ISC Solved Paper 2022 Semester -1

Physics

Class-XII

(Maximum Marks : 40)

(Time allowed : One and half hours)

(Candidates are all allowed additional ***10 minutes*** *for only reading the paper.)*

ALL QUESTIONS ARE COMPULSORY.

Every question/subpart of a question carries one mark.

A simple scientific calculator may be used for doing calculations.

List of useful constant is given at the end of the paper.

Select and write the correct option for each of the following question.

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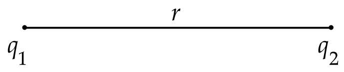
1. The force between two-point charges separated by a certain distance in air is F. If each of the two charges be halved and the distance between them be also halved, the new force would be:

(a) F **(b)** 2F

(c) 3F **(d)** 4F

Ans. Option (a) is correct

$$F = K\frac{q_1 q_2}{r^2} \quad ....(i)$$



$$F' = K(q_1\, q_2/4)/(r^2/4)$$

$$\boxed{\text{So } F' = F}$$

2. Which one of the following is not a property of electric lines of force?

(a) They originate at the positive charge.

(b) They terminate at the negative charge.

(c) They intersect each other.

(d) A tangent drawn to a line of force gives the direction of electric field intensity at the that point.40.

Ans. Option (c) is correct

Because at the point of intersection, two tangents can be drawn to two electric lines of force. This means two directions of electric field at the point of intersection which is not possible.

3. Electric potential at a point on the axial line of a short electric dipole is

(a) directly proportional to distance.

(b) inversely proportional to distance.

(c) inversely proportional to square of the distance.

(d) directly proportional to square of the distance.

Ans. Option (c) is correct

Let l be the length of the dipole and r be the distance of the point along the axial line. Then electric potential due to the short dipole will be:

$$V = \frac{1}{4\pi\varepsilon_0} \times \frac{1}{r^2 - l^2}$$

$$l << r$$

$$V = \frac{1}{4\pi\varepsilon_0} \times \frac{1}{r^2}$$

$$V \propto \frac{1}{r^2}$$

4. The electric flux emanating from a sphere of radius 2m is φ. If radius of the sphere be made four times, without changing the charge enclosed, electric flux would

(a) Become (φ/4) **(b)** Become (φ/2)

(c) Become (2φ) **(d)** Become (φ)

Ans. Option (d) is correct

From Gauss Theorem,

$$\varphi = \frac{q_{\text{enclosed}}}{\varepsilon_0}$$

$$\varphi = \left(\frac{q}{\varepsilon_0}\right)$$

When radius becomes 4 times, the charge enclosed remains same. So,

$$\varphi' = \varphi$$

5. An electric dipole consists of two-point charges +2mC and –2mC separated by a distance of 4 cm. It is kept at an angle of 30° with an electric field of intensity of 1×10^5 NC^{-1}. The torque experienced by the dipole is:

(a) 1 Nm **(b)** 2 Nm

(c) 3 Nm **(d)** 4 Nm

Ans. Option (d) is correct

Torque = $p\,E\sin\theta$, $p = q(2a)$

$$\tau = q(2a)E\sin\theta$$

$$=\left(2\times10^{-3}\right)\times\left(4\times10^{-2}\right)\times1\times10^{5}\times\sin30^{\circ}$$

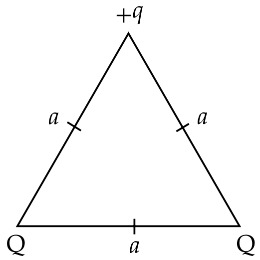
$= 8 \times 10^{-5} \times 10^{-5} \times 0.5$
$= 4$ Nm

6. Three point charges Q, Q and q are kept at the vertices A, B and C respectively of an equilateral triangle ABC having each side equal to a. Electrostatic potential energy of the system is zero. This is possible if q is equal to:

(a) Q **(b)** Q/2
(c) –Q/2 **(d)** –Q/4

Ans. Option (c) is correct.

Given



$$E=0=\frac{KQq}{a}+\frac{KQq}{a}+\frac{KQQ}{a}$$

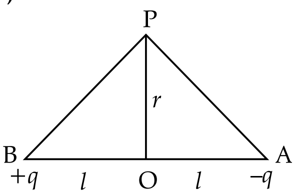
$$\Rightarrow\frac{2KQq}{a}+\frac{KQ^{2}}{a}$$

$$\Rightarrow2q+Q=0\Rightarrow\left[q=\frac{-Q}{2}\right]$$

7. Consider a point P on the perpendicular bisector of an electric dipole. At point P,

(a) Electric field is zero.
(b) Electric potential is zero.
(c) Electric field is perpendicular to the axis of the dipole.
(d) Potential gradient is zero.

Ans. Option (b) is correct



Potential at P due to $-q$ charge

$$V=\frac{1}{4\pi\varepsilon_0}\frac{-q}{AB}=V_1$$

Potential at P due to $+q$ charge

$$=\frac{1}{4\pi\varepsilon_0}+\frac{q}{BP}=V_2$$

So potential at point $P= V_1 + V_2 = 0$

8. Consider 10 identical capacitors each of capacitance 5 μF. The ratio of the minimum and the maximum possible values of the capacitance that can be obtained from them, is:

(a) 1 : 50 **(b)** 1 : 100
(c) 50 : 1 **(d)** 100 : 1

Ans. Option (b) is correct.

Let C_s be the equivalent capacitance in series case

So $$\frac{1}{C_s}=\left[\frac{1}{5}+\frac{1}{5}+\ldots\ldots\ldots\ldots+10\ times\right]$$

$$\frac{1}{C_s}=\frac{10}{5}$$

Let C_p be the equivalent capacitance in parallel case

$$C_s=\frac{1}{2}\mu F$$

$C_p = [\,5 + 5+ 5+ \ldots\ldots +10$ times$]$
$C_p = 50\ \mu F$

Then, The ratio of C_s and C_p $\frac{C_s}{C_p}=\frac{\frac{1}{2}}{50}$

$=1:100$

9. The capacitance of a parallel plate capacitor does not depend on

(a) area of each plate.
(b) potential difference between the two plates.
(c) nature of the medium between the two plates.
(d) distance between the two plates.

Ans. Option (b) is correct

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

So, C is independent of potential difference between two plates.

10. The surface charge density of large conducting sheet is 17.7×10^{-6} cm^{-2}. The electric field intensity at a point just outside the sheet is:

(a) 1×10^{4} NC^{-1} **(b)** 5×10^{4} NC^{-1}
(c) 1×10^{5} NC^{-1} **(d)** 1×10^{6} NC^{-1}

Ans. Option (d) is correct

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

$\sigma = 17.7 \times 10^{-6}$ C/m^2,
$\varepsilon_0 = 8.854 \times 10^{-12}$ Nm^2/C^2

$$E=\frac{\sigma}{2\varepsilon_0}=\frac{17.7\times10^{-6}}{2\times8.854\times10^{-12}}$$

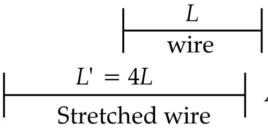
$$E=1\times10^{6}\,\text{N}/\text{C}$$

11. A metallic wire of resistance R is stretched slowly and uniformly (keeping its temperature constant) till its new radius becomes half. Its resistance, then becomes:

(a) 16R **(b)** 8R
(c) 4R **(d)** R

Ans. Option (a) is correct

$R = \frac{\rho L}{A}$



$A = \pi r^2$

$A' = \frac{\pi r^2}{4}$

$R' = \frac{\rho L'}{A'}$

$$R' = \frac{\rho(4L)}{\frac{\pi r^2}{4}} \Rightarrow R' = 16\left(\frac{\rho L}{\pi r^2}\right) = 16R$$

12. Specific resistance of the material of a wire depends on:

(a) Length of the wire.
(b) Area of cross section of the wire.
(c) Volume of the wire.
(d) Temperature of the wire.

Ans. Option (d) is correct

Specific resistance depends on the temperature and the nature of the material.

13. Two electric bulbs, whose resistances are in the ratio 1:2, are connected in parallel to a constant voltage supply. The powers dissipated in them are in the ratio:

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

Ans. Option (c) is correct

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

$$\frac{P_1}{P_2} = \frac{\frac{V^2}{R_1}}{\frac{V^2}{R_2}} = \frac{R_2}{R_1}$$

Given,

$$\frac{R_1}{R_2} = \frac{1}{2} \quad \text{So, } \frac{P_1}{P_2} = \frac{2}{1}$$

or $P_1 : P_2 = 2 : 1$

14. When a potential difference of 2 V is applied between the two ends of a 1 m long and uniform metallic wire, current density in it is found to be 4×10^6 Am^{-2}. Resistivity of the material of the wire is:

(a) 5×10^{-7} Ωm **(b)** 5×10^{-8} Ωm
(c) 5×10^{6} Ωm **(d)** 5×10^{8} Ωm

Ans. Option (a) is correct

$V = 2\text{V}, \; L = 1\text{m}, J = 4 \times 10^6 \text{ Am}^{-2}$

$$E = \frac{V}{L} = \frac{2}{1} = 2 \text{ V/m}$$

We know $J = \sigma E$

$$\sigma = \frac{J}{E} = \frac{4 \times 10^6}{2} = 2 \times 10^6$$

$$\text{Resistivity } (\rho) = \frac{1}{\sigma} = \frac{1}{2 \times 10^6}$$

$$= 0.5 \times 10^{-6}$$

$$= 5 \times 10^{-7} \; \Omega\text{m}$$

15. SI unit of electrical conductivity is:

(a) $\Omega \text{ m}^{-1}$ **(b)** $\Omega \text{ m}^{-2}$
(c) $\Omega^{-1} \text{ m}^{-1}$ **(d)** $\Omega^{-1} \text{ m}^{-2}$

Ans. Option (c) is correct

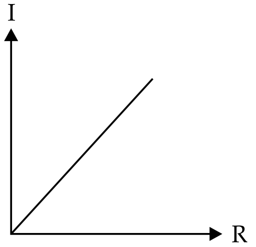
$$\text{Conductivity} = \frac{1}{\text{Resistivity}}$$

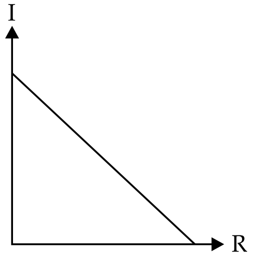
Since $R = \frac{\rho \ell}{A} \Rightarrow \rho = \frac{RA}{\ell} = \frac{\text{ohm.}(\text{metre})^2}{(\text{meter})}$

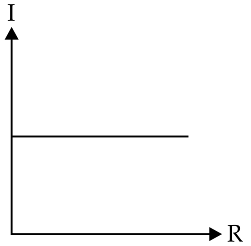
Unit of ρ ohm – meter (Ωm)

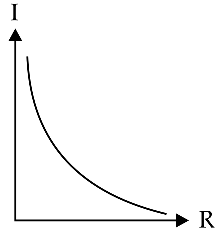
So, Unit of conductivity is $\frac{1}{\Omega\text{m}} = \Omega^{-1}\text{m}^{-1}$

16. If a variable resistance is connected to a cell of constant emf, then the graph which represents the correct relationship between current I and resistance R is:

(a)


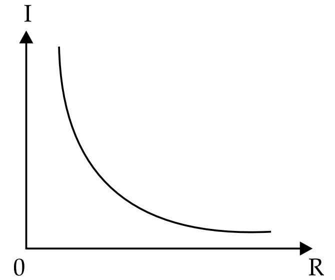
(b)


(c)


(d)


Ans. Option (d) is correct

If the emf of a cell is constant then $I \propto \frac{1}{R}$



17. A battery sends a current of 1.5 A through an external resistance of 1.0 Ω. If the internal resistance of the battery is 0.5 Ω, its emf is:

(a) 2.00 V **(b)** 2.25 V
(c) 2.50 V **(d)** 2.75 V

Ans. Option (b) is correct

$R = 1.0\ \Omega,\ r = 0.5\ \Omega$

$I = 1.5$ A

$$I = \frac{E}{R+r} \Rightarrow E = I(R+r)$$

$= 1.5\ (1.0 + 0.5)$

$E = 1.5 \times 1.5 = 2.25$ V

18. N identical cells each of emf 'e' and internal resistance 'r' are connected in series to form a row. M such rows are connected in parallel to form a battery. When an external resistance R is connected to the battery, current flowing through it is:

(a) $MNe/(R + r)$ **(b)** $MNe(NR + Mr)$
(c) $MNe/(MR + Nr)$ **(d)** $Ne/(MR + Nr)$

Ans. Option (c) is correct

Let e and r be emf and internal resistor, N = no. of cells

emf of single row $= Ne$

internal resistance of cell in row $= Nr$

e.mf of combination $= Ne$

Then $$\frac{1}{R'} = \frac{1}{Nr} + \frac{1}{Nr} \text{............} M \text{ times}$$

$$\frac{1}{R'} = \frac{M}{Nr} \Rightarrow R' = \frac{Nr}{M}$$

Current $$I = \frac{Ne}{R + \frac{Nr}{M}}$$

$$I = \frac{MNe}{(MR + Nr)}$$

19. Kirchhoff's junction rule is based on the principle of conservation of:

(a) energy **(b)** charge
(c) momentum **(d)** momentum and energy

Ans. Option (b) is correct

20. Wheatstone bridge principle is used to measure:

(a) Resistance of a wire
(b) Potential difference across a resistor.
(c) Current flowing through a wire.
(d) Emf of a cell

Ans. Option (a) is correct

21. In a potentiometer, balancing length with a standard cell of emf 1.08 V is 21.6 cm. Balancing length with a cell of emf 1.50 V will be

(a) 21.6 cm **(b)** 30.0 cm
(c) 45.0 cm **(d)** 60.0 cm

Ans. Option (b) is correct

$E_1 = 1.08$ V, $l_1 = 21.6$ cm

$E_2 = 1.50$ V, $l_2 = ?$

Since $$E \propto l \Rightarrow \frac{E_1}{E_2} = \frac{l_1}{l_2}$$

$$l_2 = \frac{21.6 \times 1.5}{1.08} = 30\ cm$$

22. If potential difference across 80 cm of a potentiometer wire is 2 V, potential gradient across the wire is

(a) 0.025 Vm^{-1} **(b)** 0.050 Vm^{-1}
(c) 0.075 Vm^{-1} **(d)** 2.50 Vm^{-1}

Ans. Option (d) is correct

Potential difference $P.D.$ for 80 cm = 2V

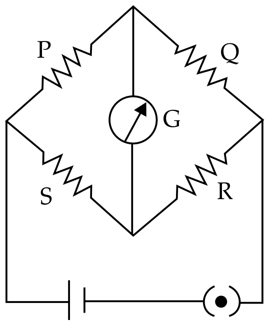
$$P.D. \text{ for } 1 \text{ cm} = \frac{2}{80} \text{V}$$

$$P.D. \text{ for } 100 \text{ cm} = \frac{2}{80} \times 100$$

$$P.D. \text{ for } 1 \text{ m} = \frac{20}{8} \Rightarrow \frac{5}{2}$$

So Potential gradient $$= \frac{5}{2} = 2.50 \text{ Vm}^{-1}$$

23. In the Wheatstone bridge circuit shown below, $P = 10\ \Omega$, $Q = 20\ \Omega$, $R = 200\ \Omega$ and $S = 100\ \Omega$, emf of the battery being 2 V. The current flowing through the galvanometer is:



(a) 0 **(b)** 1 A
(c) 2 A **(d)** 3 A

Ans. Option (a) is correct

$P = 10\ \Omega$, $Q = 20\ \Omega$, $R = 200\ \Omega$, $S = 100\ \Omega$

$E = 2$V

$$\frac{P}{S} = \frac{Q}{R} \Rightarrow \frac{10}{100} = \frac{20}{200}$$

So $$\frac{1}{10} = \frac{1}{10}$$

It means bridge is balanced.

So current through Galvanometer is 0 A.

24. An electric bulb is marked 200 V, 50 W. If it is used on a 400 V supply, it will draw a current of:

(a) 0.25 A **(b)** 0.40 A
(c) 0.50 A **(d)** 0.80 A

Ans. Option (c) is correct

$$R = \frac{V^2}{P} = \frac{200 \times 200}{50}$$

$$P' = \frac{(V_1)^2}{R} = \frac{400 \times 400 \times 50}{200 \times 200}$$

$$P' = I^2 R \Rightarrow I^2 = \frac{P'}{R}$$

$$\Rightarrow I^2 = \frac{200 \times 50}{200 \times 200} \Rightarrow I^2 = \frac{1}{4}$$

$$I = \sqrt{\frac{1}{4}} = \frac{1}{2} = 0.50 \text{ A}$$

25. SI unit of magnetic dipole moment is:

(a) Am **(b)** Am^2
(c) Hm^{-1} **(d)** Wbm^{-2}

Ans. Option (b) is correct

26. The point P is at a perpendicular distance of 0.2 m from a long straight wire YY′, which carries a current of 1.6 A, as shown in Figure 1 below.

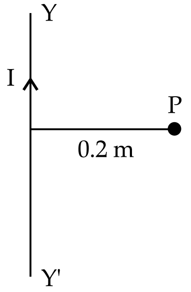


Figure 1

Magnetic flux density of the magnetic field at point P is:

(a) 1.6×10^{-6} T directed into the paper.
(b) 1.6×10^{-6} T coming out of the paper.
(c) 0.8×10^{-6} T directed into the paper.
(d) 0.8×10^{-6} T coming out of the paper.

Ans. Option (a) is correct

$$B = \frac{\mu_0 I}{2\pi r} \Rightarrow B = \frac{4\pi \times 10^{-7} \times 1.6}{2\pi \times 0.2}$$

$$= 1.6 \times 10^{-6} \text{ T}$$

Using right hand palm rule, the direction of $\vec{B}$ will be directed into the paper.

27. A proton is moving in a uniform magnetic field B with a velocity v at an angle θ with the field. The force acting on the proton is minimum when θ is:

(a) 120° **(b)** 90°
(c) 60° **(d)** Zero

Ans. Option (d) is correct

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

$$F = q\, v\, B \sin\theta$$

Force will be minimum when sin θ is minimum

Min. of sin θ is 0

$$\theta = 0°$$

28. Magnetic field 'B' at a point on the axis of (and inside) a long current carrying solenoid is given by:

(a) $2\mu NI/l\pi$ **(b)** $\mu NI/l\pi$
(c) $\mu NI/l$ **(d)** $\mu NI/2l$

Ans. Option (c) is correct

where $n = N/l$ ...(1)

$B = \mu_0 nI = \mu_0 NI/l$ ...(2)

29. Two long straight wires P and Q are parallel to each other. They carry currents in the same direction as shown in the Figure 2 below.

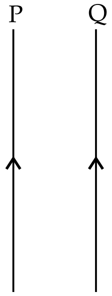


Figure 2

The wire P is kept fixed. Then, the wire Q will:

(a) also remain at rest.
(b) move towards the wire P.
(c) move away from the wire P.
(d) come out of the plane of this paper.

Ans. Option (b) is correct

Two conductors carrying current in the same direction attract and carrying current in the opposite direction repel each other.

30. Two coils P and S are wound on a common core. Their coefficient of mutual inductance does not depend on:

(a) Number of turns in the coil P.
(b) Number of turns in the coil S.
(c) Material of the core.
(d) Voltage applied to the coil P or Q.

Ans. Option (d) is correct

$$M = \mu_0 n_1 n_2 A l$$

31. Which one of the following statements is not true at resonance of a series LCR circuit?

(a) Reactance of the capacitor is equal to the reactance of the inductor.
(b) Impedance of the circuit is minimum
(c) Current in the circuit is minimum
(d) Current is in phase with supply voltage.

Ans. Option (c) is correct

At resonance,

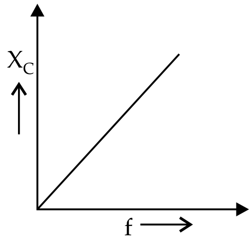
$$X_L = X_C \text{ and } Z = \sqrt{R^2 + (X_L - X_C)^2}$$

So, $Z = R$

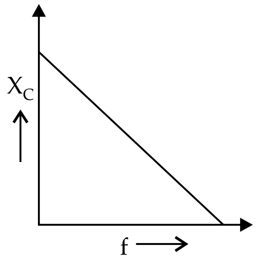
So, current becomes maximum.

32. A graph of reactance of capacitor X_c *vs* frequency (*f*) of an ac source is :

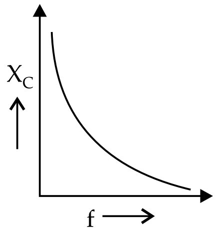
(a)



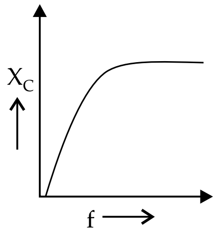
(b)



(c)



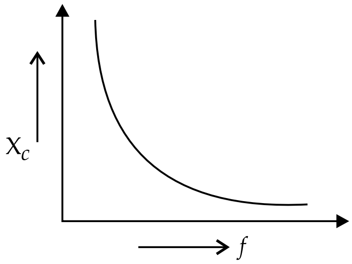
(d)



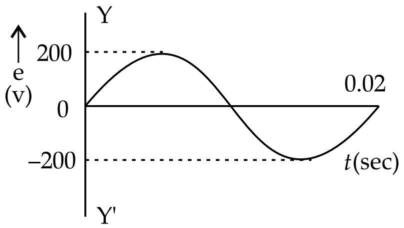
Ans. Option (c) is correct

$$X_C = \frac{1}{\omega C} \text{ or } X_C = \frac{1}{2\pi f C}$$

So X_C and *f* are inversely proportional to each other.



33. The graph below shows how emf (*e*) generated by an ac generator varies with time (*t*):



Mean value of the emf for the whole cycle is:

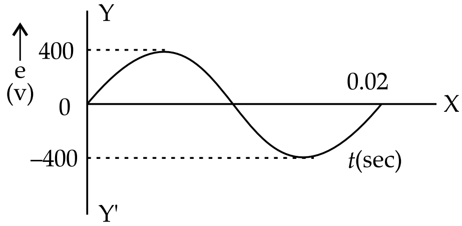
(a) Zero **(b)** $(400/\pi)$V

(c) $(200\sqrt{2})$V **(d)** $(200/\sqrt{2})$V

Ans. Option (a) is correct

The value of emf or current varies with time and direction changes after every half cycle. Hence for a full cycle, the mean value or average value is zero.

34. If potential difference across a resistor of 80 Ω varies as shown in the graph below, average power consumed by the resistor is:



(a) Zero **(b)** 500 W

(c) 1000 W **(d)** 2000 W

Ans. Option (c) is correct

$$P_{avg} = V_{rms} \times I_{rms}$$

$$\Rightarrow P_{avg} = \frac{V_0}{\sqrt{2}} \times \frac{I_0}{\sqrt{2}}$$

$$P_{avg} = \frac{400}{\sqrt{2}} \times \frac{5}{\sqrt{2}}$$

$$\left[I_0 = \frac{400}{80} = 5\right]$$

$$P_{avg} = \frac{2000}{2} = 1000\text{W}$$

35. Which one of the following travels with the speed of light in vacuum?

(a) alpha rays **(b)** beta rays

(c) gamma rays **(d)** ions

Ans. Option (c) is correct

Gamma rays are electromagnetic rays.

36. Consider four electromagnetic radiations namely infrared radiations, ultraviolet radiations, micro-waves and light. Which one of these has maximum frequency?

(a) infrared radiations

(b) ultraviolet radiations

(c) micro-waves

(d) light

Ans. Option (b) is correct

Ultraviolet radiation has frequency of range of (8×10^{14} Hz to 8×10^{16} Hz).

37. Which one of the following is used to detect infrared radiations?

(a) Photocell

(b) Fluorescent screen

(c) Ionization chamber

(d) Thermopile

Ans. Option (d) is correct.

Thermopile

38. Which one of the following is used to study crystal structure of a crystalline salt?

(a) UV rays **(b)** X rays
(c) Micro-waves **(d)** Radio waves

Ans. Option (b) is correct

X-rays

39. The equipotential surfaces of a uniform electric field E are planes parallel to the YZ plane.

(i) What is the direction of the electric field E?

(a) The electric field is along x-axis.
(b) The electric field is along y-axis.
(c) The electric field is along z-axis.
(d) The electric field is along negative y-axis.

Ans. (i)Option (a) is correct

The equipotential surface is always perpendicular to the electric field.

(ii) An electric dipole, with its charges $-q$ and $+q$, located at the points (0,-I,0)and (0,+I,0) lies in this fiel(d) Magnitude of the torque acting on the dipole is:

(a) qlE **(b)** $2qlE$
(c) $4qlE$ **(d)** $8qlE$

Ans. (ii)Option (b) is correct

$$\text{Torque} = pE\sin\theta$$
$$= q \times 2l \times E \sin 90°$$
$$\text{Torque} = 2qlE$$

40. A capacitor of capacitance 10 μF is charged to a potential difference of 1000 V.

(i) Electrostatic potential energy stored in the capacitor is:

(a) 0.005 J **(b)** 0.25 J
(c) 0.5 J **(d)** 5.0 J

Ans. Option (d) is correct

$$P.E = \frac{1}{2}CV^2$$
$$= \frac{1}{2} \times \left(10 \times 10^{-6}\right) \times (1000)^2$$
$$= \frac{1}{2} \times 10 = 5\text{J}$$

(ii) If a slab of dielectric constant K =5 is introduced between its two plates in order to occupy the space completely, capacitance of the capacitor becomes:

(a) 2μF **(b)** 10μF
(c) 50μF **(d)** 100μF

Ans. Option (c) is correct

$$C' = K \times C$$
$$C' = 5 \times 10\ \mu\text{F} = 50\ \mu\text{F}$$

41. With reference to the free electron theory of conductors,

(i) Drift velocity is

(a) The average velocity of free electrons with which they move towards the positive terminal.
(b) The velocity of free electrons with which they move towards the positive terminal.
(c) The average speed of free electrons with which they move towards the negative terminal.
(d) The speed of free electrons with which they move towards the negative terminal.

Ans. Option (a) is correct

(ii) Relaxation time is

(a) the time interval between number of collisions of a free electron in a conductor.
(b) the average time interval between two successive collisions of a free electron with metallic ions in a conductor.
(c) the time interval between number of collisions of metal ions in a conductor.
(d) the time interval between collision of free electrons with each other.

Ans. Option (b) is correct

42. Consider a strong bar magnet NS **and a solenoid** AB **as shown in Figure 3 below.** G **is a central zero galvanometer. Both the bar magnet and the solenoid are at rest.**

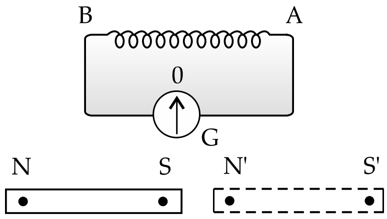


Figure 3

(i) The bar magnet is now moved slowly to the new position N′S′**.**

The pointer of the galvanometer G

(a) remains undeflected at 0 mark.
(b) shows a constant deflection.
(c) shows a momentary deflection and comes back to zero.
(d) vibrates simple harmonically about 0 mark.

Ans. Option (c) is correct

(ii) If the bar magnet be once again taken from its initial position NS **to the final position** N′S′ **but more rapidly, then, the pointer of the galvanometer** G

(a) remains undeflected at 0 mark.
(b) shows a constant and greater deflection.
(c) shows a momentary and a smaller deflection and comes back to zero.
(d) shows a momentary and a greater deflection and comes back to zero.

Ans. Option (d) is correct

As the speed of magnet increases, induced current also increases.

43. Consider a moving coil galvanometer G **and two resistors R_1=5000 Ω and R_2=0.1 Ω.**

(i) To convert the given galvanometer G **into an ammeter**

(a) R_1 is connected in series with G.
(b) R_1 is connected in parallel with G.
(c) R_2 is connected in series with G.
(d) R_2 is connected in parallel with G.

Ans. Option (d) is correct

To convert a galvanometer into an ammeter a low resistor is connected in parallel.

(ii) To convert the given galvanometer G into a voltmeter,

(a) R_1 is connected in series with G.
(b) R_1 is connected in parallel with G.
(c) R_2 is connected in series with G.
(d) R_2 is connected in parallel with G.

Ans. Option (a) is correct

To convert a galvanometer into an voltmeter a high resistor is connected in series.

44. A solenoid having self-inductance of 8 H is connected to a battery through a switch. when the switch is closed, current through the solenoid increases from 0 to 5 A in 0.2 s.

(i) Magnitude of the emf induced in the solenoid is:

(a) 2 V **(b)** 20 V
(c) 200 V **(d)** 2000 V

Ans. Option (c) is correct

$$\phi = L\frac{dI}{dt} = 8\times\left(\frac{5-0}{0.2}\right)$$

$$= \frac{40}{0.2} = 200\text{V}$$

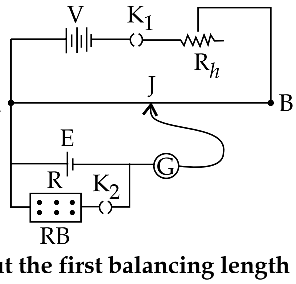
(ii) If the switch is now opened, magnitude of the emf induced in the solenoid will be:

(a) Same as in part **(i).**
(b) More than that in part **(i)**
(c) Less than that in part **(i)**
(d) Zero.

Ans. Option (b) is correct

The magnitude of emf will be more because the current drops to 0 instantly

45. The circuit diagram given below is that of a potentiometer used to measure internal resistance 'r' of a cell.



(i) To find out the first balancing length l_1,

(a) Both the keys, K_1 and K_2, are closed together.
(b) Both the keys K_1 and K_2, are kept open.
(c) K_1 is closed and K_2 is kept open.
(d) K_2 is closed and K_1 is kept open.

Ans. Option (c) is correct

To find the first balancing length K_2 has no role to play. So, it is kept open.

(ii) Working formula to calculate the internal resistance of a cell is:

(a) $r = R\left(\frac{l_1}{l_2}-1\right)$ **(b)** $r = R\left(\frac{l_2}{l_1}-1\right)$

(c) $R = r\left(\frac{l_2}{l_1}-1\right)$ **(d)** $R = r\left(\frac{l_1}{l_2}-1\right)$

Ans. Option (a) is correct

(iii) If the value of R is increased,

(a) balancing length l_1 increases.
(b) balancing length l_2 increases.
(c) balancing length l_2 decreases.
(d) balancing length l_2 remains unchange

Ans. Option (c) is correct

If R increases, energy loss increases, terminal voltage decreases. So, I_2 decreases.

46. When a capacitor, an inductor and a resistor are connected in series to an ac source,

(i) Average power consumed by the capacitor is

(a) $I^2 \times (X_c)$ **(b)** $I^2 \times C$
(c) $I^2 \times R$ **(d)** Zero

Ans. Option (d) is correct

Power = $E_{rms}I_{rms}\cos\varphi$

$\varphi = 90°$

So, Power = 0

(ii) Phase difference between potential difference across a capacitor and that across an inductor is

(a) 90° **(b)** 180°
(c) $\tan^{-1}(X_L - X_c)/R$ **(d)** $\cos^{-1}(X_L - X_c)R$

Ans. Option (b) is correct

Since, V_L leads and V_C lags by 90°, the phase difference between them is 180°.

(iii) Current flowing through the circuit is maximum when

(a) $X_L = X_C$ **(b)** $X_L > X_C$
(c) $X_L < X_C$ **(d)** $Z > R$

Ans. Option (a) is correct

When $X_L = X_C$, then $Z = R$

i.e., Z is minimum. So current is maximum

47. X and Y are two concentric and coplaner circular coils carrying currents of 6 A and 2 A in opposite directions as shown in Figure 4 below. Their radii are $R_x = 8\pi$ cm and $R_y = 4\pi$ cm whereas number of turns in X and Y are 50 and 100 respectively.

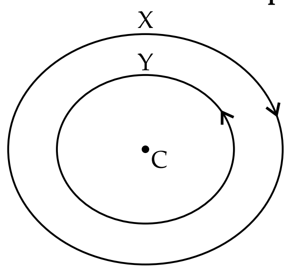


Figure 4

(i) Magnetic field at the common centre C due to current in the coil X is:

(a) 7.5×10^{-4} T **(b)** 7.5×10^{-6} T
(c) 1.0×10^{-4} T **(d)** 2.0×10^{-4} T

Ans. Option (a) is correct

$$B = \frac{\mu_0 nI}{2r} = \frac{4\pi\times10^{-7}\times50\times6}{2\times8\pi\times10^{-2}}$$

$$B = \frac{300 \times 10^{-7}}{4 \times 10^{-2}} \Rightarrow B = 75 \times 10^{-5} \text{ T}$$

So $\quad B = 7.5 \times 10^{-4}$ T

(ii) Magnetic field at the common centre C due to current in the coil Y is:

(a) 1×10^{-5} T **(b)** 2×10^{-4} T

(c) 2×10^{-3} T **(d)** 1×10^{-3} T

Ans. Option (d) is correct.

$$B = \frac{\mu_0 nI}{2r} = \frac{4\pi\times10^{-7}\times100\times2}{2\times4\pi\times10^{-2}} = 1\times10^{-3} T$$

(iii) Resultant magnetic field at the common centre C due to the current in the coils X and Y is:

(a) 2.5×10^{-3} T **(b)** 2.5×10^{-4} T

(c) 2.5×10^{-5} T **(d)** 2.5×10^{-6} T

Ans. Option (b) is correct

$$B = 1 \times 10^{-3} - 7.5 \times 10^{-4}$$
$$B = 2.5 \times 10^{-4} \text{ T}$$

48. With reference to a transformer, choose the correct option.

(i) The principle of its working is

(a) Self-induction.

(b) Mutual induction.

(c) Magnetic effect of current.

(d) Chemical effect of current.

Ans. Option (b) is correct

(ii) In an actual transformer,

(a) Output voltage is always equal to the input voltage.

(b) Output current is always equal to the input current.

(c) Output power is always equal to the input power.

(d) Output power is always less than input power.

Ans. Option (d) is correct

Due to losses output power is less than input power.

(iii) For a step-up transformer,

(a) Output voltage is greater than input voltage.

(b) Output current is greater than input current.

(c) Output power is greater than input power.

(d) Number of turns in primary coil is greater than that in secondary coil.

Ans. Option (a) is correct

49. A 220 V, 50 Hz ac source is connected to a series combination of a 3.16 μF capacitor, a 0.63 H inductor and a 600 Ω resistor. Then, (approximately)

(i) Reactance of the capacitor is:

(a) 1000 Ω **(b)** 900 Ω

(c) 1 Ω **(d)** 0.1 Ω

Ans. Option (a) is correct

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

$$= \frac{1}{2 \times 3.14 \times 50 \times 3.16 \times 10^{-6}}$$

$$= \frac{1}{1000} \times 10^6 = 10^3 \Omega$$

(ii) Reactance of the inductor is:

(a) 400 Ω **(b)** 300 Ω

(c) 200 Ω **(d)** 100 Ω

Ans. Option (c) is correct

$$X_L = \omega_L \Rightarrow X_L = 2\pi f L$$
$$X_L = 2 \times 3.14 \times 50 \times 0.63$$
$$\approx 200 \ \Omega$$

(iii) Impedance of the circuit is:

(a) 800 Ω **(b)** 1000 Ω

(c) 1200 Ω **(d)** 1400 Ω

Ans. Option (b) is correct

$$Z = \sqrt{R^2 + (X_C - X_L)^2}$$

$$Z = \sqrt{(600)^2 + (1000 - 200)^2}$$

$$Z = \sqrt{(600)^2 + (800)^2}$$

$$Z = \sqrt{360000 + 640000}$$

$$Z = \sqrt{1000000} = 10^3 \ \Omega$$

$$Z = 1000 \ \Omega$$

(iv) Phase difference between the current and the supply voltage is:

(a) 53°, with current leading over supply voltage.

(b) 53°, with current lagging behind supply voltage.

(c) 37°, with current lagging behind supply voltage.

(d) 37°, with current leading over supply voltage.

Ans. Option (a) is correct

$$\tan\phi = \frac{X_C - X_L}{R}$$

$$\tan\phi = \frac{1000 - 200}{600} = \frac{800}{600}$$

$$\tan\phi = 4/3 \Rightarrow \phi = \tan^{-1} 4/3 = \phi = 53°$$

Since $X_C > X_L$,

So, $V_C > V_L$

So, $V_C - V_L$ will lag the current.

Hence the current will lead the voltage.

50. A school organised an educational tour to two places. First one was to a thermal power station and the second one was to a factory manufacturing dry cells. The engineer at the power station explained to the students how electric power is generated at the power station and how it is transmitted to the city. The manager at the dry cell factory took them around the factory and explained to them the importance of dry cells in our daily life.

(i) Voltages generated by the power station and the dry cell are:

(a) dc voltage and ac voltage respectively

(b) ac voltage and dc voltage respectively.

(c) Both ac voltages.

(d) Neither ac voltages nor dc voltages

Ans. Option (b) is correct

(ii) AC voltage generated all over the world has a frequency of about:

(a) 50 Hz **(b)** 500 Hz
(c) 1000 Hz **(d)** 1500 Hz

Ans. Option (a) is correct

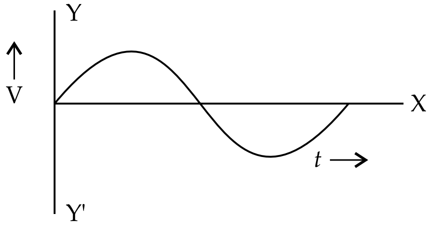
(iii) Which one of the following statements is true?

(a) dc voltage can be stepped up or down.
(b) ac voltage can be stepped up or down.
(c) both dc and ac voltages can be stepped up or down.
(d) neither ac nor dc voltage can be stepped up or down.

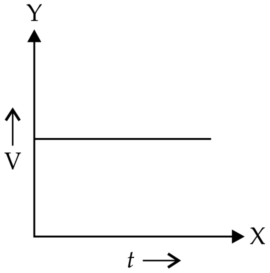
Ans. Option (b) is correct

Using transformers, only ac voltage can be stepped up or stepped down.

(iv) Refer to graphs G_1 and G_2 shown below and choose the correct option.



G_1



G_2

(a) Both G_1 and G_2 represent ac voltage.
(b) Both G_1 and G_2 represent dc voltage.
(c) G_1 represents ac voltage.
(d) G_1 represents dc voltage

1	Permittivity of free space	ε_0	$= 8.85 \times 10^{-12}\ \text{Fm}^{-1}$
2	Constant in Biot Savart's law	$\frac{\mu_0}{4\pi}$	$= 1 \times 10^{-7}\ \text{Hm}^{-1}$

Ans. Option (c) is correct