the galvanometer

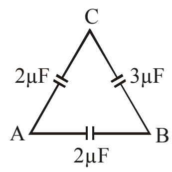
(c) A combination of cells, galvanometer and resistances

(d) Cells

27. A charged particle having drift velocity of 7.5×10^{-4} m s^{-1} in an electric field of 3×10^{-10} Vm^{-1}, has a mobility in $m^2 V^{-1} s^{-1}$ of :

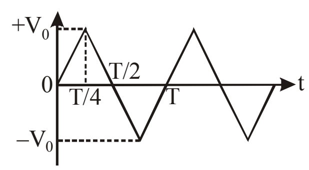
(a) 2.5×10^{6} (b) 2.5×10^{-6} (c) 2.25×10^{-15} (d) 2.25×10^{15}

28. Three capacitors are connected in the arms of a triangle ABC as shown in figure 5 V is applied between A and B. The voltage between B and C is



(a) 2V (b) 1V (c) 3V (d) 1.5V

29. The voltage time (V-t) graph for triangular wave having peak value V_0 is as shown in figure. The rms value of V in time interval from t = 0 to T/4 is $\frac{V_0}{\sqrt{x}}$ then find the value of x.



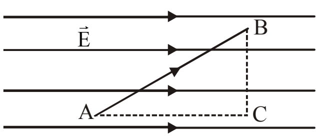
(a) 5 (b) 4 (c) 7 (d) 3

30. In a series resonant circuit, having L,C and R as its elements, the resonant current is i. The power dissipated in circuit at resonance is

(a) $\frac{i^2R}{(\omega L - 1/\omega C)}$ (b) zero (c) $i^2 \omega L$ (d) $i^2 R$

Whereas ω is angular resonant frequency

31. An electron is taken from point A to point B along the path AB in a uniform electric field of intensity E = 10 Vm^{-1}. Side AB = 5 m, and side BC = 3 m. Then, the amount of work done on the electron is



(a) 50 eV (b) 40 eV (c) – 50 eV (d) – 40 eV

32. A capacitor has two circular plates whose radius are 8cm and distance between them is 1mm. When mica (dielectric constant = 6) is placed between the plates, the capacitance of this capacitor and the energy stored when it is given potential of 150 volt respectively are

(a) 1.06×10^{-5} F, 1.2×10^{-9} J (b) 1.068×10^{-9} F, 1.2×10^{-5} J

(c) 1.2×10^{-9} F, 1.068×10^{-5} J (d) 1.6×10^{-9} F, 1.208×10^{-5} J

33. A surface has the area vector $\vec{A} = \left(2\hat{i} + 3\hat{j}\right)m^2$. The flux of an electric field through it if the field is $\vec{E} = 4\hat{i}\,\frac{V}{m}$:

(a) 8V-m (b) 12V-m (c) 20V-m (d) zero

34. Two point charges + Q and + q are separated by a certain distance. If + Q > + q then in between the charges the electric field is zero at a point

(a) closer to + Q

(b) closer to + q

(c) exactly at the mid-point of line segment joining + Q and + q.

(d) no where on the line segment joining + Q and + q.

35. The electric field at a point on equatorial line of a dipole and direction of the dipole moment

(a) will be parallel (b) will be in opposite direction

(c) will be perpendicular (d) are not related

36. A coil has 200 turns and area of 70 cm^2. The magnetic field perpendicular to the plane of the coil is 0.3 Wb/m^2 and take 0.1 sec to rotate through 180º.The value of the induced e.m.f. will be

(a) 8.4 V (b) 84 V (c) 42 V (d) 4.2 V

37. A circular coil and a bar magnet placed nearby are made to move in the same direction. If the coil covers a distance of 1 m in 0.5. sec and the magnet a distance of 2 m in 1 sec, the induced e.m.f. produced in the coil is

(a) zero (b) 0.5 V (c) 1 V (d) 2V.

38. In series L-C-R circuit, the voltages across R, L and C are V_R, V_L and V_C respectively. Then the voltage of applied a.c. source must be

(a) $V_R + V_L + V_C$ (b) $\sqrt{[(V_R)^2 + (V_L - V_C)^2]}$

(c) $V_R + V_C - V_L$ (d) $[(V_R + V_L)^2 + (V_C)^2]^{1/2}$

39. Two coaxial solenoids are made by winding thin insulated wire over a pipe of cross-sectional area A = 10 cm^2 and length = 20 cm. If one of the solenoid has 300 turns and the other 400 turns, their mutual inductance is

$(\mu_0 = 4\pi \times 10^{-7}\ \text{Tm A}^{-1})$

(a) $2.4\pi \times 10^{-5}$ H (b) $4.8\pi \times 10^{-4}$ H

(c) $4.8\pi \times 10^{-5}$ H (d) $2.4\pi \times 10^{-4}$ H

40. A bar magnet is cut into two equal halves by a plane parallel to the magnetic axis. Of the following physical quantities the one which remains unchanged is

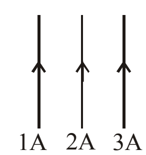
(a) pole strength (b) magnetic moment

(c) intensity of magnetisation (d) None of these

41. The magnetic field due to a current carrying circular loop of radius 3 cm at a point on the axis at a distance of 4 cm from the centre is 54 μT. What will be its value at the centre of loop?

(a) 125 μT (b) 150 μT (c) 250 μT (d) 75 μT

42. Three wires are situated at the same distance. A current of 1A, 2A, 3A flows through these wires in the same direction. What is ratio of F_1/F_2, where F_1 is force on 1 and F_2 on 2?



(a) 7/8 (b) 1

(c) 9/8 (d) None of these

43. On interchanging the resistances, the balance point of a meter bridge shifts to the left by 10 cm. The resistance of their series combination is 1kΩ. How much was the resistance on the left slot before interchanging the resistances?

(a) 990 Ω (b) 505 Ω (c) 550 Ω (d) 910 Ω

44. In a large building, there are 15 bulbs of 40 W, 5 bulbs of100 W, 5 fans of 80 W and 1 heater of 1 kW. The voltage of electric mains is 220 V. The minimum capacity of the main fuse of the building will be:

(a) 8 A (b) 10 A (c) 12 A (d) 14 A

Given below are two statements labelled as Assertion (A) and Reason (R). Select the most appropriate answer from the options given below:

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true but R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false and R is also false.

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45. **Assertion :** A laminated core is used in transformers to increase eddy currents.

Reason : The efficiency of a transformer increases with increase in eddy currents.

46. **Assertion :** A capacitor blocks direct current in the steady state.

Reason : The capacitive reactance of the capacitor is inversely proportional to frequency f of the source of emf.

47. **Assertion :** Magnetic moment of an atom is due to both the orbital motion and spin motion of every electron.

Reason : A charged particle produces magnetic field.

48. **Assertion :** In the absence of an external electric field, the dipole moment per unit volume of a polar dielectric is zero.

Reason : The dipoles of a polar dielectric are randomly oriented.

49. **Assertion :** In the purely resistive element of a series LCR, AC circuit the maximum value of rms current increases with increase in the angular frequency of the applied emf.

Reason : $\varepsilon_{max} = \frac{I_{max}}{z}$, $z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$, where I_{max} is the peak current in a cycle.

SECTION-C

This section consists of 6 multiple choice questions with an overall choice to attempt ***any 5****. In case more than desirable number of questions are attempted, ONLY first 5 will be considered for evaluation.*

50. A rod of length 2.4 *m* and radius 4.6 *mm* carries a negative charge of 4.2×10^{-7} C spread uniformly over it surface. The electric field near the mid–point of the rod, at a point on its surface is

(a) -8.6×10^5 N C^{-1} (b) 8.6×10^4 N C^{-1} (c) -6.7×10^5 N C^{-1} (d) 6.7×10^4 N C^{-1}

51. Consider the following statements and select the correct option

I. In an external electric field, the positive and negative charges of a non–polar molecule are displaced in opposite directions.

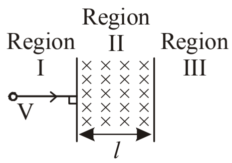
II. In non –polar molecules displacement stops when the external force on the constituent charges of the molecule is balanced by the restoring force.

III. The non–polar molecule develops an induced dipole moment.

(a) I and II (b) II and III (c) I and III (d) I, II and III

Case Study : *Read the following paragraph and answers the questions.*

A particle of mass *m* and charge *q*, moving with velocity *V* enters Region II normal to the boundary as shown in the figure. Region II has a uniform magnetic field *B* perpendicular to the plane of the paper. The length of the Region II is *l*.



52. (a) The particle enters Region III only if its velocity $V > \frac{qB}{m}$

(b) The particle enters Region III only if its velocity $V < \frac{qlB}{m}$

(c) The particle enters Region III only if its velocity $V = \frac{qlB}{m}$

(d) All of the above

53. Path length of the particle in Region II is maximum when

(a) velocity $V = \frac{qlB}{2m}$ (b) velocity $V = \frac{2qlB}{m}$

(c) velocity $V = \frac{qlB}{m}$ (d) velocity $V = \frac{4qlB}{m}$

54. Time spent in Region II as long as the particle returns to Region I is

(a) two times if velocity *V* is doubled (b) halved if velocity is doubled

(c) halved if velocity is halved (d) same for any value of *V*

55. A charged particle moves with velocity $\vec{V}$ in a uniform magnetic field $\vec{B}$. The magnetic force experienced by the particle is

(a) always zero (b) never zero

(c) zero, if $\vec{B}$ and $\vec{V}$ are perpendicular (d) zero, if $\vec{B}$ and $\vec{V}$ are parallel

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

$$\frac{4}{1}=\frac{nev_{d_1}\pi(1)^2}{nev_{d_2}\pi(2)^2} \text{ or } \frac{v_{d_1}}{v_{d_2}}=\frac{4\times1}{1}=\frac{16}{1}.$$

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 $\ell'=2\ell$

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

Percentage change in resistance

$$=\frac{R_f-R_i}{R_i}\times100=\frac{\rho\left(\frac{\ell'}{A'}-\frac{\ell}{A}\right)}{\rho\frac{\ell}{A}}\times100$$

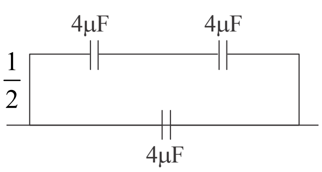
$$=\left[\left(\frac{2\ell}{A/2}\times\frac{A}{\ell}\right)-1\right]\times100=300\%$$

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

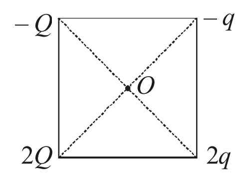
$$\therefore\frac{1}{C}=\frac{1}{C_1}+\frac{1}{C_2}=\frac{1}{4}+\frac{1}{4}=\frac{1}{2}$$



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

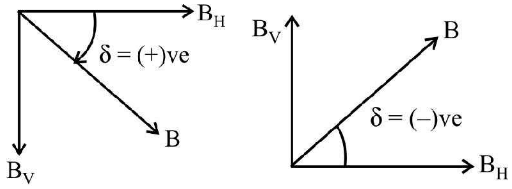
At x = 4 μm,

$$E=+\frac{40\times4}{(4^2-4)^2}=+\frac{160}{144}=+\frac{10}{9}\text{ volt}/\mu\text{m}.$$

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).

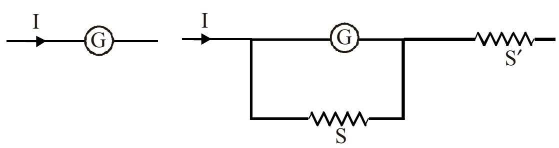
14. (c) Force, $\vec{F}_B = q(\vec{V} \times \vec{B})$

which gives direction of force towards centre.

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

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) $F = qE = mg$ ($q = 6e = 6 \times 1.6 \times 10^{-19}$)

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 $r = 7.8 \times 10^{-7}$ 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 $= 5$m/s

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

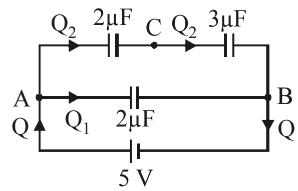
27. (a) Given,

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

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

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

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

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

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

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

$\therefore \quad$ 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 $\omega L = 1/\omega C$

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

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

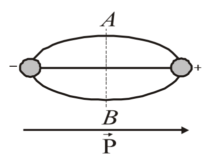
Energy stored,

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

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 $= \frac{1}{0.5} = 2m/s$

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

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 $\Rightarrow B' = \frac{54(5^3)}{3 \times 3 \times 3} = 250\mu T$

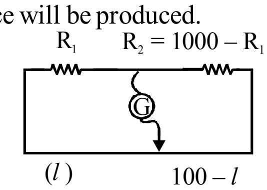
42. (a) Due to flow of current in same direction at adjacent side, an attractive magnetic force will be produced.

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

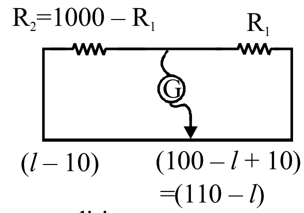
$\Rightarrow R_2 = 1000 - R_1$

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, $\lambda = \dfrac{q}{\ell}$

$= \dfrac{-4.2\times10^{-7}}{2.4} = -1.75 \times 10^{-7}\ \text{C m}^{-1}$

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

$= \dfrac{-1.75\times10^{-7}}{2\times3.14\times8.854\times10^{-12}\times4.6\times10^{-3}}$

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

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

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

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 $V \square B$, then $\vec{F} = 0$