CBSE Sample Question Paper Term 1

Class – XII (Session : 2021 - 22)

SUBJECT - PHYSICS 042 - TEST - 03

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

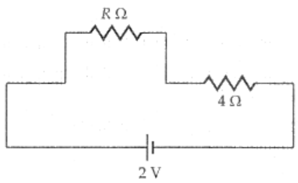
1. Point charges +4q, -q and +4q are kept on the X-axis at points x = 0, x = a and x = 2a respectively: **[0.77]**

a) all the charges are in unstable equilibrium
b) all the charges are in stable equilibrium
c) none of the charges is in equilibrium
d) only - q is in stable equilibrium

2. To make a condenser of 16μF, 1000 volts, how many condensers are needed which have written on them "8μF,, 250 volts"? **[0.77]**

a) 8
b) 32
c) 40
d) 2

3. A current of 0.25 A flows in the main circuit. Now, the resistance R is disconnected and then connected across the 4 Ω resistance. Current in the circuit is: **[0.77]**



a) $\frac{1}{19} A$
b) $\frac{2}{9} A$
c) $\frac{1}{2} A$
d) 1 A

4. Hollow spherical conductor with a charge of 500 C is acted upon by a force 562.5 N. What is E at its surface? **[0.77]**

a) Zero
b) $4.5 \times 10^{-4} NC^{-1}$
c) 1.125 NC^{-1}
d) $2.25 \times 10^{6} NC^{-1}$

5. In a region, the potential is represented by V(x, y, z) = 6x - 8xy - 8y + 6yz, where V is N volts and x, y, z are in metres. The electric force experienced by a charge of 2 coulomb situated at point (1, 1, 1) is: **[0.77]**

a) 24 N
b) $4\sqrt{35}$ N
c) 30 N
d) $6\sqrt{5}$ N

6. The internal resistance of a cell of emf 2 V is 0.1 Ω. It is connected to a resistance of 3.9 Ω. The voltage across the cell will be: **[0.77]**

a) 1.9 V
b) 1.95 V
c) 0.5 V
d) 2 V

7. When a dc motor operates at 200 V, its initial current is 5A, but when it runs at maximum speed, the current is only 3A. What is its back emf? **[0.77]**

a) 80 V
b) Zero
c) 100 V
d) 120 V

8. The value of 1 Bohr magneton is: [Given h = 6.62 $\times$ 10^{-34} Js, e = 1.6 $\times$ 10^{-19} C and m_e = 9.1 $\times$ 10^{-31} kg] **[0.77]**

a) 7.27×10^{-24} Am^2
b) 9.27×10^{-24} Am^2
c) 10.57×10^{-24} Am^2
d) 8.57×10^{-24} Am^2

9. The magnetic flux linked with a coil (in Wb) is given by the equation: **[0.77]**
$\phi = 5\,t^2 + 3\,t + 16$
The induced e.m.f. in the coil in the fourth second will be

a) 10 V
b) 145 V
c) 210 V
d) 108 V

10. A hair dryer meant for 110V, 60Hz is to be used in India. If 220 V is the supply voltage in India, the turns ratio for a transformer would be **[0.77]**

a) step-down transformer with turn ratio 3 : 1
b) step-up transformer with turn ratio 1 : 2
c) step-down transformer with turn ratio 2 : 1
d) step-down transformer with turn ratio 2.5 : 1

11. To convert a galvanometer into an ammeter, we connect: **[0.77]**

a) high resistance in parallel
b) low resistance in parallel
c) high resistance in series
d) low resistance in series

12. A current is passed though two coils connected in series. The potential difference across the first coil of resistance 2 ohm is 5 volt. If the potential difference across the second coil is 12.5 volt, the resistance of the second coil is **[0.77]**

a) 12.5 ohm
b) 4 ohm
c) 5 ohm
d) 7 ohm

13. The working of a dynamo is based on the principle of **[0.77]**

a) Chemical effect of current
b) Electromagnetic induction
c) Magnetic effect of current
d) Heating effect of current

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. Impedance of this circuit when the angular frequency of the ac source is adjusted to twice the resonant angular frequency is **[0.77]**

a) 146 Ω
b) 176 Ω
c) 166 Ω
d) 156 Ω

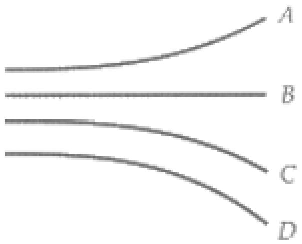
15. If a charge q is placed at the centre of the line joining two equal charges Q such that the system is in equilibrium, then the value of q is : **[0.77]**

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

16. If the charge on a capacitor is increased by 2 coulomb, the energy stored in it increases by 21%. The original charge on the capacitor (in coulomb) is - **[0.77]**

a) 30
b) 20
c) 40
d) 10

17. In the following diagram which particle has the highest $\frac{e}{m}$ value? **[0.77]**



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

18. If C and R denote capacitance and resistance, then dimensions of CR are **[0.77]**

a) $[M^0LT^0A^1]$
b) $[MLT^0A^2]$
c) $[M^0L^0TA^0]$
d) $[ML^0TA^{-2}]$

19. The susceptibility of a magnetic substance is found to depend on temperature and the strength of the magnetising field. The material is a: **[0.77]**

a) diamagnet
b) superconductor
c) ferromagnet
d) paramagnet

20. Capacitors are used in electrical circuits where appliances need more: **[0.77]**

a) watt
b) resistance
c) voltage
d) current

21. If a charge q is placed at the centre of the line joining two equal like charges Q such that the system is in equilibrium, then the value of q is: **[0.77]**

a) $\frac{-Q}{2}$

b) $\frac{Q}{2}$

c) 4Q

d) $\frac{-Q}{4}$

22. A current I = $I_0 \sin(\omega t + \pi/2)$ flows in a circuit across which an alternating potential E = $E_0 \sin \omega t$ is applied. The power consumed in the circuit is **[0.77]**

a) $E_0 I_0 / 2$

b) $E_0 I_0$

c) E

d) zero

23. Current in a circuit falls from 5 A to 0 A in 0.1 s. If an average emf of 200 V is induced, the self-inductance of the circuit is **[0.77]**

a) 5H

b) 4H

c) 2H

d) 3H

24. A magnet of magnetic moment M is suspended in a uniform magnetic field B. The maximum value of torque acting on the magnet is **[0.77]**

a) zero

b) MB

c) 2MB

d) $\frac{1}{2}MB$

25. A galvanometer of resistance 25Ω is shunted by a 2.5Ω wire. The part of total current I_0 that flows through the galvanometer is given by **[0.77]**

a) $\frac{I}{I_0} = \frac{2}{11}$

b) $\frac{I}{I_0} = \frac{4}{11}$

c) $\frac{I}{I_0} = \frac{1}{11}$

d) $\frac{I}{I_0} = \frac{3}{11}$

Section B

Attempt any 20 questions

26. A beam of cathode rays is subjected to crossed electric (E) and magnetic fields (B). The fields are adjusted such that the beam is not deflected. The specific charge of the cathode rays is given by where V is the potential difference between cathode and anode. **[0.77]**

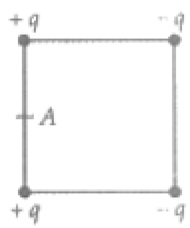
a) $\frac{E^2}{2VB^2}$

b) $\frac{B^2}{2VE^2}$

c) $\frac{2VE^2}{2B^2}$

d) $\frac{2VB^2}{E^2}$

27. Four electric charges + q, + q, -q and - q are placed at the corners of a square of side 2 L (see figure). The electric potential at point A, midway between the two charges + q and + q is **[0.77]**



a) zero

b) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}(1+\sqrt{5})$

c) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$

d) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$

28. A conducting sphere of radius 10 cm is charged with 10 μC. Another uncharged sphere of radius 20 cm is allowed to touch it for some time. After that if the spheres are separated, **[0.77]**

then surface density of charges on the spheres will be in the ratio of

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

29. A transformer has 500 primary turns and 10 secondary turns. If the secondary has a resistive load of 15 Ω, the currents in the primary and secondary respectively, are [0.77]

a) 3.2×10^{-3} A, 3.2×10^{-3} A
b) 3.2×10^{-3} A, 0.16 A
c) 0.16 A, 3.2×10^{-3} A
d) 0.16 A, 0.16 A

30. A wire loop is rotated in a magnetic field. The frequency of change of direction of the induced emf is: [0.77]

a) four times per revolution
b) twice per revolution
c) six times per revolution
d) once per revolution

31. 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

32. A square loop of wire of each side 50 cm is kept so that its plane makes an angle θ with a uniform magnetic field of induction IT. The magnetic field is withdrawn in 0.1 s. It is found that the induced emf across the loop is 125 mV. The angle θ is: [0.77]

a) 45^o
b) 60^o
c) 90^o
d) 30^o

33. The mobility of charge carriers increases with: [0.77]

a) increase in the average collision time
b) increase in the mass of the charge carriers
c) the decrease in the charge of the mobile carriers
d) increase in the electric field

34. If the potential of a capacitor having capacity 8 pF is increased from 10 V to 20 V, then increase in its energy will be: [0.77]

a) 12×10^{-4} J
b) 4×10^{-6} J
c) 12×10^{-6} J
d) 4×10^{-4} J

35. An electric kettle boils some water in 16 min. Due to some defect, it becomes necessary to remove 10% turns of the heating coil of the kettle. Now, how much time will it take to boil the same amount of water? [0.77]

a) 19.6 min
b) 14.4 min
c) 15.0 min
d) 12.7 min

36. An inductor with L = 9.50 mH is connected across an ac source that has voltage amplitude [0.77]

45.0 V. Frequency of the source that results in a current amplitude of 3.90 A is

a) 180 Hz
b) 129 Hz
c) 193 Hz
d) 150 Hz

37. A coil of cross-sectional area 400 cm^2 having 30 turns is making 1800 rev/min in a magnetic field of 1 T. The peak value of the induced emf is: **[0.77]**

a) 2.26 V
b) 226 V
c) 0.6 V
d) 0.4 V

38. A toroid wound with 60 turns/m of wire carries a current of 5.00 A. The torus is iron, which has a magnetic permeability of $\mu_m = 5000\mu_0$ under the given conditions. H and B inside the iron are **[0.77]**

a) 380A/m,1.98T
b) 340A/m,1.88T
c) 300A/m, 1.88T
d) 340A/m, 2.88T

39. In an oscillating LC-circuit, the maximum charge on the capacitor is Q. The charge on the capacitor, when the energy is stored equally between the electric and magnetic field is: **[0.77]**

a) $Q/\sqrt{2}$
b) Q/2
c) Q
d) $Q/\sqrt{3}$

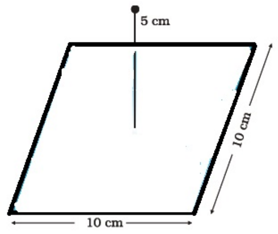
40. The wire of the potentiometer has resistance 4 ohms and length 1 m. It is connected to a cell of e.m.f. 2 volts and internal resistance 1 ohm, the potential gradient in the potentiometer wire is **[0.77]**

a) 1.6 volt/m
b) 2.0 volt/m
c) 1.2 volt/m
d) 0.8 volt/m

41. A hot electric iron has a resistance of 80 Ω and is used on a 200 V source. The electrical energy spent, if it is used for 2 h, will be: **[0.77]**

a) 800 Wh
b) 1000 Wh
c) 2000 Wh
d) 8000 Wh

42. A point charge +10 μC is at a distance 5 cm directly above the centre of a square of side 10 cm, as shown in Figure. What is the magnitude of the electric flux through the square? (Hint: Think of the square as one face of the cube with edge 10cm) **[0.77]**



a) $3.4 \times 10^5 Nm^2/C$
b) $2.55 \times 10^5 Nm^2/C$
c) $1.88 \times 10^5 Nm^2/C$
d) $3.0 \times 10^5 Nm^2/C$

43. A galvanometer having 30 divisions has a current sensitivity of 20 μA/div. It has a resistance of 25 ohm. How will you convert it into an ammeter measuring upto 1 ampere. Find the shunt to be used. **[0.77]**

a) 0.30 Ω

b) 0.15 Ω

c) 0.015 Ω

d) 0.030 Ω

44. Angle of dip is 90° at **[0.77]**

a) both poles and equator

b) equator

c) poles

d) none of these

45. **Assertion (A):** Electric field is discontinuous across the surface of a spherical charged shell. **[0.77]**

Reason (R): Electric potential is continuous across the surface of a spherical charged shell.

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 compass needle when placed on the magnetic north pole of the earth rotates in vertical direction. **[0.77]**

Reason: The earth has only horizontal component of its magnetic field at the north pole.

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

47. **Assertion (A):** An induced current has a direction such that the magnetic field due to the current opposes the change in the magnetic flux that induces the current. **[0.77]**

Reason (R): Above statement is in accordance with the conservation of energy.

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):** The alternating current lags behind the e.m.f. by a phase angle of $\frac{\pi}{2}$, when ac flows through an inductor. **[0.77]**

Reason (R): The inductive reactance increases as the frequency of ac source decreases.

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):** A deuteron and an α-particle are placed in an electric field. If F_1 and F_2 be the forces acting on them and a_1 and a_2 be their accelerations respectively then, $a_1 = a_2$. **[0.77]**

Reason (R): Forces will be same in electric field.

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. Dielectric polarization is the phenomenon, in which atomic dipoles are aligned **[0.77]**

a) at an acute angle to the direction of the electric field
b) perpendicular to the direction of the electric field
c) in the direction of the electric field
d) opposite to the direction of the electric field

51. Each of the two-point charges are doubled and their distance is halved. Force of interaction becomes n times, where n is **[0.77]**

a) 1
b) 18
c) 16
d) 4

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

According to Ohm's law, the current flowing through a conductor is directly proportional to the potential difference across the ends of the conductor i.e., $I \propto V \Rightarrow \frac{V}{I} = R$, where R is resistance of the conductor. Electrical resistance of a conductor is the obstruction posed by the conductor to the flow of electric current through it. It depends upon length, area of cross-section, nature of material and temperature of the conductor. We can write, $R \propto \frac{l}{A}$ or $R = \rho\frac{l}{A}$, where ρ is electrical resistivity of the material of the conductor.

52. Dimensions of electric resistance is **[0.77]**

a) $[M^{-1}L^{-2}T^{-1}A]$
b) $[M^{-1}L^{2}T^{2}A^{-1}]$
c) $[ML^{2}T^{-2}A^{-2}]$
d) $[ML^{2}T^{-3}A^{-2}]$

53. If 1 μA current flows through a conductor when potential difference of 2 volt is applied across its ends, then the resistance of the conductor is **[0.77]**

a) $5 \times 10^{7}\ \Omega$
b) $1.5 \times 10^{5}\ \Omega$
c) $2 \times 10^{6}\ \Omega$
d) $3 \times 10^{5}\ \Omega$

54. Specific resistance of a wire depends upon **[0.77]**

a) mass
b) none of these
c) cross-sectional area
d) length

55. The slope of the graph between potential difference and current through a conductor is **[0.77]**

a) first straight line then curve
b) curve
c) a straight line
d) first curve then straight line

Solution

SUBJECT - PHYSICS 042 - TEST - 03

Class 12 - Physics

Section A

1. **(a)** all the charges are in unstable equilibrium
   Explanation: The net force on each charge is zero. Therefore, all the charges are in equilibrium. If we slightly displace the charge -q to the right, the net force of attraction will further displace it to the right i.e., away from its mean positive. The equilibrium is, therefore, unstable.

2. **(b)** 32
   Explanation: Each capacitor of capacitance $8\mu F$ can withstand a maximum potential of 250 V.
   When equal capacitors are connected in series, the potential difference across them is equal.
   If there are 'm' capacitors in series such that the potential across each is 250 V, then,
   $\frac{1000}{m} = 250; m = 4$
   The equivalent capacitance of 4 capacitors connected in series is $C_S = \frac{C}{m} = \frac{8}{4} = 2\mu F$
   To achieve a capacitance of 16, 'n' such rows of capacitors need to be connected in parallel.
   $C_{eq} = nC_S = 16\mu F$
   $n = \frac{16}{C_S} = \frac{16}{2} = 8$
   To make a condenser of 16 μF, 8 rows of capacitors with each row containing 4 capacitors are to be connected.
   The total number of capacitors = n $\times$ m = 4 $\times$ 8 = 32

3. **(d)** 1 A
   Explanation: In first case, R + 4 = $\frac{2V}{0-25A} = 8\Omega$
   $\therefore \quad R = 4\Omega$
   When R is connected across 4 Ω resistance,
   $R' = \frac{4 \times 4}{4+4} = 2\Omega$
   $\therefore I = \frac{V}{R'} = \frac{2\text{ V}}{2\Omega}$ = 1 A

4. **(c)** 1.125 NC^{-1}
   Explanation: $E = \frac{F}{q}$
   Putting values, $E = \frac{562.5}{500}$ = 1.125 NC^{-1}

5. **(b)** $4\sqrt{35}$ N
   Explanation: V = 6x - 8xy - 8y + 6yz
   At the point (1, 1, 1), we have
   $E_x = -\frac{\partial V}{\partial x}$ = -(6 - 8y) = 2
   $E_y = -\frac{\partial V}{\partial y}$ = -(-8x - 8 + 6z) = 10
   $E_2 = -\frac{\partial V}{\partial z}$ = -6y = -6
   $E = \sqrt{E_x^2 + E_y^2 + E_z^2} = \sqrt{4 + 100 + 36} = \sqrt{140}$
   $= 2\sqrt{35}\text{NC}^{-1}$
   $F = qE = 2 \times 2\sqrt{35} = 4\sqrt{35}$ N

6. **(b)** 1.95 V
   Explanation: V = $\frac{\varepsilon R}{R+r} = \frac{2 \times 3.9}{3.9 + 0.1}$ = 1.95 V

7. **(a)** 80 V
   Explanation: The induced e.m.f. acts in opposite direction to the applied voltage V (Lenz's law) and in known as back or counter e.m.f.
   $i = \frac{V}{R}$
   $R = \frac{V}{i} = \frac{200}{5} = 40\Omega$

When motor is at its maximum speed it operates at
$V = iR = 3 \times 40 = 120V$
i.e. back emf or oppose to applied voltage = 200 - 120 = 80V

8. **(b)** 9.27×10^{-24} Am^2
Explanation: 1 Bohr magneton
$= \frac{eh}{4\pi m_e}$
$= \frac{1.6\times10^{-19}\times6.62\times10^{-34}}{4\pi\times9.1\times10^{-31}}$
$= 9.27 \times 10^{-24}$ Am^2

9. **(a)** 10 V
Explanation: As induced emf, $|e| = \frac{d\phi}{dt}$
$= \frac{d}{dt}(5t^2 + 3t + 16)$
$= 10t + 3$
So, at $t = 3s, induced \mid e \mid is = 10 \times 3 + 3 = 33V$
So, at $t = 4s, induced \mid e \mid is = 10 \times 4 + 3 = 43V$
Therefore emf induced in the fourth second s given by $= 43 - 33 = 10V$

10. **(c)** step-down transformer with turn ratio 2 : 1
Explanation: The ratio between the number of primary turns to the number of secondary turns being called the “turns ratio” or “transformer ratio”.
Thus, $\frac{N_p}{N_s} = \frac{V_p}{V_s}\left(= \frac{input}{output}\right)$
$\frac{N_p}{N_s} = \frac{220}{110} = \frac{2}{1}$
Turn ratio is $N_p : N_s = 2 : 1$
As $N_p > N_s$, hence it is a step down transformer.

11. **(b)** low resistance in parallel
Explanation: To convert a galvanometer into an ammeter, we connect a low resistance in parallel with it.

12. **(c)** 5 ohm
Explanation: If coils are connected in series then current through each coils must be same.
Given potential difference across first coils with resistance 2Ω is 5 V.
$\therefore I = \frac{V}{R}$
$\Rightarrow I = \frac{5}{2} = 2.5A$
Same current must flow through second coil. Potential difference across second coil is,
$V_2 = 12.5V$
$\therefore R_2 = \frac{V_2}{I}$
$\Rightarrow R_2 = \frac{12.5}{2.5}$
$R_2 = 5\ ohm$

13. **(b)** Electromagnetic induction
Explanation: Electromagnetic induction

14. **(a)** 146 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,
$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{4.5\times10^{-3}\times1.25\times10^{-6}}} = \frac{1}{7.5\times10^{-5}}$
Given that the angular frequency of the ac source, $\omega = 2\omega_0 = \frac{2}{7.5\times10^{-5}} = 26666.6rad/s$
impedance,

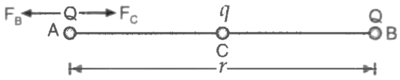
$$Z=\sqrt{R^2+\left(\omega L-\frac{1}{\omega C}\right)^2}=\sqrt{115^2+\left[(26666.6\times 4.5\times 10^{-3})-\left(\frac{1}{26666.6\times 1.25\times 10^{-6}}\right)\right]^2}$$

$Z=146\Omega$

15. **(c)** $-\frac{Q}{4}$

Explanation:

Two equal charges of Q each are placed at the points A and B at a distance r apart and the charge q, at the centre C of the line joining the two equal charges as shown in the figure.



Let us first consider the equilibrium of the charge Q placed at point A. Let F_B and F_C be the forces on it due to the charges at the points B and C. For the equilibrium of charge Q at the point A, the net force on it must be zero i.e.

$F_B + F_C = 0$

$$\frac{1}{4\pi\varepsilon_0}\cdot\frac{Q\times Q}{r^2}+\frac{1}{4\pi\varepsilon_0}\cdot\frac{Q\times q}{(r/2)^2}=0$$

or Q + 4 q = 0

or q = $-\frac{Q}{4}$

It follows that the forces due to charges at the points A and B on the charge q are equal and opposite and hence it will also be in equilibrium.

16. **(b)** 20

Explanation: The initial energy of the capacitor of capacitance C and charge Q_1 is $U_1=\frac{Q_1^2}{2C}$

When the charge increases to Q_2, the energy of the capacitor $\frac{U_2-U_1}{U_1}=\frac{Q_2^2-Q_1^2}{Q_1^2}$

Given percentage increase of energy $\frac{U_2-U_1}{U_1}=0.21$

$\therefore \frac{Q_2^2-Q_1^2}{Q_1^2}=\frac{Q_2^2}{Q_1^2}-1$

$\Rightarrow 0.21=\frac{Q_2^2}{Q_1^2}-1$

$\Rightarrow 1.21=\frac{Q_2^2}{Q_1^2}$

$\Rightarrow \frac{Q_2}{Q_1}=1.1$

But $Q_2-Q_1=2; Q_2=1.1Q_1$

On solving, we get initial charge on capacitor is, Q_1 = 20C

17. **(a)** D

Explanation: Here $evB=\frac{mv^2}{r}$ or $\frac{e}{m}=\frac{v}{rB}$

For same v and B , $\frac{e}{m}\propto\frac{1}{r}$

The radius of curvature is minimum for D. Hence its $\frac{e}{m}$ is highest.

18. **(c)** $[M^0L^0TA^0]$

Explanation: CR is the time constant of CR-circuit.

$\therefore [CR]=\left[M^0L^0TA^0\right]$

19. **(d)** paramagnet

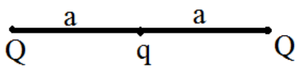
Explanation: The susceptibility of a paramagnetic substance depends both on the temperature and strength of the magnetising field.

20. **(d)** current

Explanation: Capacitor is a device to store charge. It is used in appliances where more current is needed.

21. **(d)** $\frac{-Q}{4}$

Explanation:



The total force on one Q is

$$F = \frac{kQ^2}{4a^2} + \frac{kqQ}{a^2}$$

For the system to be in equilibrium F = 0

$$\frac{kQ^2}{4a^2} + \frac{kqQ}{a^2} = 0$$

$$q = -\frac{Q}{4}$$

22. **(d)** zero

Explanation: Here, the phase difference between current and e.m.f.,

$\phi = \pi/2$

$\therefore P_{av} = E_V I_V \cos\phi = E_V I_V \cos\pi/2 = 0$

23. **(b)** 4H

Explanation: $L = -\frac{e}{\frac{di}{dt}} = -\frac{200}{\frac{-5}{0.1}} = 4H$

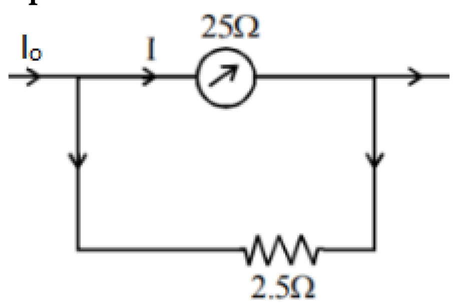
24. **(b)** MB

Explanation: $\tau = MBsin\theta$

$\tau_{max} = MBsin90^o = MB$

25. **(c)** $\frac{I}{I_0} = \frac{1}{11}$

Explanation:



$$I = \frac{I_o \times 2.5}{(25+2.5)} = I_o \times \frac{25}{275} = \frac{1}{11} \times I_o$$

$$\Rightarrow \frac{I}{I_0} = \frac{1}{11}$$

Section B

26. **(a)** $\frac{E^2}{2VB^2}$

Explanation: For undeflected beam, $v = \frac{E}{B}$

Also, $\frac{1}{2}mv^2 = eV$

$\Rightarrow \quad v^2 = \frac{2eV}{m}$

$\therefore \frac{2eV}{m} = \frac{E^2}{B^2}$

or $\frac{e}{m} = \frac{E^2}{2VB^2}$

27. **(d)** $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1 - \frac{1}{\sqrt{5}}\right)$

Explanation: $V = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{L} + \frac{1}{L} - \frac{1}{\sqrt{5}L} - \frac{1}{\sqrt{5}L}\right]$

$= \frac{2q}{4\pi\varepsilon_0 L}\left[1 - \frac{1}{\sqrt{5}}\right]$

28. **(b)** 2 : 1

Explanation: When the two conducting spheres touch each other there will be a flow of charge until they both have the same potential. Let R_1 and R_2 be the radii of spheres 1 and 2, respectively. Let Q_1 and Q_2 be the charges on spheres 1 and 2, respectively, after they are separated.

Let the common potential=V,

$Q_1 = 4\pi\epsilon_o R_1$

$Q_2 = 4\pi\epsilon_o R_2$

R_1 = 10cm

R_2 = 20cm

Surface charge density on sphere 1,$\sigma_1 = \frac{Q_1}{4\pi R_1^2}$

Surface charge density on sphere 2, $\sigma_2 = \frac{Q_2}{4\pi R_2^2}$

$\frac{\sigma_1}{\sigma_2} = \frac{Q_1}{Q_2} \times \frac{R_2^2}{R_1^2}$

$\frac{\sigma_1}{\sigma_2} = \frac{R_1}{R_2} \times \frac{R_2^2}{R_1^2}$

$\frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1}$

$\frac{\sigma_1}{\sigma_2} = \frac{20}{10}$

$\sigma_1 : \sigma_2 = 2 : 1$

29. **(b)** 3.2×10^{-3} A, 0.16 A

Explanation: $\frac{I_1}{I_2} = \frac{3.2\times10^{-3}}{0.16} = \frac{1}{50} = \frac{10}{500} = \frac{N_2}{N_1}$

30. **(b)** twice per revolution

Explanation: The direction of induced emf changes after every half revolution i.e., twice per revolution.

31. **(a)** 0.52 G

Explanation: $B = \frac{H_E}{cos\delta} = \frac{0.26}{0.5} = 0.52\ G$

32. **(a)** 45^o

Explanation: $\varepsilon = -\frac{\phi_2 - \phi_1}{t}$

$125 \times 10^{-3} = -\frac{0-1\times0.5\times0.5\times\cos(90^\circ-\theta)}{0.1}$

$125 \times 10^{-3} = 0.50 \times 0.50 \times \sin\theta$

$\sin\theta = \frac{125\times10^{-3}}{0.50\times0.50} = \frac{1}{2}$

$\theta = 45^\circ$

33. **(a)** increase in the average collision time

Explanation: Mobility,

$\mu = \frac{q\tau}{m}$ i.e., $\mu \propto \tau$

34. **(a)** 12×10^{-4} J

Explanation: $\Delta U = U_2 - U_1 = \frac{1}{2}C\left(V_2^2 - V_1^2\right)$

$= \frac{1}{2} \times 8 \times 10^{-6}\left(20^2 - 10^2\right)$

= $4 \times 10^{-6} \times 300$ J = 12×10^{-4} J

35. **(b)** 14.4 min

Explanation: H = $\frac{V^2 t}{JR}$ cal

$\frac{t}{R} = \frac{HJ}{V^2}$ = constant

$\therefore$ R = kt and R $\propto$ t $\Rightarrow$ t $\propto$ l

$t_2 = \frac{90}{100} \times 16$ min = 14.4 min

36. **(c)** 193 Hz

Explanation: V = 45 volt

L = 9.5 mH

i = 3.9 A

f = ?

$V = iX_L = i \times \omega L = i \times 2\pi f L$

Frequency of the source,

$f = \frac{V}{i\times2\pi L} = \frac{45}{3.9\times2\times3.14\times9.5\times10^{-3}} = 0.193 \times 10^3$ = 193Hz

37. **(b)** 226 V

Explanation: $\varepsilon_0 = NBA\omega = 30 \times 1 \times 400 \times 10^{-4} \times \left(1800 \times \frac{2\pi}{60}\right)$

= 226 V

38. **(c)** 300A/m, 1.88T

Explanation: H = nI = 60 × 5 = 300A/m

B = $\mu_o \mu_r H = \mu_m H$

= 5000 × 300 × $4\pi \times 10^{-7}$

= 1.88 T

39. **(a)** $Q/\sqrt{2}$

Explanation: Let C be the capacitance of the capacitor, when the energy is stored equally between the electric and magnetic fields. Then,

$U_C = \frac{Q^2}{2C}$

Let Q' be the charge on the capacitor, when the energy is stored equally between the electric and magnetic fields. Then,

$U_C' = \frac{U_C}{2}$

or $\frac{Q'^2}{2C} = \frac{1}{2} \times \frac{Q^2}{2C}$

or Q' = $Q/\sqrt{2}$

40. **(a)** 1.6 volt/m

Explanation: If the battery has an e.m.f E, resistance of the potentiometer is R and the internal resistance of the battery is r, then the current I flowing in the potentiometer wire is given as,

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

$I = \frac{2}{(4+1)}$

I = 0.4A

The potential difference V across the potentiometer,

$V = I \times R$

$\Rightarrow V = 0.4 \times 4$

V = 1.6V

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

$= \frac{V}{l}$

$= \frac{1.6}{1}$

$\Rightarrow$ Potential gradient = 1.6V/m

41. **(b)** 1000 Wh

Explanation: H = $\frac{V^2 t}{R} = \frac{200 \times 200 \times 2 \times 60 \times 60}{80} J$

= $\frac{200 \times 200 \times 2 \times 60 \times 60}{80 \times 3600}$ W = 1000 Wh

42. **(c)** $1.88 \times 10^5 \mathrm{Nm}^2/\mathrm{C}$

Explanation: The square can be considered as one face of a cube of edge 10 cm with a center where charge q is placed.

According to Gauss's theorem for a cube, total electric flux $\phi = \frac{q}{\epsilon_0}$ is through all its six faces.

Since the charge lies at the center of cube, so by symmetry flux through each of the 6 faces will be equal.

Hence, electric flux through one face of the cube i.e., through the square, $\phi = \frac{q}{6\epsilon_0}$

Where, ϵ_0 = Permittivity of free space = 8.854 × 10^{-12} $N^{-1}C^2 m^{-2}$

charge is given by ; q = 10 μC = 10 × 10^{-6} C = 10^{-5} C

$\therefore \phi = \frac{q}{6\epsilon_0} = \frac{10 \times 10^{-6}}{6 \times 8.854 \times 10^{-12}} = 1.88 \times 10^5 Nm^2C^{-1}$

43. **(c)** 0.015 Ω

Explanation: The value of each division is 20μA. The range of the galvanometer $I_g = 20 \times 30 = 600\mu A$

To convert it into an ammeter of range I = 1A, a shunt S is connected in parallel to it.

$S = \frac{I_g}{I - I_g} G = \frac{600 \times 10^{-6}}{1 - 600 \times 10^{-6}} \times 25 = 0.015\Omega$

44. **(c)** poles

Explanation: The angle of dip is 90° at poles.

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. **(d)** A is false and R is also false
Explanation: The earth has only a vertical component of its magnetic field at the magnetic poles and the compass needle is only free to rotate in a horizontal plane. At the north pole, the vertical component of the earth's magnetic field will exert torque on the magnetic needle so as to align it along its direction. As the compass needle cannot rotate in a vertical plane, it will rest horizontally when placed on the magnetic pole of the earth.

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. **(c)** A is true but R is false.
Explanation: When ac flows through an inductor current lags behind the emf., by phase of $\frac{p}{2}$, inductive reactance, $X_L = \omega L = \pi.2f.L$, so when frequency increases correspondingly inductive reactance also increases.

49. **(c)** A is true but R is false.
Explanation: A is true but R is false.

Section C

50. **(c)** in the direction of the electric field
Explanation: Atomic dipoles in a dielectric experience a torque when placed in an external electric field. As a result of this torque, they align themselves in the direction of the electric field, since this is the position of least potential energy. This phenomenon in which the atomic dipoles align themselves in the diorection of the electric field is called dielectric polarization.

51. **(c)** 16
Explanation: $F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}$
$F' = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2q_1 \times 2q_2}{(r/2)^2} = 16\ F$
$\therefore n = 16$

52. **(d)** $[ML^2T^{-3}A^{-2}]$
Explanation: $[ML^2T^{-3}A^{-2}]$

53. **(c)** $2 \times 10^6\ \Omega$
Explanation: $R = \frac{V}{I} = \frac{2}{10^{-6}} = 2 \times 10^6\ \Omega$

54. **(b)** none of these
Explanation: Specific resistance depends upon the nature of material and is independent of mass and dimensions of the material.

55. **(c)** a straight line
Explanation: a straight line