FIRST TERM EXAMINATION

APRIL/MAY 2018

CLASS XII

Marking Scheme – SUBJECT [PHYSICS] [THEORY]

Q.NO.	**Answers**	Marks
	SECTION-A	
1.	J/C	1
2.	Positive because negative charge moves from higher potential energy to lower potential energy.	1
3.	$\frac{\phi}{6}$	1
4.	If the field lines are not normal, then the electric field would have a tangential component which will make electrons move along the surface creating surface currents and the conductor will not be in equilibrium.	1
5.	The capacitor plates will get discharged immediately. The stored energy in the capacitor changes into heat energy.	
	SECTION-B	
6.	$k\frac{4e \times q}{x^2} = k\frac{e \times q}{(a-x)^2}$ $x = \frac{2a}{3}$ or $2a$ Only $x = \frac{2a}{3}$ is possible	2
7.	(i) Equipotential surfaces equally spaced in the diagram along Z- direction in x-y plane (ii) Gap between Equipotential surfaces keep on decreasing in the diagram along Z- direction in x-y plane	1 1
8.	PE = - 5.0 X 10^{-7} J	2
9.	(i) Due to infinitely thin metallic charged sheet (ii) Due to infinitely long wire (iii) Due to point charge (iv) Due to electric dipole	½ ½ ½ ½
10.	C_s = 3 pF PD across each capacitor = 40 V OR C_{II} = 9pF Charge on each capacitor = 360 pC	1 1 1 1
11.	(i) F' = F (ii) Decreases	1 1
12.	(i) Graph (ii) ΔV = 0 therefore W = q ΔV = 0	1 1

	SECTION-C	
13.	F_1 = 180 N along BA	½
	F_2 = 180 N along AC	½
	Resultant force	1½
	F = 180 N	
	Resultant force F is parallel to BC.	½
14.	Charge on shell A, $q_A = 4\pi a^2\sigma$	
	Charge on shell B, $q_B = -4\pi b^2\sigma$	
	Charge of shell C, $q_C = 4\pi c^2\sigma$	
	Potential of shell A: Any point on the shell A lies inside the shells B and C.	
	$V_A = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_A}{a} + \frac{q_B}{b} + \frac{q_C}{C}\right]$	
	$= \frac{1}{4\pi\varepsilon_0}\left[\frac{4\pi a^2\sigma}{a} - \frac{4\pi b^2\sigma}{b} + \frac{4\pi c^2\sigma}{c}\right]$	
	$= \frac{\sigma}{\varepsilon_0}(a - b + c)$	1
	Any point on B lies outside the shell A and inside the shell C. Potential of shell B,	
	$V_B = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_A}{b} + \frac{q_B}{b} + \frac{q_C}{c}\right]$	
	$= \frac{1}{4\pi\varepsilon_0}\left[\frac{4\pi a^2\sigma}{b} - \frac{4\pi b^2\sigma}{b} + \frac{4\pi c^2\sigma}{c}\right] = \frac{\sigma}{\varepsilon_0}\left[\frac{a^2}{b} - b + c\right]$	
	Any point on shell C lies outside the shells A and B. Therefore, potential of shell C.	
	$V_C = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_A}{c} + \frac{q_B}{b} + \frac{q_C}{c}\right]$	
	$= \frac{1}{4\pi\varepsilon_0}\left[\frac{4\pi a^2\sigma}{c} - \frac{4\pi b^2\sigma}{c} + \frac{4\pi c^2\sigma}{c}\right]$	
	$= \frac{\sigma}{\varepsilon_0}\left[\frac{a^2}{c} - \frac{b^2}{c} + c\right]$	1
	Now, we have	
	$V_A = V_C$	
	$\frac{\sigma}{\varepsilon_0}(a - b + c) = \frac{\sigma}{\varepsilon_0}\left(\frac{a^2}{c} - \frac{b^2}{c} + c\right)$	
	$a - b = \frac{(a-b)(a+b)}{c}$	
	or $a + b = c$	1
15.	Derivation of Electric field at axial point for the electric dipole	
	Diagram	½
	Derivation	2
	Graph **E** versus **r**	½
16.	On disconnecting the battery, the charge q on the plates of capacitor remains unchanged, if the distance d is doubled, then (i) $E = \frac{q}{\varepsilon_0 A} = E_0$ i.e. the electric field unchanged	1
	(ii) $C = \frac{\varepsilon_0 A}{2d} = \frac{1}{2}C_0$ i.e. the capacitance is halved.	1
	(iii) $U = \frac{q^2}{2C} = \frac{q^2}{C_0}$ i.e. the stored energy is doubled	1

17.	Work done in moving a unit positive charge along distance $\delta \ell$ $\lvert E_l \rvert \, \delta \ell = V_A - V_B$ $= V - (V + \delta V)$ $= -\delta V$ $E = -\frac{\delta V}{\delta \ell}$ (i) Electric field is in the direction in which the potential decreases steepest. (ii) Magnitude of Electric field is given by the change in the magnitude of potential per unit displacement, normal to the equipotential surface at the point.	1 ½ ½
18.	KE of the electron = e $\lambda/4\pi\varepsilon_0$ Graph is a straight line between KE and λ	2 1
19.	Let $A \to$ area of each plate. Let initially $C_1 = C = \frac{\epsilon_0 A}{d} = C_2$ After inserting respective dielectric slabs: $C_1' = KC$ ...(*i*) and $C_2' = K_1 \frac{\epsilon_0 (A/2)}{d} + \frac{K_2 \epsilon_0 (A/2)}{d}$ $= \frac{\epsilon_0 A}{2d}(K_1 + K_2)$ $C_2' = \frac{C}{2}(K_1 + K_2)$ ...(*ii*) From (*i*) and (*ii*) $C_1' = C_2'$ $KC = \frac{C}{2}(K_1 + K_2)$ $K = ½ (K_1 + K_2)$	1 1 1
20.	Derivation of electric potential at any point due to dipole. Diagram Derivation	 ½ 2 ½
21.	C_{eq} = 100 pF V_4 =150 V $Q_4 = 3 \times 10^{-8}$ C	2 ½ ½
22.	Derivation of electric field due to long wire. Diagram Derivation	 ½ 2 ½
23.	$C_S = c/2$ and $C_p = 2C$ $U_S = U_p$ $½ C_S V_S^2 = ½ C_p V_p^2$ $V_S : V_p = 2 : 1$	1 2
24.	Net flux $\phi = \phi_1 + \phi_2$ where $\phi_1 = \vec{E} \cdot \vec{dS}$ $= 2aC\, dS \cos 0° = 2aC \times a^2 = 2a^3C$ $\phi_2 = aC \times a^2 \cos 180° = -a^3C$ $\phi = 2a^3C + (-a^3C) = a^3C \text{ Nm}^2 \text{ C}^{-1}$ Net charge $(q) = \varepsilon_0 \times \phi = a^3C\varepsilon_0$ coulomb $q = a^3C\, \varepsilon_0$ coulomb. OR	½ ½ 1 1

	(i) $\phi_L = E.dA \cos 180^0$ $= -50 \times 1 \times 25 \times 10^{-4}$ $= -0.125\ Nm^2C^{-1}$ $\phi_R = E.dA \cos 0^0$ $= -50 \times 2 \times 25 \times 10^{-4}$ $= -0.250\ Nm^2C^{-1}$ $\phi_{net} = \phi_R + \phi_L$ $= 0.125\ Nm^2C^{-1}$ (ii) $q = \varepsilon_0 q_{net}$ $= 1.107 \times 10^{-12}$ C	½ ½ 1 1
	SECTION-D	
25.	(i) Explanation of no translator motion (ii) Diagram Derivation of torque on dipole (iii) W = 2 pE OR (i) Electric lines never cross each other – explanation (ii) Diagram Derivation of electric field at equatorial point due to dipole (iii) Sketch of electric field lines	1 ½ 2 ½ 1 1 ½ 2 ½ 1
26.	(i) Statement of Gauss's theorem Electric field due to charged spherical shell (a) outside the shell (b) inside the shell (ii) –Q (with all working) OR (i) Definition of electric flux and SI unit (ii) Prove of the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it. (iii) Direction of electric field if (i) the sheet is positively charged, (ii) negatively charged?	1 1 1 2 ½ , ½ 3 ½,1/2
27.	(i) Electric field inside a dielectric decreases when it is placed in an external electric-explanation (ii) Derivation of capacitance when when dielectric of t = d/2 is introduced between the plates OR (i) Two differences between polar and non-polar dielectric (ii) Derivation of energy stored in capacitor Derivation of energy density	2 3 2 2 1