SAMPLE PAPER

PHYSICS

*A Highly Simulated Practice Questions Paper for CBSE **Class XII** (Term I) Examination*

Instructions

1. This question paper is divided into three sections.
*2. **Section - A** contains 25 questions. Attempt **any 20** questions.*
*3. **Section - B** contains 24 questions. Attempt **any 20** questions.*
*4. **Section - C** contains 6 questions. Attempt **any 5** questions.*
5. Each question carries 0.77 mark.
*6. There is **no** negative marking.*

Roll No. | | | | | | | |

Maximum Marks : 35
Time allowed : 90 min

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. The magnitude of electric field between two uniformly charged parallel sheets with surface charge density of 3.6×10^{-14} C/m^2 is

(a) 2 N/C (b) 20 N/C (c) 200 N/C (d) None of these

2. A cylinder of radius R and length L is placed in a uniform electric field E, parallel to the cylinder axis. The total flux for the curved surface of the cylinder is

(a) zero (b) $E\pi R^2$ (c) $\frac{\pi R^2}{E}$ (d) $2\pi R^2 E$

3. The unit of electric permittivity is

(a) V/m^2 (b) J/C (c) F/m (d) H/m

4. Three charges $-q$, $+Q$ and $-q$ are placed at equal distance on a straight line. If the potential energy of the system of the three charges is zero, then the ratio of $Q : q$ is

(a) 1 : 4 (b) 4 : 1 (c) 2 : 1 (d) 3 : 1

5. Conducting sphere of radius R_1 is covered by concentric sphere of radius R_2. Capacity of this combination is proportional to

(a) $\frac{R_2 - R_1}{R_1 R_2}$ (b) $\frac{R_2 + R_1}{R_1 R_2}$ (c) $\frac{R_1 R_2}{R_1 + R_2}$ (d) $\frac{R_1 R_2}{R_2 - R_1}$

6. A parallel plate capacitor is made by stocking n equally spaced plates alternately. If the capacitance between any two plates is x, then the total capacitance is

(a) nm (b) n/m (c) mn^2 (d) $(n-1)x$

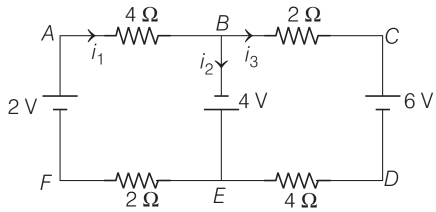
7. For a metallic wire, the ratio of potential difference (V) and current (i) flowing is

(a) independent of temperature
(b) increases as the temperature rises
(c) decreases as the temperature rises
(d) increases or decreases as temperature rises depending upon the metal

8. Four cells, each of emf E and internal resistance r, are connected in series across an external resistance R. By mistake one of the cells is connected in reverse. Then, the current in the external circuit is

(a) $\frac{2E}{4r+R}$ (b) $\frac{3E}{4r+R}$
(c) $\frac{3E}{3r+R}$ (d) $\frac{2E}{3r+R}$

9. A circuit diagram is shown below. For loop $ABEFA$, the expression for the net voltage is



(a) $-4i_1+4-2i_1+2=0$ (b) $-2i_3-6-4i_3-4=0$
(c) $4i_1-4-2i_1+2=0$ (d) $+2i_3+6-4i_3-4=0$

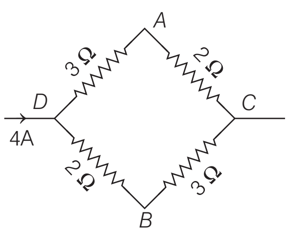
10. A potential difference of V is applied at the ends of a copper wire of length l and diameter D. On doubling only D, drift speed

(a) becomes double (d) becomes half
(c) does not change (b) becomes one-fourth

11. Which of the following is the main cause of heat production in a current carrying? conductor?

(a) Collisions of free elctrons with one another
(b) High drift speed of free electrons
(c) Collision of free electrons with atoms or ions of the conductor
(d) High resistance value

12. A current of 4A flows in the resistance network as shown below. The potential difference $V_A - V_B$ will be

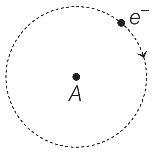


(a) $+4$ V (b) -2 V (c) $+2$ V (d) -1 V

13. A galvanometer is shunted by a resistance of $\frac{1}{r}$. The fraction of total current passing through the galvanometer is

(a) $\frac{1}{1+r^2}$ (b) $\frac{1}{1+r}$ (c) r (d) r^2+1

14. An electron is revolving around a circular loop as shown in the figure. The direction of magnetic field at the point A will be



(a) inward (b) outward (c) zero (d) Cannot determine

15. When the radius of a circular loop carrying current is doubled, its magnetic moment will be (Take, $n=1$)

(a) $\mathbf{M}$ (b) $\frac{\mathbf{M}}{4}$ (c) $4\mathbf{M}$ (d) zero

16. Magnetic moment of an atom is due to

(a) orbital motion of electron
(b) spin motion of electron
(c) radial motion of electrons
(d) Both (a) and (b)

17. The ratio of horizontal component to the total magnetic field of the earth at a place, where angle of dip is 30° will be

(a) $2:\sqrt{3}$ (b) $\sqrt{3}:2$ (c) $2:\sqrt{2}$ (d) $2:3$

18. Two current carying coils are placed close to each other. The mutual inductance of the pair of coils depends upon which of the following factors?

(a) Distance between two coils (b) Geometry of two coils
(c) Both (a) and (b) (d) None of these

19. Self induction of an air core inductor increases from 0.01 mH to 10 mH on introducing an iron core into it. The relative permeability of the core used is

(a) 10 (b) 100 (c) 1000 (d) 1

20. Two coils have mutual inductance of 1.5 H. If current in primary coil is raised to 5A in one millisecond after closing the circuit, emf induced in the secondary coil is

(a) 2.5×10^3 V (b) 5.0×10^3 V (c) 7.5×10^3 V (d) 8.0×10^3 V

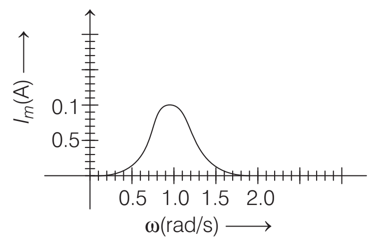
21. An expression for alternating current in a circuit is given as $I = 2\sin(100\pi t + \pi/3)$A. The first time, when the current is maximum will be

(a) 0.01 s (b) 0.002 s (c) 0.005 s (d) 0.05 s

22. The core of a transformer is laminated. Which of the following is the correct result of it?

(a) Energy losses due to eddy currents may be minimised.
(b) The weight of the transformer may be reduced.
(c) Rusting of the core may be prevented.
(d) Ratio of voltage in primary and secondary may be increased.

23. In series *L-C-R* circuit, the plot of $I_{\max}$ *versus* ω is shown in the figure. The bandwidth of the circuit (in rad/s) is

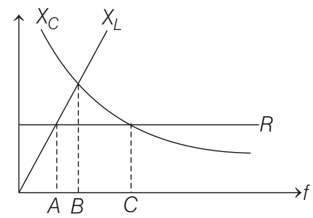


(a) 0.1 rad/s (b) 1.2 rad/s (c) 0.4 rad/s (d) 0.8 rad/s

24. In the fetching mechanism of a radio or a TV set, the phenomenon used in the circuit is

(a) eddy currents (b) resonance
(c) alternating current (d) None of these

25. The figure shows variation of R, X_L and X_C with frequency f in a series *L-C-R* circuit. Then, for what frequency point, the circuit is inductive?

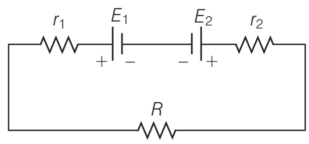


(a) A (b) B (c) C (d) All points

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. Two cells of emf E_1 and E_2 are joined in opposition (such that $E_1 > E_2$). If r_1 and r_2 be the internal resistances and R be the external resistance, then the terminal potential difference is



(a) $\dfrac{E_1 - E_2}{r_1 + r_2} \times R$ (b) $\dfrac{E_1 + E_2}{r_1 + r_2} \times R$ (c) $\dfrac{E_1 - E_2}{r_1 + r_2 + R} \times R$ (d) $\dfrac{E_1 + E_2}{r_1 + r_2 + R} \times R$

27. The instantaneous voltage through a device of impedance $20\,\Omega$ is $V = 80 \sin 100\pi t$. The effective value of the current is

(a) 3 A (b) 2.828 A (c) 1.732 A (d) 4 A

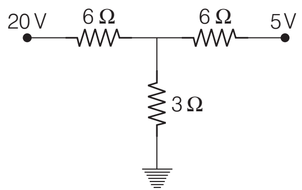
28. The amount of work done in increasing the voltage across the plates of a capacitor from 5V to 10 V is W. The work done in increasing it from 10 V to 5 V will be

(a) 0.6 W (b) 1 W (c) 1.25 W (d) 1.67 W

29. Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area $1.0 \times 10^{-7}\ m^2$ carrying a current of 1.5 A. Assume that, each copper atom contributes roughly one conduction electron. (Take, $m_{Cu} = 63.5$ g and mass of one cubic meter of copper $= 9 \times 10^6$ g)

(a) 1.1 ms^{-1} (b) 0.11 mms^{-1}
(c) 1.1 mms^{-1} (d) 11 ms^{-1}

30. Three resistances are connected to form a T-shape as shown in the figure. Then, the current in 3Ω resistor is



(a) 0.93 A (b) 4.5 A (c) 2 A (d) 1.57 A

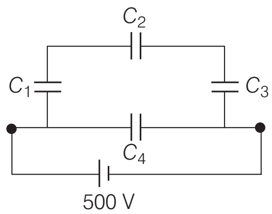
31. A parallel plate air capacitor is charged to a potential difference of *V*. After disconnecting the battery, distance between the plates of the capacitor is increased using an insulating handle. As a result, the potential difference between the plates

(a) decreases (b) increases (c) becomes zero (d) does not change

32. Two similar magnetic poles, having pole strengths in the ratio 1 : 3 are placed 1 m apart. Find the point where a unit pole experiences no net force due to these two poles.

(a) 0.523 m (b) 1.052 m (c) 0.366 m (d) 0.273 m

33. A network of four capacitors each of 12 μF capacitance is connected to a 500 V supply as shown in the figure. The equivalent capacitance of the network will be



(a) 6 μF (b) 16 μF (c) 60 μF (d) 8 μF

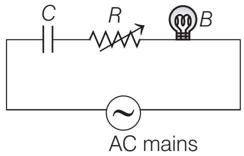
34. A cell of internal resistance *r* is connected across an external resistance *R*. The current in the circuit will be maximum, when

(a) $R > r$ (b) $R < r$ (c) $R = r$ (d) $R = r = \infty$

35. A charged particle is moving in circular path with velocity *v* in a uniform magnetic field *B*. If the velocity of the charged particle is doubled and the radius becomes four times, then the strength of magnetic field will be

(a) B (b) $2B$ (c) $4B$ (d) $\frac{B}{2}$

36. A capacitor *C*, a variable resistance *R* and a bulb *B* are connected in series to the AC mains in a circuit as shown below. When a dielectric slab is introduced between the plates of capacitor, keeping resistance *R* fixed, then which of the following statement(s) is/are correct?



(a) The brightness of bulb will increase.
(b) The brightness of bulb will decrease.
(c) The brightness of bulb will remains the same.
(d) The bulb will get fused.

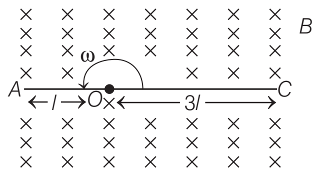
37. Two moving coil meters M_1 and M_2 having the particulars
$R_1 = 10\,\Omega$, $N_1 = 30$, $A_1 = 3.6 \times 10^{-3}\ \text{m}^2$, $B_1 = 0.25\ \text{T}$, $R_2 = 14\ \Omega$,
$N_2 = 42$, $A_2 = 1.8 \times 10^{-3}\ \text{m}^2$ and $B_2 = 0.50\ \text{T}$.

The ratio of their current sensitivity, for same restoring torque per twist (k) is
(a) 2 : 3 (b) 5 : 3 (c) 7 : 5 (d) 5 : 7

38. The flux associated with a coil changes from 1.35 Wb to 0.79 Wb within $\frac{1}{10}$ s. Then, the charge produced by the coil, if its resistance is $7\,\Omega$ is
(a) 0.08 C (b) 0.8 C (c) 0.008 C (d) 8 C

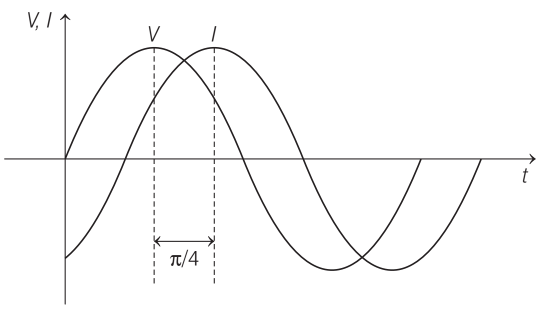
39. A wire *AB* carrying a steady current of 12 A and is lying on the table. Another wire *CD* carrying 5 A is held directly above *AB* at a height of 1 mm.
The mass per unit length of the wire *CD*, so that it remains suspended at its position when left free is (Take $g = 10\ \text{m/s}^2$)
(a) 1×10^{-3} kg/m (b) 2×10^{-3} kg/m
(c) 1.2×10^{-3} kg/m (d) 2.2×10^{-3} kg/m

40. A conducting rod *AC* of length $4l$ is rotated about a point *O* in a uniform magnetic field B directed into the paper. If $AO = l$ and $OC = 3l$, then which of the following relation is not correct?



(a) $V_O - V_A = \frac{B\omega l^2}{2}$ (b) $V_O - V_C = \frac{9}{2} B\omega l^2$ (c) $V_A - V_C = 4B\omega l^2$ (d) $V_C - V_O = \frac{9}{2} B\omega l^2$

41. An AC voltage $V = V_0 \sin 100t$ is applied to the circuit, the phase difference between current and voltage is found to be $\frac{\pi}{4}$, then which of the following statements is true?



(a) It shows variation for a RC-circuit, where $R = 100\,\Omega$ and $C = 1\,\mu F$.
(b) It shows variation for a RC-circuit, where $R = 1\,k\Omega$ and $C = 10\,\mu F$.
(c) It shows variation for a RL-circuit, where $R = 10\,k\Omega$ and $L = 1\,H$.
(d) It shows variation for a RL-circuit, where $R = 1\,k\Omega$ and $L = 10\,H$.

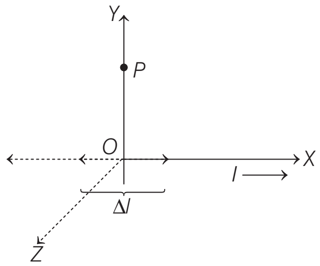
42. A dip circle shows an apparent dip of 45° at a place, where the true dip is 30°. If the dip circle is rotated through 90°, what apparent dip will it show?

(a) 35.2°
(b) 27.8°
(c) 30°
(d) 42.5°

43. The electrostatic force between two spheres of charge $0.2\,\mu C$ and $-0.4\,\mu C$ in air is 0.4 N. The distance between the two spheres is

(a) 43.2×10^{-6} m
(b) 42.4×10^{-3} m
(c) 18.1×10^{-3} m
(d) 19.2×10^{-6} m

44. An element $\Delta \mathbf{l} = \Delta x \hat{\mathbf{i}}$ m is placed at the origin (as shown in figure) and carries a current $I = 2\,A$. The magnetic field at a point P on the Y-axis at a distance of 1 m due to the element $\Delta x = \omega$ m will be



(a) $\frac{\mu_0}{2\pi\omega}$
(b) $\frac{\mu_0 \omega}{2\pi}$
(c) $\frac{\mu_0}{\pi\omega}$
(d) zero

ASSERTION-REASONING MCQs

Direction (Q. Nos. 45-49) *For given questions two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as 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.

45. **Assertion** The charge is uniformly distributed over the surface as a conductor. The surface of a conductor behaves as an equipotential surface.

Reason An equipotential surface is a surface over which potential is zero.

46. **Assertion** Torque on a current carrying coil in a magnetic field **B** is given by $\tau = nI(\mathbf{A} \times \mathbf{B})$, where **A** is area of the coil.

Reason Torque on the coil is maximum, when it is suspended in a radial magnetic field.

47. **Assertion** Generation of eddy currents depends on the principle of electromagnetic induction.

Reason The heat generated in the operations of eddy currents depends on current and resistance.

48. **Assertion** The formation of positive and negative charges inside the dielectric is due to the dielectric polarisation.

Reason An applied electric field will polarise the polar dielectric material.

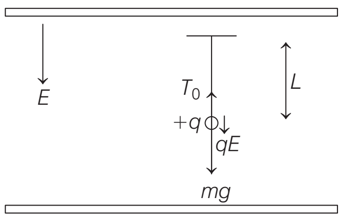
49. **Assertion** A transformer works on the principle of mutual induction in which a change of flux in primary coil, appears as a change of flux linked with the secondary coil.

Reason Transformer gives the desired AC voltage and current.

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.

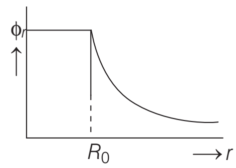
50. A pendulum ball having charge q and mass m, suspended from a string of length L is placed between the metal plates, where a vertical electric field E is established. The time period of the pendulum, if E is directed downwards is



(a) $2\pi\sqrt{\frac{L}{g}}$ (b) $2\pi\sqrt{\frac{gL}{g+qE}}$

(c) $2\pi\sqrt{\frac{L}{g-\frac{qE}{m}}}$ (d) $2\pi\sqrt{\frac{L}{g+\frac{qE}{m}}}$

51. The electrostatic potential ϕ_r of a spherical symmetrical system kept at origin as shown in the adjacent figure is given as



$$\phi_r = \frac{q}{4\pi\varepsilon_0 r} \; (r \geq R_0)$$

$$\phi_r = \frac{q}{4\pi\varepsilon_0 R_0} \; (r \leq R_0)$$

Which of the following statement(s) is/are incorrect?

I. For spherical region $r \leq R_0$, total electrostatic energy stored is zero.

II. Within $r = 2R_0$, total charge is $q/2$.

III. There will be no charge anywhere except at $r = R_0$.

(a) Only I (b) Only II

(c) Both I and II (d) I, II and III

Case Study

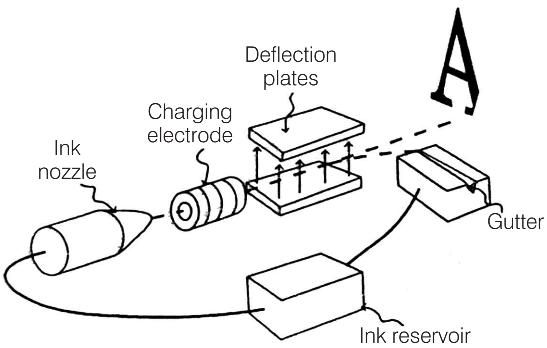
Read the following paragraph and answer the questions.

Ink- Jet Printer

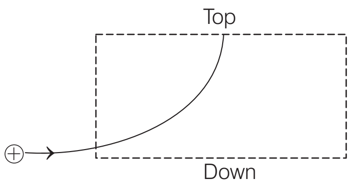
The ink-jet printer is commonly used to print computer-generated text and graphics, employs electrostatics. The nozzle of an ink-jet printer produces small ink droplets, which are sprayed with electrostatic charge.

Once charged, the droplets can be directed using pairs of charged metal plates, with great precision to form letters and images on paper. The direction in which charged ink droplets move can be controlled by charged metal plates. This is very similar to a cathode ray oscilloscope, where an electric beam is directed to a particular place on a screen.

A labelled ink-jet printer is as shown below

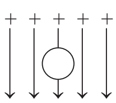


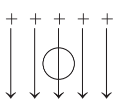
52. The figure shows the path of positively charged ink droplets through a region of uniform electric field as shown in the figure below. The direction of the electric field will be towards

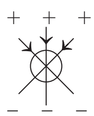


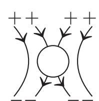
(a) top (b) down (c) parallel to the down (d) anti-parallel to the top

53. An uncharged metallic sphere is placed between the two charged plates of ink-jet printer. The lines of force will be represented as

(a) 

(b) 

(c) 

(d) 

54. The ink has 14.4×10^{-19} C positive charge, then which of the following statement(s) is/are correct about it? (Take, charge on electron, $e = 1.6 \times 10^{-19}$ C)

(a) It has 9 electrons in excess.
(b) It has 27 electrons in short.
(c) It has 27 electrons in excess.
(d) It has 9 electrons in short.

55. A positively charged ink droplet and an electron are placed 1.6 cm apart. The magnitude and nature of electrostatic force between them is

(a) 9×10^{-25} N, repulsive
(b) 6×10^{-24}, attractive
(c) 6×10^{-24}, repulsive
(d) 9×10^{-25} N, attractive

Answers

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

SOLUTIONS

1. Using Gauss's law, electric field intensity at any point P between the two plates is

$$E = \frac{\sigma}{2\varepsilon_0}$$

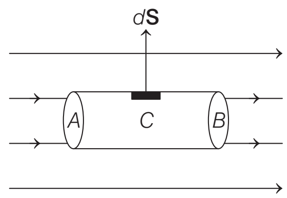
where, $\varepsilon_0 = 8.854 \times 10^{-12}\ \text{C}^2\ \text{N}^{-1}\ \text{m}^{-2}$.

and $\sigma = 3.6 \times 10^{-14}\ \text{C/m}^2$.

$$\Rightarrow \quad E = \frac{3.6 \times 10^{-14}}{2 \times 8.854 \times 10^{-12}}$$

$$= 0.2 \times 10^2 = 20\ \text{N/C}$$

2. This situation is as shown below



Since, the area vector d**S** of curved surface is perpendicular to the magnetic field.

$\therefore$ Flux through curved surface C,

$$\phi_C = \int \mathbf{E} \cdot d\mathbf{S} = \int E dS \cos 90° = 0$$

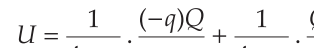
3. Capacity of parallel plate capacitor is given by

$$C = \frac{\varepsilon_0 A}{d}$$

$$\Rightarrow \quad \varepsilon_0 = \frac{Cd}{A}$$

$$\therefore \text{Unit of } \varepsilon_0 = \frac{\text{farad} \times \text{metre}}{(\text{metre})^2} = \frac{\text{farad(F)}}{\text{metre (m)}}$$

4. Let the three charges are located as shown



Potential energy of the system,

$$U = \frac{1}{4\pi\varepsilon_0} \cdot \frac{(-q)Q}{r} + \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q(-q)}{r} \} + \frac{1}{4\pi\varepsilon_0} \cdot \frac{(-q)(-q)}{2r}$$

$$\Rightarrow \quad \frac{1}{4\pi\varepsilon_0}\left(\frac{-qQ}{r} - \frac{qQ}{r} + \frac{q^2}{2r}\right) = 0 \qquad (\because U = 0)$$

$$\Rightarrow \quad \frac{2qQ}{r} = \frac{q^2}{2r} \Rightarrow \frac{Q}{q} = \frac{1}{4} \text{ or } 1:4$$

5. Potential between two spheres,

$$\Delta V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{q}{4\pi\varepsilon_0}\left(\frac{R_2 - R_1}{R_1 R_2}\right)$$

Charge on capacitor, $q = C\Delta V$

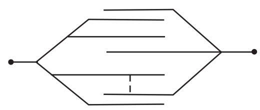
$$\Rightarrow \quad C = \frac{q}{\Delta V} = \frac{q}{q/4\pi\varepsilon_0\left(\frac{R_2 - R_1}{R_1 R_2}\right)}$$

$\therefore$ Capacity of two concentric spherical capacitors,

$$C = 4\pi\varepsilon_0\left(\frac{R_1 R_2}{R_2 - R_1}\right) \Rightarrow C \propto \frac{R_1 R_2}{R_2 - R_1}$$

6. Here, $(n-1)$ capacitors are formed by n equally spaced plates.

All capacitors are connected in parallel because plates are connected alternately as shown



$\therefore$ Total capacitance $= (n-1)\,x$

7. The resistance of a metallic wire at temperature 1°C is given by

$$R_t = R_0(1 + \alpha t)$$

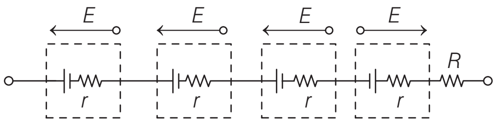
where, α is temperature coefficient.

Hence, resistance of wire increases on increasing the temperature. Also, from Ohm's law, ratio of $\frac{V}{i}$ is equal to R.

i.e. $\quad \frac{V}{i} = R$

Hence, on increasing the temperature, the ratio of $\frac{V}{i}$ increases.

8. Total emf of the cell $= 3E - E = 2E$



Total internal resistance of cells $= 4r$

$\therefore$ Total resistance of the circuit $= 4r + R$

So, the current in the external circuit,

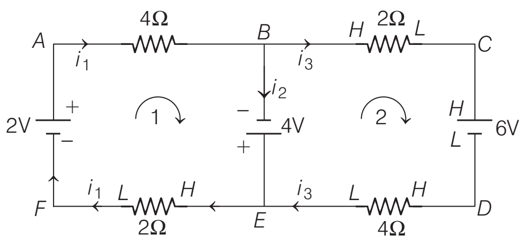
$$i = \frac{2E}{4r + R} \qquad \left(\because i = \frac{V}{R}\right)$$

9. According to Kirchhoff's second law, in any closed part of an electrical circuit, the algebraic sum of the emfs is equal to the algebraic sum of the products of the resistances and currents flowing through them. It is also known as **loop rule**.

i.e. $\quad \sum_{\text{closed loop}} \Delta V = 0$

Applying Kirchhoff's second law in loop 1 ($ABEFA$),

$$-4i_1 + 4 - 2i_1 + 2 = 0$$



10. Drift speed, $v_d = \frac{eE}{m}\tau = \frac{eV}{ml}\tau$

As, drift speed does not depend upon the diameter so long as V and l remain unchanged. Hence, drift speed does not change.

11. Due to collision of free electrons with the atoms or ions of the conductor, heat is generated in it.

12. As resistance of arm DBC is equal to that of arm DAC, so equal current (of 2 A) will be distributed in the two branches.

$\therefore \quad V_D - V_A = 3 \times 2 = 6\text{ V} \qquad \ldots\text{(i)}$

and $V_D - V_B = 2 \times 2 = 4\text{ V} \qquad \ldots\text{(ii)}$

Subtracting Eq. (i) from Eq. (ii), we get

$\therefore \quad V_A - V_B = -2\text{ V}$

13. Here, galvanometer resistance, $R_g = r$

Shunt resistance, $R_s = \frac{1}{r}$

Using the relation, $I = I_g\left(\frac{R_s + R_g}{R_s}\right)$

The fraction of total current passing through galvanometer is

$$\frac{I_g}{I} = \frac{R_s}{R_s + R_g} = \frac{\frac{1}{r}}{\frac{1}{r} + r} = \frac{1}{1 + r^2}$$

14. As, electron is revolving clockwise, so conventional current due to the motion of electron will be in anti-clockwise direction. Hence, according to right hand rule, the magnetic field at point A will be in outward direction.

15. Magnetic dipole moment of the current loop

= Ampere turns × Area of the coil

Initially, magnetic moment, $\mathbf{M} = I\pi r^2$

New magnetic moment,

$$\mathbf{M}' = I\pi(2r)^2$$
$$= 4I(\pi r^2) = 4\mathbf{M}$$

So, when radius becomes doubled, the magnetic moment will become four times.

16. In an atom, electrons revolve around the nucleus and the circular orbits of electrons may be considered as the small current loops. In addition to orbital motion, an electron also has spin motion. So, the total magnetic moment of electron is the vector addition of its magnetic moments due to orbital and spin motions.

17. Here, $\delta = 30° = \frac{\pi}{6}$

$\because$ Horizontal component of the earth's magnetic field, $H_e = B_e \cos\delta$

where, B_e = earth's magnetic field.

$$\Rightarrow \quad \frac{H_e}{B_e} = \cos\delta$$
$$= \cos\frac{\pi}{6} = \frac{\sqrt{3}}{2}$$
$$\Rightarrow H_e : B_e = \sqrt{3} : 2$$

18. Mutual inductance of the pair of current carrying coils depends on distance between two coils and geometry of two coils.

19. Here, $L_0 = 0.01\text{ mH} = 10^{-5}\text{ H}$

$$L = 10\text{ mH} = 10^{-2}\text{ H}$$

We know that, $\mu_r = \frac{L}{L_0} = \frac{10^{-2}}{10^{-5}} = 10^3$

$$\Rightarrow \qquad \mu_r = 1000$$

20. Here, $M = 1.5\text{ H}$, $\Delta i_1 = 5\text{ A}$, $\Delta t = 10^{-3}\text{ s}$

We know that,

$$M = \frac{-e_2}{\Delta i_1 / \Delta t}$$

$$\Rightarrow \quad |e_2| = M \times \frac{\Delta i_1}{\Delta t} = 1.5 \times \frac{5}{10^{-3}}$$

$$= 7.5 \times 10^3 \text{ V}$$

21. Here, $I = 2\sin(100\pi t + \pi/3)$ A

From this relation,

$$\omega t = \frac{2\pi t}{T} = 100\pi t$$

$$\Rightarrow \quad T = \frac{2\pi}{100\pi} = \frac{1}{50} \text{ s}$$

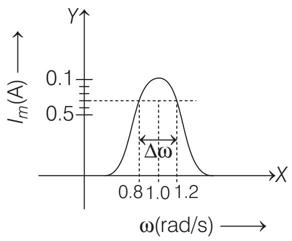
The first time, when the current is maximum is $T/4$.

$$\therefore \quad t = \frac{T}{4} = \frac{1}{50 \times 4} = \frac{1}{200} = 0.005 \text{ s}$$

22. Eddy currents produced in a coil oppose the cause of their origin, therefore due to eddy currents, a great amount of energy is wasted in form of heat energy. If the core of transformer is laminated, then energy losses due to eddy currents can be minimised.

23. Consider the diagram,

Bandwidth $= \omega_2 - \omega_1$



where, ω_1 and ω_2 corresponds to frequencies at which magnitude of current is $\frac{1}{\sqrt{2}}$ times of maximum value. i.e. 0.7 A.

Clearly, from the diagram, the corresponding frequencies are 0.8 rad/s and 1.2 rad/s.

$\therefore$ Bandwidth, $\Delta\omega = 1.2 - 0.8 = 0.4$ rad/s

24. The receiving antenna picks up the frequencies transmitted by different stations and a number of voltages appear in L-C-R circuit corresponding to different frequencies. But maximum current flows in the circuit for that AC voltage which have the frequency equal to the resonant frequency of circuit. Therefore, it is based on the phenomenon of resonance.

25. At point A, $X_C > X_L$,

At point B, $X_C = X_L$

and at point C, $X_C < X_L$.

So, at point C, circuit is inductive.

26. Given, two cells of emf E_1 and E_2 are joined in opposition, such that $E_1 > E_2$, then

Current, $I = \dfrac{E_1 - E_2}{r_1 + r_2 + R}$

Now, terminal potential difference across a circuit,

$$V = IR = \left(\frac{E_1 - E_2}{r_1 + r_2 + R}\right) R$$

27. The instantaneous voltage through the given device,

$$V = 80 \sin 100\pi t$$

Comparing the given instantaneous voltage with standard instantaneous voltage $V = V_0 \sin\omega t$, we get

$$V_0 = 80 \text{ V}$$

where, V_0 is the peak value of voltage.

Impedance, $Z = 20\,\Omega$ (given)

Peak value of current, $I_0 = \dfrac{V_0}{Z} = \dfrac{80}{20} = 4$ A

Effective value of current (root mean square value of current),

$$I_{\text{rms}} = \frac{I_0}{\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2} = 2.828 \text{ A}$$

28. As we know that, work done

$$= U_{\text{final}} - U_{\text{initial}} = \frac{1}{2} C(V_2^2 - V_1^2)$$

When potential difference increases from 5 V to 10 V, then

$$W = \frac{1}{2} C(10^2 - 5^2) = \frac{15 \times 5 \times C}{2} \quad \dots \text{(i)}$$

When potential difference increases from 10 V to 15 V, then

$$W' = \frac{1}{2} C(15^2 - 10^2) = \frac{25 \times 5 \times C}{2} \quad \dots \text{(ii)}$$

On solving Eqs. (i) and (ii), we get

$$W' = 1.67\, W$$

29. Given, $e = 1.6 \times 10^{-19}$C, $A = 1.0 \times 10^{-7}$ m^2

and $\quad I = 1.5$ A

As, a cubic metre of copper has a mass of 9.0×10^6 g. Since, 6.0×10^{23} copper atoms have a mass of 63.5 g.

$$\therefore \quad n = \frac{6.0 \times 10^{23}}{63.5} \times 9.0 \times 10^6$$

$$= 8.5 \times 10^{28} \text{ m}^{-3}$$

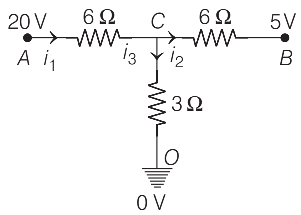
The drift speed (v_d) is given by

$$v_d = \frac{I}{neA}$$

$$\Rightarrow \quad v_d = \frac{1.5}{8.5 \times 10^{28} \times 1.6 \times 10^{-19} \times 1.0 \times 10^{-7}}$$

$$= 1.1 \times 10^{-3} \text{ ms}^{-1} = 1.1 \text{ mms}^{-1}$$

30. Let at junction C, potential is V.



$$\therefore \frac{V_A - V_C}{6} + \frac{V_B - V_C}{6} = \frac{V_C - V_O}{3}$$

$$\Rightarrow \quad \frac{20 - V}{6} + \frac{5 - V}{6} = \frac{V - 0}{3}$$

$$\Rightarrow \quad V = 6.25 \text{ V}$$

$$\therefore \text{Current, } i = \frac{6.25}{3} \simeq 2 \text{ A}$$

31. Potential on parallel plate capacity, $V = \frac{Q}{C}$

Also, capacity of parallel plate capacitor is given by

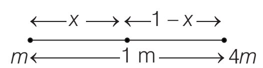
$$C = \frac{\varepsilon_0 KA}{d}$$

$$\therefore \quad V = \frac{Qd}{\varepsilon_0 KA}$$

$$\Rightarrow \quad V \propto d$$

So, on increasing the distance between plates of capacitor, the potential difference between plates also increases.

32. Let the pole strengths of the two magnetic poles be m and $3m$. Suppose the required point is located at distance x from the first pole, then



Force on unit pole due to first pole

= Force on unit pole due to second pole

$$\Rightarrow \quad \frac{\mu_0}{4\pi} \cdot \frac{m \times 1}{x^2} = \frac{\mu_0}{4\pi} \cdot \frac{3m \times 1}{(1 - x)^2}$$

$$\Rightarrow \quad 3x^2 = (1 - x)^2 \text{ or } \sqrt{3}x = 1 - x$$

$$\Rightarrow \quad x = \frac{1}{1 + \sqrt{3}} = 0.366 \text{ m}$$

33. Here, C_1, C_2 and C_3 are in series.

Therefore, their equivalent capacitance,

$$\frac{1}{C'} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$C' = \frac{C}{3} = \frac{12}{3} = 4 \ \mu\text{F}$$

Now, C' and C_4 are in parallel combination.

$$\therefore \quad C_{net} = C' + C_4 = 4 + 12 = 16 \mu\text{F}$$

34. Current in a circuit will be maximum, when total internal resistance is equal to the total external resistance.

i.e. $\quad R = r$

35. As, magnetic force provides centripetal force for circular motion.

$$\Rightarrow \quad qvB = \frac{mv^2}{r}$$

$$\Rightarrow \quad B = \frac{mv}{qr} \quad \ldots \text{(i)}$$

Here, $v' = 2v$ and $r' = 4r$

$$\therefore \quad B' = \frac{mv'}{qr'}$$

$$\Rightarrow \quad B' = \frac{m \times 2v}{q \times 4r} = \frac{1}{2} \frac{mV}{qr} = \frac{1}{2} B$$

[using Eq. (i)]

36. As, the dielectric slab is introduced between the plates of the capacitor, its capacitance will increase. Hence, the potential drop across the capacitor will decrease, because $V = \frac{Q}{C}$.

As a result, the potential drop across the bulb will increase. Thus, its brightness will increase.

37. Using the formula of current sensitivity,

$$I = \frac{NAB}{k}$$

$$\therefore \quad \frac{I_{s_2}}{I_{s_1}} = \frac{N_2 B_2 A_2 k}{N_1 B_1 A_1 k} \quad (\because k_1 = k_2)$$

$$= \frac{42 \times 0.50 \times 1.8 \times 10^{-3}}{30 \times 0.25 \times 3.6 \times 10^{-3}} = \frac{7}{5} \text{ or } 7 : 5$$

38. As, $I = \frac{e}{R} = \frac{d\phi}{Rdt} \Rightarrow Idt = \frac{d\phi}{R}$

Integrating the above equation, we get

$$\Rightarrow \quad \int Idt = \int \frac{d\phi}{R} \Rightarrow q = \frac{\phi}{R}$$

If coil contains N turns, then $q = \frac{N\phi}{R}$

If there is a flux change of $\Delta\phi$, then

$$q = \frac{N\Delta\phi}{R} = \frac{1}{7} \times (1.35 - 0.79) = 0.08 \text{ C}$$

39. Force per unit length between the current carrying wires is given as $F = \frac{\mu_0}{4\pi} \cdot \frac{2 I_1 I_2}{r}$

where, I_1 = current in wire $AB = 12$ A,

I_2 = current in wire $CD = 5$ A

r = height above AB

$= 1 \text{ mm} = 1 \times 10^{-3}$ m.

$\therefore \quad \frac{\mu_0}{4\pi} \cdot \frac{2 I_1 I_2}{r} = mg$

where, m = mass per unit length.

$\Rightarrow 10^{-7} \times \frac{2 \times 12 \times 5}{1 \times 10^{-3}} = m \times 10$

$\therefore \quad m = 1.2 \times 10^{-3}$ kg/m

40. For given rod, we can get potential as

$$V_O - V_A = \frac{B\omega l}{2} \times l = \frac{B\omega l^2}{2} \quad \ldots\text{(i)}$$

$$V_O - V_C = \frac{B\omega 3l \times 3l}{2} = \frac{9\,B\omega l^2}{2} \quad \ldots\text{(ii)}$$

Subtracting Eq. (i) from Eq. (ii), we get

$$V_A - V_C = 4\,B\omega l^2$$

41. In the given graph, current is leading the voltage by 45°.

Therefore, from the graph it is R-C circuit.

As, $\tan\phi = \frac{X_C}{R}$ and $\phi = \frac{\pi}{4}$ (given)

$\Rightarrow \quad X_C = R \quad \left(\because \tan\frac{\pi}{4} = 1\right)$

$\Rightarrow \quad \omega CR = 1$

$\Rightarrow \quad CR = \frac{1}{\omega} = \frac{1}{100}$

When $R = 1\,\text{k}\Omega = 10^3\,\Omega$, then

$$C = \frac{1}{10^5} = 10^{-5}\text{ F} = 10\,\mu\text{F}$$

42. Let θ_1 and θ_2 are the angles of dip in two arbitrary planes which are perpendicular to each other.

As, $\cot^2\theta = \cot^2\theta_1 + \cot^2\theta_2$

where, θ is true dip.

Here, $\theta_1 = 45°$ and $\theta = 30°$

$\Rightarrow \quad \cot^2 30° = \cot^2 45° + \cot^2\theta_2$

$\cot^2\theta_2 = 3 - 1 = 2 \Rightarrow \cot\theta_2 = 1.414$

$\therefore \quad \theta_2 = 35.2°$

43. Given, $q_1 = 0.2\,\mu\text{C} = 0.2 \times 10^{-6}$ C

$q_2 = -0.4\,\mu\text{C} = -0.4 \times 10^{-6}$ C and $F = -0.4$ N

From Coulomb's law, force between the charges,

$$F = \frac{|q_1||q_2|}{4\pi\varepsilon_0 r^2}$$

$$\Rightarrow \quad r^2 = \frac{|q_1||q_2|}{4\pi\varepsilon_0 F}$$

$$= \frac{0.2 \times 10^{-6} \times 0.4 \times 10^{-6} \times 9 \times 10^9}{0.4}$$

$\Rightarrow \quad r^2 = 1.8 \times 10^{-3}$

$\Rightarrow \quad r = (1.8 \times 10^{-3})^{1/2}$

$= 0.0424$ m

$= 42.4 \times 10^{-3}$ m

44. According to Biot-Savart's law,

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{Id\mathbf{l} \times \hat{\mathbf{r}}}{|r|^2}$$

Here, $\Delta x = \omega$ m,

$\Rightarrow \quad \Delta l = \Delta x\hat{\mathbf{i}}$ m $= \omega\hat{\mathbf{i}}$ m, $I = 2$ A and $r = 1$ m

$\therefore \quad dB = \frac{\mu_0}{4\pi} \cdot \frac{(2\omega\hat{\mathbf{i}} \times \hat{\mathbf{j}})}{(1)^2} \quad (\because \hat{\mathbf{r}} = \hat{\mathbf{j}})$

$\Rightarrow \quad dB = \frac{\mu_0\omega}{2\pi}\hat{\mathrm{k}} \Rightarrow |dB| = \frac{\mu_0\omega}{2\pi}$

45. A surface on which the potential has the same value everywhere is called an equipotential surface. On the surface of a conductor, the value of potential remains the same, i.e. it behaves as an equipotential surface.

Therefore, A is true but R is false.

46. The torque on the coil in a magnetic field is given by $\tau - nI\,(\mathbf{A} \times \mathbf{B}) = nIBA\cos\theta$

For radial field, the coil is set with its plane parallel to the direction of the magnetic field.

Here, $\theta = 0°$ and $\cos 0° = 1$

$\Rightarrow$ Torque $= nIBA(1) = nIBA$ (maximum)

Therefore, both A and R are true but R is not the correct explanation of A.

47. Eddy currents generation is based on the principle of electromagnetic induction.

Generation of eddy currents leads to heat of metal. The heat generated by this method is given by I^2R.

Therefore, both A and R are true but R is not the correct explanation of A.

48. When an electric field is applied to the dielectric, each molecule of dielectric gets polarised. Thus, centres of gravity of positive and negative charges gets displaced from each other.

An applied electric field will polarise the polar dielectric material by orienting the dipole moment of polar molecules.

Therefore, both A and R are true but R is not the correct explanation of A.

49. Transformer is a device which is used to increase or decrease the alternating voltage. It is based on the principle of mutual induction.

Thus, a transformer is used to obtain desired AC voltage and current.

Therefore, both A and R are correct but R is not the correct explanation of A.

50. For simple pendulum,

Time period, $T = 2\pi\sqrt{\frac{L}{a}}$

where, a = effective acceleration.

When electric field is downward,

$$a = \frac{\text{net external force on the ball}}{\text{mass of the ball}}$$

$$\Rightarrow \quad a = \frac{mg + qE}{m} = g + \frac{qE}{m}$$

$\therefore$ Time period, $T = 2\pi\sqrt{\dfrac{L}{g + \dfrac{qE}{m}}}$

51. As, total charge resides on the surface of conductor, so within $r = 2R_0$, total charge is q.

Hence, statement II is incorrect.

52. A positive charge experiences a force in the direction of the electric field.

Since, positively charged particle is diverted towards top.

$\therefore$ The direction of electric field is towards top.

53. Electric lines of force never intersect the conductor and never pass through it.

They are perpendicular and slightly curved near the surface of conductor as shown in option (d).

54. As conductor has positive charge, so there is a deficiency of electrons.

$\therefore$ Number of electrons $= \dfrac{14.4 \times 10^{-19}}{1.6 \times 10^{-19}} = 9$

Hence, it has 9 electrons in short.

55. We know that, charge on an electron,

$$q_1 = -1.6 \times 10^{-19}\ \text{C}$$

Charge on proton, $q_2 = 1.6 \times 10^{-19}$ C

and distance, $r = 1.6$ cm $= 1.6 \times 10^{-2}$ m

Using Coulomb's law,

$F = \dfrac{q_1 q_2}{4\pi\varepsilon_0 r^2}$, where r is the distance between proton and electron.

$$\Rightarrow \quad F = \frac{9 \times 10^9 \times (-1.6 \times 10^{-19})(1.6 \times 10^{-19})}{(1.6 \times 10^{-2})^2}$$

$$= -9 \times 10^{-25}\ \text{N}$$

Negative sign indicates that the force is attractive in nature.