CBSE Sample Question Paper Term 1

Class – XII (Session : 2021 - 22)

SUBJECT - PHYSICS 042 - TEST - 04

Class 12 - Physics

Time Allowed: 1 hour and 30 minutes **Maximum 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 any20 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

Attempt any 20 questions

1. Two equal unlike charges placed 3 cm apart in air attract each other with a force of 40 N. The magnitude of each charge in micro coulombs is: **[0.77]**

   a) 20000 b) 2

   c) 200 d) 20

2. The effective capacitance of two capacitors of capacitances C_1 and C_2 (with $C_2 > C_1$) connected in parallel is $\frac{25}{6}$ times the effective capacitance when they are connected in series. The ratio $\frac{C_2}{C_1}$ is **[0.77]**

   a) $\frac{25}{6}$ b) $\frac{5}{3}$

   c) $\frac{4}{3}$ d) $\frac{3}{2}$

3. A potentiometer wire, 10 m long, has resistance 40 ohms. It is put in series with a resistance 760 ohms and connected to a 2 volt battery. The potential gradient in the wire is: **[0.77]**

   a) $1 \times 10^{-6} volt/m$ b) $1 \times 10^{-2} volt/m$

   c) $1 \times 10^{-4} volt/m$ d) $1 \times 10^{-3} volt/m$

4. A conducting sphere of radius 10 cm has an unknown charge. If the electric field 20 cm from the centre of the sphere is $1.5 \times 10^3 \mathrm{N/C}$ and points radially inward, what is the net charge on the sphere? **[0.77]**

   a) 6.67 nC b) 7.67 nC

   c) 7.27 nC d) -6.27 nC

5. Two identical capacitors, have the same capacitance C. One of them is charged to potential V_1 and the other to V_2. The negative ends of the capacitors are connected together. When **[0.77]**

the positive ends are also connected, the decrease in energy of the combined system is -

a) $\frac{1}{4}C(V_1 - V_2)^2$

b) $\frac{1}{4}C\left(V_1{}^2 + V_2{}^2\right)$

c) $\frac{1}{4}C\left(V_1{}^2 - V_2{}^2\right)$

d) $\frac{1}{4}C(V_1 + V_2)^2$

6. If the percentage change in current through a resistor is 1%, then the change in power through it would be: **[0.77]**

a) 0.5%

b) 1%

c) 2%

d) 1.7%

7. Eddy currents are produced in **[0.77]**

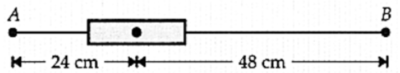
a) Induction furnace

b) All of these

c) Speedometer

d) Electromagnetic brakes

8. A bar magnet of length 3 cm has points A and B along its axis at distances of 24 cm and 48 cm on the opposite sides. Ratio of magnetic fields at these points will be **[0.77]**



a) $\frac{1}{2\sqrt{2}}$

b) 4

c) 3

d) 8

9. If number of turns per unit length of a coil of a solenoid is doubled, its self-inductance will **[0.77]**

a) be doubled

b) be halved

c) remain constant

d) be four times

10. The core of any transformer is laminated, so as to: **[0.77]**

a) reduce the energy loss due to eddy currents

b) increase the secondary voltage

c) make it robust and strong

d) make it light weight

11. An electron is moving in a circular path under the influence of a transverse magnetic field of 3.57×10^{-2} T. If the value of e/m is 1.76×10^{11} C/kg, the frequency of revolution of the electron is **[0.77]**

a) 6.28 MHz

b) 62.8 MHz

c) 100 MHz

d) 1 GHz

12. Si and Cu are cooled from 300 K to a temperature of 60 K. Then resistivity: **[0.77]**

a) decreases for both Si and Cu

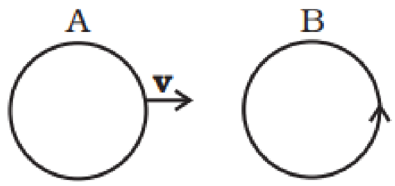
b) increases for both Si and Cu

c) for Cu increases and for Si decreases

d) for Si increases and for Cu decreases

13. There are two coils A and B as shown in Figure. A current starts flowing in B as shown when A is moved towards B and stops when A stops moving. The current in A is **[0.77]**

counterclockwise. B is kept stationary when A moves. We can infer that



a) there is a constant current in the counterclockwise direction in A

b) there is a constant current in the clockwise direction in A

c) there is no current in A

d) there is a varying current in A

14. A series circuit consists of an ac source of variable frequency, a 115.0 Ω resistor, a 1.25 μF capacitor, and a 4.50-mH inductor. The impedance of this circuit when the angular frequency of the ac source is adjusted to half the resonant angular frequency is **[0.77]**

a) 156.0 Ω

b) 166.0 Ω

c) 176.0 Ω

d) 146.0 Ω

15. Three charged particles are collinear and are in equilibrium, then **[0.77]**

a) the equilibrium is unstable

b) all the charged particles have the same polarity

c) all the charged particles cannot have the same polarity

d) the equilibrium is unstable and all the charged particles cannot have the same polarity

16. A spherical drop of capacitance 1 μF is broken into eight drops of equal radius. Then, the capacitance of each small drop is **[0.77]**

a) $\frac{1}{4}\mu$F

b) $\frac{1}{2}\mu$F

c) 8 μF

d) $\frac{1}{8}\mu$F

17. A magnet of magnetic moment 2JT^{-1} is aligned in the direction of magnetic field of 0.1.T. What is the net work done to bring the magnet normal to the magnetic field? **[0.77]**

a) 0.2J

b) 2J

c) 0.1J

d) 10^{-2}J

18. A coil has a resistance of 48.0 Ω. At a frequency of 80.0 Hz, the voltage across the coil leads the current in it by 53°. Inductance of the coil is **[0.77]**

a) 0.124 H

b) 0.94 H

c) 0.114 H

d) 0.84 H

19. A charged particle (charge q) is moving in a circle of radius R with uniform speed v. The associated magnetic moment p is given by: **[0.77]**

a) $\frac{qvR}{2}$

b) qvR

c) qvR^2

d) $\frac{qvR^2}{2}$

20. The amount of charge a capacitor can store when a potential diffrence of 1V is applied across it is called its **[0.77]**

a) resistance

b) capacitance

c) reactance

d) inductance

21. A point charge of 2.0 μC is at the centre of a cubic gaussian surface 9.0 cm on edge. What is the net electric flux through the surface? **[0.77]**

a) $2.5 \times 10^5 \mathrm{Nm}^2/\mathrm{C}$

b) $3.1 \times 10^5 \mathrm{Nm}^2/\mathrm{C}$

c) $2.26 \times 10^5 \mathrm{Nm}^2/\mathrm{C}$

d) $1.7 \times 10^5 \mathrm{Nm}^2/\mathrm{C}$

22. A series resonant LCR circuit has a quality factor (Q-factor) 0.4. If R = 2 kΩ, C = 0.1 μF, then the value of inductance is **[0.77]**

a) 0.064 H

b) 0.1 H

c) 5 H

d) 2 H

23. When the current changers from + 2 A to - 2 A in $0 \cdot 05\ s$, an e.m.f. of 8 V is induced in the coil. The coefficient of self-induction of the coil is: **[0.77]**

a) $0 \cdot 2\ H$

b) $0 \cdot 1\ H$

c) $0 \cdot 4\ H$

d) $0 \cdot 8\ H$

24. The materials suitable for making electromagnets should have **[0.77]**

a) low retentivity and high coercivity

b) high retentivity and high coercivity

c) high retentivity and low coercivity

d) low retentivity and low coercivity

25. Two long parallel wires P and Q are held perpendicular to the plane of the paper with distance of 5 m between them. If P and Q carry current of 2.5 A and 5A respectively in the same direction, then the magnetic field at a point half way between the wire is **[0.77]**

a) $\frac{\sqrt{3}\mu_0}{\pi}$

b) $\frac{\mu_0}{\pi}$

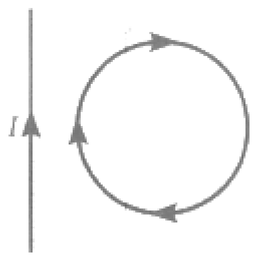
c) $\frac{3\mu_0}{2\pi}$

d) $\frac{\mu_0}{2\pi}$

Section B

Attempt any 20 questions

26. In the given figure, the loop is fixed but the straight wire can move. The straight wire will: **[0.77]**



a) rotate about the axis

b) move towards the loop

c) remain stationary

d) move away from the loop

27. If potential (in volts) in a region is expressed as V(x, y, z) = 6xy - y + 2yz, the electric field (in N/C) at point (1, 1, 0) is: **[0.77]**

a) $-(3\hat{i} + 5\hat{j} + 3\hat{k})$

b) $-(2\hat{i} + 3\hat{j} + \hat{k})$

c) $-(6\hat{i} + 5\hat{j} + 2\hat{k})$

d) $(6\hat{i} + 5\hat{j} + 2\hat{k})$

28. A half ring of radius R has a charge per unit length equal to λ. The field at the center is **[0.77]**

a) zero
b) $\frac{2\lambda}{4\pi\varepsilon_0 R}$
c) $\frac{\lambda}{4\pi\varepsilon_0 R}$
d) None of these

29. A coil has resistance 30 ohm and inductive reactance 20 ohm at 50 Hz frequency. If an ac source of 200 volt, 100 Hz, is connected across the coil, the current in the coil will be: **[0.77]**

a) 2.0 A
b) 4.0 A
c) $\frac{20}{\sqrt{13}}$ A
d) 8.0 A

30. Which of the following quantities remain constant in a step down transformer? **[0.77]**

a) Current
b) None of these
c) Power
d) Voltage

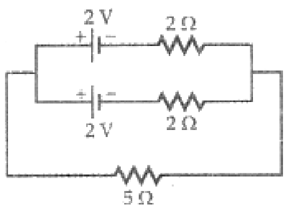
31. A closely wound solenoid of 800 turns and area of cross section $2.5 \times 10^{-4} \mathrm{m}^2$ carries a current of 3.0 A. What is its associated magnetic moment? **[0.77]**

a) 0.4 J/T
b) 0.8 J/T
c) 0.6 J/T
d) 0.5 J/T

32. A moving conductor coil produces an induced emf. This is in accordance with: **[0.77]**

a) Lenz's law
b) Coulomb's law
c) Ampere's law
d) Faraday's law

33. In the circuit shown, the current through the 5Ω resistor is: **[0.77]**



a) $\frac{8}{3}A$
b) $\frac{4}{13}A$
c) $\frac{9}{13}A$
d) $\frac{1}{3}A$

34. An electric charge 10^{-3} μ C is placed at the origin (0, 0) of the (x-y) coordinate system. Two points A and B are situated at $(\sqrt{2}, \sqrt{2})$ and (2, 0) respectively. The potential difference between points A and B will be **[0.77]**

a) zero
b) 9 volt
c) 4.5 volt
d) 2 volt

35. Three copper wires have lengths and cross-sectional areas as (l, A); (2l, $\frac{A}{2}$) and ($\frac{l}{2}$, 2 A). Resistance is minimum in: **[0.77]**

a) same in all the three cases
b) wire of cross-sectional area A
c) wire of cross-sectional area $\frac{A}{2}$
d) wire of cross-sectional area 2 A

36. The phase difference between the current and voltage at resonance is **[0.77]**

a) 0
b) $-\pi$

c) π d) $\frac{\pi}{2}$

37. An aeroplane having a wingspan of 35m files due north with the speed of 90 m/s, given B = 4×10^{-5} T. The potential difference between the tips of the wings will be **[0.77]**

a) 0.126 V b) 1.26 V

c) 0.013 V d) 12.6 V

38. In the magnetic meridian of a certain place, the horizontal component of the earth's magnetic field is 0.26 G and the dip angle is 60^o. What is the magnetic field of the earth at this location? **[0.77]**

a) 0.52 G b) 0.58 G

c) 0.65 G d) 0.62 G

39. If the resistance of 100 Ω, the inductance of 0.5 H, and capacitance of 10 $\times$ 10^{-6} F are connected in series through 50 Hertz AC supply, the impedance will be: **[0.77]**

a) 18.7 Ω b) 189.7 Ω

c) 101.3 Ω d) 1.87 Ω

40. One kilowatt-hour is equal to: **[0.77]**

a) 36×10^5 J b) 36×10^{-5} J

c) 36×10^3 J d) 36×10^{-3} J

41. The equivalent resistance of two resistances P and Q which are in series is **[0.77]**

a) $\frac{PQ}{(P+Q)}$ b) $\frac{P\times P}{P+Q}$

c) $\frac{Q\times Q}{(P+Q)}$ d) P + Q

42. A charged oil drop is suspended in uniform field of 3×10^4 V m^{-1} so that it neither falls nor rises. The charge on the drop will be : (take the mass of the charge 9.9×10^{-15} kg and g =10 ms^{-2}) **[0.77]**

a) $3 \cdot 3 \times 10^{-18}$ C b) $4 \cdot 8 \times 10^{-18}$ C

c) $1 \cdot 6 \times 10^{-18}$ C d) $4 \cdot 3 \times 10^{-18}$ C

43. The resistance of a galvanometer is 50Ω and the current required to give full scale deflection is $100\mu A$. In order to convert it into an ammeter for reading up to 10 A, it is necessary to put a resistance of **[0.77]**

a) $5 \times 10^{-2}\Omega$ b) $5 \times 10^{-5}\Omega$

c) $5 \times 10^{-4}\ \Omega$ d) $5 \times 10^{-3}\Omega$

44. The best material for the core of a transformer is **[0.77]**

a) soft iron b) hard steel

c) mild steel d) stainless steel

45. **Assertion (A):** Two adjacent conductors of unequal dimensions, carrying the same positive charge have a potential difference between them. **[0.77]**

Reason (R): The potential of a conductor depends upon the charge given to it.

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 but R is true.

46. **Assertion (A):** Magnetic susceptibility is a pure number. **[0.77]**
Reason (R): The value of magnetic susceptibility for vacuum is one.

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 but R is true.

47. **Assertion (A):** An induced emf appears in any coil in which the current is changing. **[0.77]**
Reason(R): Self-induction phenomenon obeys Faraday's law of induction.

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 but R is true.

48. **Assertion (A):** When capacitive reactance is smaller than the inductive reactance in LCR current, e.m.f. leads the current. **[0.77]**
Reason (R): The phase angle is the angle between the alternating e.m.f. and alternating current of the circuit.

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 but R is true.

49. **Assertion (A):** In a cavity within a conductor, the electric field is zero. **[0.77]**
Reason (R): Charges in a conductor reside only at its surface.

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 but R is true.

Section C

Attempt any 5 questions

50. Two charges -10C and +10C are placed 10 cm apart. Potential at the centre of the line joining the two charges is: **[0.77]**

a) 4 V
b) zero
c) -2 V
d) 2 V

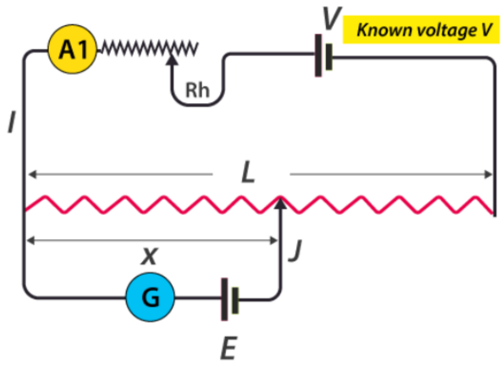
51. Two charged spheres separated at a distance d exert a force F on each other. If they are immersed in a liquid of dielectric constant 2, then the force (if all conditions are same) is **[0.77]**

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

Question No. 52 to 55 are based on the given text. Read the text carefully and answer the

questions:

The potentiometer consists of a long resistive wire(L) and a battery of known EMF, **V** whose voltage is known as driver cell voltage. Assume a primary circuit arrangement by connecting the two ends of L to the battery terminals. One end of the primary circuit is connected to the cell whose EMF **E** is to be measured and the other end is connected to galvanometer G. This circuit is assumed to be a secondary circuit.



52. How can we increase the sensitivity of a potentiometer? **[0.77]**

a) Decreasing the length of potentiometer wire

b) Decreasing the potential gradient

c) Increasing the potential gradient

d) Increasing resistance put in parallel

53. If l_1 and l_2 are the balancing lengths of the potentiometer wire for the cells of EMFs ε_1 and ε_2, then **[0.77]**

a) None of these

b) $\varepsilon_1 \varepsilon_2 = l_1 l_2$

c) $\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$

d) $\varepsilon_1 + \varepsilon_2 = l_1 + l_2$

54. Example of a potentiometer is **[0.77]**

a) Joystick

b) All of these

c) Mobile

d) Modem

55. The emf of a cell is always greater than its terminal voltage. Why? **[0.77]**

a) Because there is some potential drop across the cell due to its high current

b) Because there is some potential drop across the cell due to its small internal resistance

c) Because there is some potential drop across the cell due to its large internal resistance

d) Because there is some potential drop across the cell due to its low current

Solution

SUBJECT - PHYSICS 042 - TEST - 04

Class 12 - Physics

Section A

1. **(b)** 2

   Explanation: As we know, $F=\frac{1}{4\pi\varepsilon_o}\frac{q^2}{r^2}$

   On putting values, F = 40N, r = 3 cm = 0.03 m, we get

   $q^2 = 40 \times (0.03)^2 / 9 \times 10^9$

   q = $2\times10^{-6}C\ =\ 2\ \mu C$

2. **(d)** $\frac{3}{2}$

   Explanation: Given $\frac{C_p}{C_s}=\frac{25}{6}$

   Let C_p = 25k; C_s = 6k where k is a constant.

   $C_p = C_1 + C_2 = 25k$

   $C_s=\frac{C_1C_2}{C_1+C_2}=6k$

   $\frac{C_1C_2}{25k}=6k$

   $C_1C_2 = 150k^2$

   On Solving, We get C_2 = 15k; C_1 = 10k and their ratio is $\frac{C_2}{C_1}=\frac{3}{2}$

3. **(b)** $1\times10^{-2}volt/m$

   Explanation: The total resistance is the sum of the resistance of the potentiometer and the external resistance.

   $R=R_{pot}+R_{ext}=40+760=800\Omega$

   Current through the potentiometer is

   $I=\frac{E}{R}=\frac{2}{800}$

   $I=2.5\times10^{-3}A$

   The potential drop across the potentiometer

   $V=I\times R_{pot}$

   $V=\left(2.5\times10^{-3}\right)\times40$

   $\Rightarrow V=0.1\ V$

   The potential gradient = (potential drop across the potentiometer) / (length of the potentiometer wire)

   $=\frac{0.1}{10}V/m$

   $\therefore$ Potential gradient $=1\times10^{-2}V/m$

4. **(a)** 6.67 nC

   Explanation: $\mathrm{E}=\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

   $1.5\times10^3=\frac{9\times10^9q}{\left(20\times10^{-2}\right)^2}$

   So, net charge is given by :-

   $q=6.67\times10^{-9}C=6.67nC$

   Since the electric field is inwards so charge is negative.

5. **(a)** $\frac{1}{4}\mathrm{C}\left(\mathrm{V}_1-\mathrm{V}_2\right)^2$

   Explanation: The initial energy of the two capacitors $U_i=\frac{1}{2}CV_1^2+\frac{1}{2}CV_2^2$

   The charges on the capacitors are $Q_1=CV_1;Q_2=CV_2$

   When they are joined, they attain a common potential V.

   $V=\frac{\text{total charge}}{\text{total capacitance}}$

   $=\frac{Q_1+Q_2}{C+C}=\frac{CV_1+CV_2}{2C}=\frac{V_1+V_2}{2}$

Final energy $U_f = \frac{1}{2}CV^2 + \frac{1}{2}CV^2 = CV^2$
Loss of energy,
$U_i - U_f = \frac{1}{2}C\left(V_1^2 + V_2^2\right) - CV^2$
$= \frac{1}{2}C\left(V_1^2 + V_2^2\right) - C\left(\frac{V_1+V_2}{2}\right)^2$
$= \frac{1}{4}C(V_1 - V_2)^2$

6. **(c)** 2%
Explanation: Power, P = I^2R
$\therefore \frac{\Delta P}{P} \times 100 = 2\frac{\Delta I}{I} \times 100 + \frac{\Delta R}{R} \times 100$
= 2 × 1% + 0 = 2%

7. **(b)** All of these
Explanation: All of these

8. **(d)** 8
Explanation: For a short magnet,
$B_{\text{axial}} \propto \frac{1}{d^3}$
$\therefore \frac{B_A}{B_B} = \left(\frac{48}{24}\right)^3$ = 8

9. **(d)** be four times
Explanation: $L = \mu_0 n^2$ Al i.e., $\mu \propto n^2$
When n is doubled, L becomes four times its initial value.

10. **(a)** reduce the energy loss due to eddy currents
Explanation: reduce the energy loss due to eddy currents

11. **(a)** 6.28 MHz
Explanation: $f_c = \frac{eB}{2\pi m} = \frac{e}{m} \times \frac{B}{2\pi}$
$f_c = \frac{1.76\times10^{11}\times3.57\times10^{-2}}{2\times3.14}$ Hz
$f_c = 10^9$ Hz $= 1$GHz

12. **(d)** for Si increases and for Cu decreases
Explanation: Si is a semiconductor, its resistivity increases with the decrease in temperature. Cu is a conductor, its resistivity decreases with the decrease in temperature.

13. **(a)** there is a constant current in the counterclockwise direction in A
Explanation: Coil A must be carrying a constant current in counter-clockwise direction. When coil A moves towards coil B with constant velocity so the rate of change of magnetic flux due to coil B in coil A will be constant gives constant current in A in the same direction as in B by Lenz's law.

14. **(d)** 146.0 Ω
Explanation: $R = 115\Omega$
$C = 1.25\mu F = 1.25 \times 10^{-6}F$
$L = 4.5mH = 4.5 \times 10^{-3}H$
Resonant angular frequency is given by ,
$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{4.5\times10^{-3}\times1.25\times10^{-6}}} = \frac{1}{7.5\times10^{-5}}$
Given that the angular frequency of the ac source, $\omega = \frac{\omega_0}{2} = \frac{1}{15\times10^{-5}} = 6666.6rad/s$
Thus, Impedance is given by ,
$Z = \sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2} = \sqrt{115^2 + \left[\left(\frac{1}{6666.6\times1.25\times10^{-6}}\right) - \left(6666.6 \times 4.5 \times 10^{-3}\right)\right]^2}$
$Z = 146\Omega$

15. **(d)** the equilibrium is unstable and all the charged particles cannot have the same polarity
Explanation: The three charged particles cannot be in stable equilibrium and cannot have the same polarity.

16. **(b)** $\frac{1}{2}\mu\mathrm{F}$

Explanation: $\frac{4}{3}\pi R^3 = 8 \times \frac{4}{3}\pi r^3 \Rightarrow R = 2r$

For a large drop, $C = 4\pi\varepsilon_0 R = 4\pi\varepsilon_0 \times 2r$

For each small drop,$C = 4\pi\varepsilon_0 r$

$\therefore \frac{C'}{C} = \frac{1}{2}$

or $C' = \frac{1}{2}C = \frac{1}{2} \times 1\mu\mathrm{F} = \frac{1}{2}\mu\mathrm{F}$

17. **(a)** 0.2J

Explanation: The potential energy of a magnetic dipole of moment m placed in a magnetic field is $U = -mB\cos\theta$.

When the magnet is aligned in the direction of the field, and the initial potential energy U_i = -mB

When the magnet is placed perpendicular to the direction of the field, $\theta = 90$

its potential energy is U_f = 0.

Work done in rotating the magnet is equal to the change in its potential energy.

$W = U_f - U_i = 0 - (mB) = mB = 2 \times 0.1 = 0.2\mathrm{J}$

18. **(a)** 0.124 H

Explanation: $R = 48\Omega$

f = 80Hz

$\phi = 53^\circ$

Now, $\omega = 2\pi f = 2 \times 3.14 \times 80$

In series LR circuit,

$\tan\phi = \frac{\omega L}{R}$

$\tan 53^\circ = \frac{2 \times 3.14 \times 80 \times L}{48}$

$\frac{4}{3} = \frac{2 \times 3.14 \times 80 \times L}{48}$

Thus, L = 0.124 H

19. **(a)** $\frac{qvR}{2}$

Explanation: Here T = $\frac{2\pi R}{v}$

$\therefore$ I = $\frac{q}{T} = \frac{qv}{2\pi R}$

Magnetic moment, $\mu = IA = \frac{qv}{2\pi R} \times \pi R^2 = \frac{qvR}{2}$

20. **(b)** capacitance

Explanation: Q = CV

When V = 1

Thus, Q = C

21. **(c)** $2.26 \times 10^5 \mathrm{Nm}^2/\mathrm{C}$

Explanation: $\phi = \frac{q}{\epsilon_0} = \frac{2 \times 10^{-6}}{8.85 \times 10^{-12}} = 2.26 \times 10^5 \mathrm{Nm}^2/\mathrm{C}$

22. **(a)** 0.064 H

Explanation: $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

L = $(QR)^2C$

= $(0.4 \times 2 \times 10^3)^2 \times 0.1 \times 10^{-6}$ H

= 0.064 H

23. **(b)** $0 \cdot 1\ H$

Explanation: Here, dI = (-2) -2 = -4 A,

dt = $0 \cdot 5\ s$ and e = 8 V

Now, $e = -L\frac{dI}{dt}$

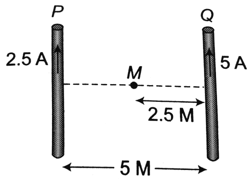
or $L = -\frac{e}{dI/dt} = -\frac{8}{-4/0 \cdot 05}$ = $0 \cdot 1\ H$

24. **(d)** low retentivity and low coercivity

Explanation: A material suitable for making electromagnet is that which will become a strong magnet. In an electromagnet since the magnetic effects are created through the application of a current. When current is switched on and will lose magnetism on switching off the current. Therefore, such a material should have low retentivity and low coercivity.

25. **(d)** $\frac{\mu_0}{2\pi}$

Explanation:



$B_{\#t} = B_Q - B_P$

$= \frac{\mu_0}{4\pi} \frac{.2}{r} (i_Q - i_P)$

$= \frac{\mu_0}{4\pi} \times \frac{2}{2.5} (5 - 2.5) = \frac{\mu_0}{2\pi}$

Section B

26. **(b)** move towards the loop

Explanation: The left portion of the loop will exert an attraction on the straight wire while its right position will exert repulsion. The net force is attractive. The wire will move towards the loop.

27. **(c)** $-(6\hat{i} + 5\hat{j} + 2\hat{k})$

Explanation: $\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$

$\vec{E} = -(6y)\hat{i} - (6x - 1y + 2z)\hat{j} - (2y)\hat{k}$

At the point (1, 1, 0),

$\vec{E} = -6\hat{i} - 5\hat{j} - 2\hat{k} = -(6\hat{i} + 5\hat{j} + 2\hat{k})\mathrm{NC}^{-1}$

28. **(b)** $\frac{2\lambda}{4\pi\varepsilon_0 R}$

Explanation: the field at center is given by $\frac{2\lambda}{4\pi\varepsilon_0 R}$

29. **(b)** 4.0 A

Explanation: $X_L = 2\pi f L = 20\Omega$

$\therefore L = \frac{20}{2\pi \times 50} = \frac{20}{100\pi}\mathrm{H}$

$X_L' = 2\pi f' L = 2\pi \times 100 \times \frac{20}{100\pi} = 40\Omega$

$Z' = \sqrt{R^2 + X_L^2} = \sqrt{900 + 1600} = 50\Omega$

$I = \frac{\varepsilon}{Z'} = \frac{200}{50}$ = 4 A

30. **(c)** Power

Explanation: Energy losses be zero in transformers hence power remains constant in step down and step up transformer also.

31. **(c)** 0.6 J/T

Explanation: m = NIA = $800 \times 3 \times 2.5 \times 10^{-4}$ = 0.6 J/T

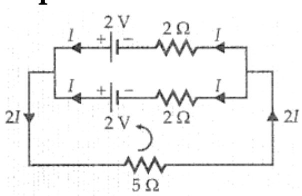
32. **(d)** Faraday's law

Explanation: According to Faraday's laws,

$|\varepsilon| = \frac{d\phi}{dt}$

33. **(d)** $\frac{1}{3}A$

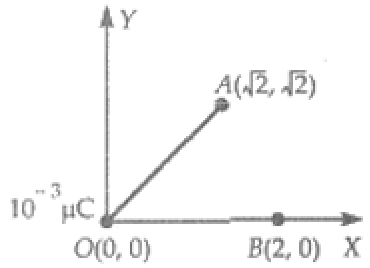
Explanation:



Applying Kirchhoff's second law to the lower loop,

$5 \times 2I + 2 \times I = 2$
$\Rightarrow I = \frac{2}{12}\ \mathrm{A} = \frac{1}{6}\ \mathrm{A}$
Current through 5 Ω resistor = $2I = \frac{1}{3}\mathbf{A}$

34. **(a)** zero
Explanation:



OA = $\sqrt{(\sqrt{2}-0)^2 + (\sqrt{2}-0)^2}$ = 2
OB = $\sqrt{(2-0)^2 + (0-0)^2}$ = 2
∴ OA = OB

35. **(d)** wire of cross-sectional area 2 A
Explanation: The resistances of the three wires are
$R_1 = \rho\frac{l}{A};\ R_2 = \rho\frac{2l}{\frac{A}{2}} = \rho\frac{4l}{A}$
$R_3 = \rho\frac{\frac{l}{2}}{2A} = \rho\frac{l}{4A}$
Clearly, the resistance of third wire of cross-sectional area 2 A is minimum.

36. **(a)** 0
Explanation: Phase factor in series LCR circuit,
$\tan\phi = \frac{X_L - X_C}{R}$
At resonance $X_L = X_C$
So, $\tan\phi = \frac{X_L - X_C}{R} = 0$
Thus, $\phi = 0^\circ$

37. **(a)** 0.126 V
Explanation: $\varepsilon = Blv$
$= 4 \times 10^{-5} \times 35 \times 90$
$= 126 \times 10^{-3}$ V = 0.126 V

38. **(a)** 0.52 G
Explanation: $B = \frac{H_E}{cos\delta} = \frac{0.26}{0.5} = 0.52\ G$

39. **(b)** 189.7 Ω
Explanation: $X_L = 2\pi fL = 2\pi \times 50 \times 0.5 = 157.08\Omega$
$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 10^{-5}} = 318.31\Omega$
$X_C - X_L = 161.23\Omega$
$Z = \sqrt{R^2 + (X_C - X_L)^2} = \sqrt{100^2 + (161.23)^2}$
$= \sqrt{35995.07}$ = 189.72 Ω

40. **(a)** 36×10^5 J
Explanation: 1 kWh = 1000 W × 3600 s = 36×10^5 J

41. **(d)** P + Q
Explanation: Equivalent resistance of two resistances connected in series is equal to the sum of the two resistances.

42. **(a)** $3 \cdot 3 \times 10^{-18}$ C
Explanation: Here, mass of the drop (m) = 9.9×10^{-15} kg; Electric field (E) = 3×10^4 Vm^{-1}

Let q be the charge on the drop. As the drop neither falls nor rises, the force due to the electric field is just equal to its weight i.e.,

qE = mg

or $q = \frac{mg}{\mathrm{E}} = \frac{9\cdot9 \times 10^{-15} \times 10}{3 \times 10^{4}} = 3.3 \times 10^{-18}\mathrm{C}$

43. **(c)** $5 \times 10^{-4}\ \Omega$

Explanation: $I_g = 10^{-4}$A

I = 10 A; G = 50Ω

$S = \frac{I_g \times G}{(I - I_g)}$

$= 5 \times 10^{-4}\ \Omega$

44. **(a)** soft iron

Explanation: Soft iron provides the best material for the core of a transformer as its permeability (μ) is very high. Its hysteresis curve is of small area and its coercivity is very low.

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

Explanation: Both A and R are true but R is not the correct explanation of A.

46. **(c)** A is true but R is false.

Explanation: $\chi_m = \frac{\text{Intensity of magnetisation}}{\text{Magnetising field intensity}}$

= $\frac{M}{H}$

As both M and H have same units (Am^{-1}), so χ_m is a pure number. But χ_m = 0 for vacuum because there can be no magnetisation in vacuum.

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

Explanation: Both A and R are true but R is not the correct explanation of A.

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

Explanation: The phase angle for the LCR circuit is given by tan ϕ = $\frac{X_L - X_C}{R} = \frac{\omega L - 1/\omega C}{R}$

Where X_L, X_C are inductive reactance and capacitive reactance respectively when $X_L > X_C$ then tan ϕ is positive i.e. ϕ is positive (between 0 and $\frac{p}{2}$). Hence emf leads the current.

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

Explanation: Both A and R are true and R is the correct explanation of A.

Section C

50. **(b)** zero

Explanation: Potential at any point due to a point charge is given by

$V = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$

The potential due to both the charges will be equal but of opposite sign.

Potential due to -10 C will be negative (let -V).

Potential due to +10C will be positive (let +V).

Thus net potential at mid point will be,

V_{net} = -V + V = zero

51. **(a)** $\frac{F}{2}$

Explanation: F_{liq} = $\frac{F_{\text{air}}}{\kappa} = \frac{F}{2}$

52. **(b)** Decreasing the potential gradient

Explanation: Decreasing the potential gradient

53. **(c)** $\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$

Explanation: $\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$

54. **(a)** Joystick

Explanation: Joystick

55. **(b)** Because there is some potential drop across the cell due to its small internal resistance
Explanation: Because there is some potential drop across the cell due to its small internal resistance