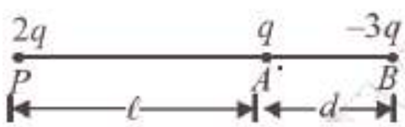
Sample Question Paper (TERM - I)

Solutions

Section - A

Ans. 1	**Ans:(b)** there is positive as well as negative charge in the body but the positive charge is more than negative charge **Explanation:** When we say that a body is charged, we always mean that the body is having excess of electrons (negatively charged) or is of deficient of protons (positively charged).
Ans. 2	**Ans: (b)** $\frac{d+\sqrt{3}d}{2}$ **Explanation:**  Let a charge 2q be placed at P, at a distance l from A where charge q is placed, as shown in figure. The charge 2q will not experience any force, when force of repulsion on it due to q is balanced by force of attraction on it due to $-3q$ at B where $AB = d$ or $\frac{(2q)(q)}{4\pi\varepsilon_0 \ell^2} = \frac{(2q)(3q)}{4\pi\varepsilon_0(\ell + d)^2}$ $(\ell + d)^2 = 3\ell^2$ or $2\ell^2 - 2\ell d - d^2 = 0$ $\therefore \quad \ell = \frac{2d \pm \sqrt{4d^2 + 8d^2}}{4} = \frac{d}{2} \pm \frac{\sqrt{3}d}{2}$ $\ell = \frac{d + \sqrt{3}d}{2}$
Ans. 3	**Ans: (c)** remains constant from centre to surface **Explanation:** Electric potential inside a conductor is constant and it is equal to that on the surface of the conductor.
Ans. 4	**Ans: (b)** r **Explanation:** $\vec{E} = -\frac{\partial v}{\partial x}\hat{i} - \frac{\partial v}{\partial y}\hat{j}$ Given V= $-kxy$

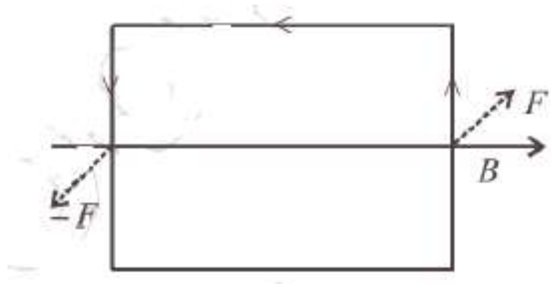
	$\therefore \vec{E} = ky\hat{i} + kx\hat{j}$ $\therefore |\vec{E}| = k\left(\sqrt{x^2+y^2}\right) = kr$ $\therefore E \propto r$
Ans. 5	**Ans: (c)** directly proportional to I **Explanation:** Field at the center of a circular coil of radius r is $B = \frac{\mu_0 I}{2r}$
Ans. 6	**Ans: (c)** $4\ B_0\ L^2$ Wb **Explanation:** As we know that, the magnetic flux linked with uniform surface of area A in uniform magnetic field is $\phi = B.A$ The direction of A is perpendicular to the plane of square and square line in $x - y$ plane in a region. $A = L^2 k$ As given that, $B = B_0(2\hat{i} + 3\hat{j} + 4\hat{k})$ So, $\phi = B \cdot A = B_0(2\hat{i} + 3\hat{j} + 4\hat{k}) \cdot L^2\hat{k} = 4B_0L^2$ Wb
Ans. 7	**Ans: (d)** $-1.5\ \mathrm{Wb/s^2}$ **Explanation:** $e = -\frac{d\phi}{dt} = -2xt = 9$ $\therefore -2x \times 3 = 9 \ \therefore x = -1.5\ \mathrm{Wb/s^2}$ [At $t = 3$]
Ans. 8	**Ans: (a)** 1×10^{-4}Nm **Explanation:** Given, Dipole moment, $p = 4 \times 10^{-9}$Cm Electric field, $E = 5 \times 10^4\mathrm{NC^{-1}}$ Torque is given by $\tau = p.E\sin\theta$ $= 4 \times 10^{-9} \times 5 \times 10^4 \times \sin 30° = 1 \times 10^{-4}$Nm
Ans. 9	**Ans: (c)** one charge is positive and other is negative **Explanation:**The potential energy is negative whenever there is attraction. Since a positive and negative charge attract each other therefore their energy is negative. When both the charges are separated by infinite distance, they do not attract each other and their energy is zero.

Ans. 10	**Ans: (c)** T, T, F, T **Explanation:** When charged particle enters perpendicularly in a magnetic field, it moves in a circular path with a constant speed. Hence its kinetic energy also remains constant.
Ans. 11	**Ans: (c)** $\frac{n}{n+1}$ **Explanation:** Internal resistance = r, External resistance = nr. Let terminal voltage = V then $V = E - Ir \Rightarrow V = E - \frac{Er}{(n+1)r}$ $V = \frac{nE}{n+1} \Rightarrow \frac{V}{E} = \frac{n}{n+1}$
Ans. 12	**Ans: (a)** 0.1 V **Explanation:** (a) We know that $\frac{W_{AB}}{q} = V_B - V_A$ $\therefore V_B - V_A = \frac{2\text{ J}}{20\text{C}} = 0.1\text{ J/C} = 0.1\text{ V}$
Ans. 13	**Ans: (c)** $\pi/6$ **Explanation:** $\tan\delta = \frac{V}{H} = \frac{V}{\sqrt{3}\,V} = \frac{1}{\sqrt{3}} \therefore\ \delta = 30° = \pi/6$ radian
Ans. 14	**Ans:(c)** $H = 0$
Ans. 15	**Ans:(d)** None of these. **Explanation:** $c = \frac{kA\varepsilon_0}{d}$ as k removed, So, c decreases ∴ V increases and as $E = \frac{V}{d}$ So, E also increases
Ans. 16	**Ans: (b)** 3: 2 **Explanation:** $P_1 = \frac{V^2}{R_1}$ and $P_2 = \frac{V^2}{R_2}$ $\therefore \frac{P_1}{P_2} = \frac{R_2}{R_1} = \frac{6}{4} = \frac{3}{2}$
17.	**Ans: (a)** 0.5Ω **Explanation:** Given : emf $\varepsilon = 2.1$ V , $I = 0.2$ A, $R = 10\Omega$ Internal resistance r =?

	From formula. $\varepsilon - Ir = V = IR$ $2.1 - 0.2r = 0.2 \times 10$ $2.1 - 0.2r = 2$ or $0.2r = 0.1 \Rightarrow r = \frac{0.1}{0.2} = 0.5\Omega$
18.	**Ans: (a)** conservation of electric charge and energy respectively **Explanation:** Kirchhoff' s first law deals with conservation of electrical charge & the second law deals with conservation of electrical energy.
19.	**Ans: (b)** increasing the length of the potentiometer **Explanation:** The sensitivity of the potentiometer depends upon the value of potential gradient K (K= Potential supplied by main battery divided by length of wire) Smaller the value of K, smaller the potential difference that a potentiometer have to measure and more is the sensitivity of the potentiometer. Thus, for a given potential difference, the sensitivity of the potentiometer increases with the increase in length of potentiometer wire.
20.	**Ans: (b)** F, T, F **Explanation:** The relative motion between the coil and the magnet produces change in the magnetic flux in the coil and the induced emf is always in such a direction that it opposes the change in the flux.
21.	**Ans: (a)** Towards A **Explanation:** $F \propto i_1 i_2$, so force on B due to C will be greater than that due to A. Hence net force on B acts towards A. As anti – parallel current repels.
22.	**Ans**: (**c**)0.8amp **Explanation:** Here, $V_G = V_S$ so $I_G G = I_S S$ or $(I - I_S)G = I_S S$ or $I_S = \frac{IG}{G+S} = \frac{1\times 8}{8+2} = 0.8$ A
23.	**Ans**: (**b**)2.828 A **Explanation:**

	Given equation, $e = 80\sin 100\pi t$ Standard equation of instantaneous voltage is given by $e = e_m \sin \omega t$ ...(ii) Compare (i) and (ii), we get $e_m = 80$ V where e_m is the voltage amplitude. Current amplitude, $I_m = \frac{e_m}{Z}$ where Z = impendence $I_m = \frac{80}{20} = 4$ A $I_{r\cdot m.s} = \frac{4}{\sqrt{2}} = \frac{4\sqrt{2}}{2} = 2\sqrt{2} = 2.828$ A
24.	**Ans**: (**d**) T, T, F **Explanation:** Resonant frequency does not depend upon the resistance of the circuit.As $F_0 = \frac{1}{2\pi\sqrt{LC}}$
25.	**Ans:(b)** 2 A **Explanation:** $N_p = 140, N_s = 280, I_p = 4A, I_s = ?$ For a transformer $\frac{I_S}{I_p} = \frac{N_p}{N_s} \Rightarrow \frac{I_S}{4} = \frac{140}{280} \Rightarrow I_s = 2A$
	Section – B
26.	**Ans:(d)** zero **Explanation:** Electric flux, $\phi = EA\cos\theta$, where θ = angle between E and normal to the surface. Here $\theta = \frac{\pi}{2} \Rightarrow \phi = 0$
27.	**Ans:(d)** $Q/6\varepsilon_o$ **Explanation:** According to Gauss' Law $\oint E.ds = \frac{Q_{\text{enclosed by closed surface}}}{\varepsilon_o} = \text{flux}$ so total flux $= Q/\varepsilon_o$ Since cube has six face, so flux coming out through one wall or one face is $Q/6\varepsilon_0$.
28.	**Ans:(d)** $K \in_0 \vec{E}$ **Explanation:** Electric displacement vector, $\vec{D} = \varepsilon\vec{E}$ As, $\varepsilon = \varepsilon_0 K \therefore \vec{D} = \varepsilon_0 K\vec{E}$

29.	**Ans:(c)** 1.6 joule **Explanation:** Energy of given to conductor, $U = \frac{1}{2}CV^2$ or $U = \frac{1}{2} \times 5 \times 10^{-6} \times (800)^2 = 1.6$ joule
30.	**Ans: (c)** T, T, F **Explanation:** Since $V = \frac{W}{Q}$, more work will be done for a positive charge of two units as compared to positive charge of one unit, but the ratio $\frac{W}{Q}$ is same. Therefore potential difference is same.
31.	**Ans:(b)** 15Ω **Explanation:** (b) This is a balanced wheatstone bridge condition, $\frac{5}{R} = \frac{\ell_1}{100 - \ell_1}$ and $\frac{5}{R/2} = \frac{1.6\ell_1}{100 - 1.6\ell_1} \Rightarrow R = 15\Omega$
32.	**Ans:(c)** He should change S to 3Ω and repeat the experiment **Explanation:** To improve the accuracy in measurement , the null point should be found near the middle of the meter bridge wire , i.e. both the known and unknown reactance should be Since, $\frac{R}{S} = \frac{l_1}{(100 - l_1)}$ $\frac{R}{S} = \frac{l_1}{100 - l_1}$ or $R = S\left[\frac{l_1}{100 - l_1}\right]$ Nearly equal , $R = S\left[\frac{2.9}{97.1}\right]$ So, here, $R: S = 2.9: 97.1$ implies that the S is nearly 33 times to that of R. In orded to make this ratio 1: 1 it is necessary to reduce the value of S nearly $\frac{1}{33}$ times i.e., neerly 3Ω.
33.	**Ans:(d)** material of the turns of the coil. **Explanation:** $M = NIA$ It doesn't depend on material of turns of the coil.
34.	**Ans:(b)** $-\vec{F}$ **Explanation:** The force on the two arms parallel to the field is zero. $\therefore$ Force on remaining arms $= -F$

	
35.	**Ans:(a)** 4H **Explanation:** Given: $e = 10\text{ V}$ and $\frac{dl}{dt} = \frac{1-0.5}{0.2} = \frac{0.5}{0.2} = 2.5\text{ A/s}$ Self-inductance of coil $L = \frac{e}{dI/dt} = \frac{10}{2.5} = 4\text{H}$
36.	**Ans:(a)** a metal is kept in varying magnetic field
37.	**Ans:(a)** both Assertion and Reason are correct and the Reason is the correct explanation of the Assertion. **Explanation:** Conservation of electric charge states that the total charge of an isolated system remains unchanged with time.
38.	**Ans:(c)** the Assertion is correct but Reason is incorrect. **Explanation:** Coulomb force and gravitational force follow the same inverse-square law. But gravitational force is always attractive force, while coulomb force can be of both force attractive and repulsive.
39.	**Ans:(b)** both Assertion and Reason are correct but Reason is not the correct explanation of the Assertion. **Explanation:** Since force on both the charges of a dipole is equal but opposite in direction, so net force = 0
40.	**Ans(a) :** both Assertion and Reason are correct and the Reason is the correct explanation of the Assertion. **Explanation:**

	If the battery remains connected to capacitor, V remains constant while C increases with the introduction of dielectric
41.	**Ans:(c).** the Assertion is correct but Reason is incorrect. **Explanation :** In a conductor there are large number of free electrons. When we close the circuit, the electric field is established instantly with the speed of electromagnetic wave which cause electron drift at every portion of the circuit. Due to which the current is set up in the entire circuit instantly. The current which is set up does not wait for the electrons flow from one end of the conductor to another end. It is due to this reason, the electric bulb glows immediately when switch is on.
42.	**Ans:(a)** both Assertion and Reason are correct and the Reason is the correct explanation of the Assertion. **Explanation:** When temperature increases the random motion of electrons and vibration of ions increases which results in more frequent collisions of electrons with the ions. Due to this the average time between the successive collisions, denoted by τ, decreases which increases ρ.
43.	**Ans:(a)** If both Assertion and Reason are correct and the Reason is the correct explanation of the Assertion. **Explanation:** (a) Power loss $= i^2R = \left(\frac{P}{V}\right)^2 R$ [P = Transmitted power]
44.	**Ans: (a)** both Assertion and Reason are correct and the Reason is the correct explanation of the Assertion.
45.	**Ans:(c)** the Assertion is correct but Reason is incorrect. **Explanation:** Soft iron is an iron that has a low carbon content and is easily magnetized and demagnetized with a small hysteresis loss. Placing a soft iron core inside the coil makes the magnetic field radial which increases the torque acting on the coil due to a given current flowing in the coil. The sensitivity increases because, for the same current, the deflection of the coil is more when a core is inserted inside the coil.

46.	**Ans:(c)** the Assertion is correct but Reason is incorrect.
47.	**Ans:(c)** CR **Explanation:** The time constant for resonance circuit, = CR Growth of charge in a circuit containing capacitance and resistance is given by the formula, $q = q_0(1 - e^{-t/CR})$ CR is known as time constant in this formula.
48.	**Ans:(b)** increases directly with frequency **Explanation:** $X_L = \omega L \Rightarrow X_L \propto \omega$
49.	**Ans:(a)** $\frac{\pi}{4}\sqrt{LC}$ **Explanation:** In LC oscillation, energy is transferred C to L or L to C, maximum energy in L is $\frac{1}{2} LI_{max^2}$ Maximum energy in C is $\frac{q_{max}^2}{2C}$ Energy will be equal when, $\frac{1}{2}LI^2 = \frac{1}{2} \times \frac{1}{2} LI_{max}^2 \Rightarrow I = \frac{I_{max}}{\sqrt{2}}$ $I = I_{max}\sin \omega t = \frac{1}{\sqrt{2}} I_{max}$ $\omega t = \frac{\pi}{4} \Rightarrow \frac{2\pi}{T} t = \frac{\pi}{4} \Rightarrow t = \frac{T}{8}$ $t = \frac{1}{8} 2\pi\sqrt{LC} = \frac{\pi}{4}\sqrt{LC}$ $\Rightarrow t = \frac{\pi}{4}\sqrt{LC}$
	Section –C
50.	**Ans: (a)** magnetic equator **Explanation:** The line on the Earth's surface joining the points where the field is horizontal is Magnetic equator.
51.	**Ans:(d)** negative direction of Z-axis **Explanation:** As electron moving in positive x-direction, so the current is moving in negative x-direction (the direction of your middle finger) and the magnetic field acts on positive Y-direction (the direction of your index finger) then thumb will be in negative Z-direction which is the direction of force.

52.	**Ans:(c)** the vector sum of electrostatic and magnetic force acting on a moving charged particle. **Explanation:** As Lorentz force is given by $\vec{F} = q(\vec{E} + \vec{V} \times \vec{B}) = q\vec{E} + q(\vec{V} \times \vec{B})$ $\vec{F} = \vec{F}_E + \vec{F}_B$
53.	**Ans:(a)** $(10\hat{i} - 7\hat{j} - 7\hat{k})$ **Explanation:** Lorentz force, $\vec{F} = q\{\vec{E} + (\vec{v} \times \vec{B})\}$ $\vec{v} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & 0 \\ 5 & 3 & 4 \end{vmatrix} = 8\hat{i} - 4\hat{j} - 7\hat{k}$ $\vec{F} = 1(2\hat{i} - 3\hat{j} + 8\hat{i} - 4\hat{j} - 7\hat{k}) = (10\hat{i} - 7\hat{j} - 7\hat{k})$
54.	**Ans:(c)** $E \neq 0, B = 0$ **Explanation:** (i) When no field is present $E = 0$, $B = 0$, the proton experiences no force. Thus it moves with a constant velocity. (ii) When $E = 0$ and $B \neq 0$, then there will be a probability that proton may move parallel to magnetic field. In this situation, there will be no force acting on proton. (iii) When both fields are present $E \neq 0$, $B \neq 0$, then let E, B and v may be mutually perpendicular to each other. In this case, the electric and magnetic forces acting on the proton may be equal and opposite. Thus, there will be no resultant force on the proton.
55.	**Ans:(c)** 3×10^3 N/C **Explanation:** $E = vB = 2 \times 10^3 \times 1.5 = 3 \times 10^3$ V/m.