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	1_
6.	$k \frac{4e \times q}{x^2} = k \frac{e \times q}{(a-x)^2}$ $x = \frac{2a}{3} \text{ or } 2a$ Only $x = \frac{2a}{3}$ is possible	2
7.	(i) Equipotential surfaces equally spaced in the diagram along Z- direction in	1
7.	x-y plane	1
	(ii) Gap between Equipotential surfaces keep on decreasing in the diagram along Z- direction in x-y plane	
8.	PE = - 5.0 X 10 ⁻⁷ J	2
9.	(i) Due to infinitely thin metallic charged sheet	1/2
J.	(ii) Due to infinitely long wire	1/2
	(iii) Due to point charge	1/2
	(iv) Due to electric dipole	1/2
10.	$C_s = 3 \text{ pF}$	1
10.	PD across each capacitor = 40 V	1
	OR OR	_
	C _{II} = 9pF	1
11.	Charge on each capacitor = 360 pC (i) F' = F	1
11.	(ii) Decreases	1 1
12.		1
14.	(i) Graph (ii) $\Delta V = 0$ therefore $W = q \Delta V = 0$	1

	SECTION-C	
13.	F ₁ = 180 N along BA	1/2
	$F_2 = 180 \text{ N along AC}$	1/2
	Resultant force	1½
	F = 180 N	
	Resultant force F is parallel to BC.	1/2
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.	
	$V_A = \frac{1}{4\pi\varepsilon_0} \left[\frac{q_A}{a} + \frac{q_B}{b} + \frac{q_C}{C} \right]$	
	$1 \left[4\pi a^2 \sigma - 4\pi b^2 \sigma - 4\pi c^2 \sigma \right]$	
	$=\frac{1}{4\pi\varepsilon_0}\left[\frac{4\pi a^2\sigma}{a}-\frac{4\pi b^2\sigma}{b}+\frac{4\pi c^2\sigma}{c}\right]$	
	$=\frac{\sigma}{\varepsilon_0}(a-b+c)$	1
	Any point on B lies outside the shell A and inside the shell C. Potential of shell B,	*
	Any point on b lies obtained the site in a mission the site in C. I obtained on site in b,	
	$V_B = \frac{1}{4\pi\epsilon_D} \left[\frac{q_A}{b} + \frac{q_B}{b} + \frac{q_C}{c} \right]$	
	$=\frac{1}{4\pi\varepsilon_0}\left[\frac{4\pi a^2\sigma}{b}-\frac{4\pi b^2\sigma}{b}+\frac{4\pi c^2\sigma}{c}\right]=\frac{\sigma}{\varepsilon_0}\left[\frac{a^2}{b}-b+c\right]$	
	$4\pi\epsilon_0 \ b \ b \ c \ \epsilon_0 \ b \ $ Any point on shell C lies outside the shells A and B. Therefore, potential of shell C.	
	$V_C = \frac{1}{4\pi\epsilon_0} \left[\frac{q_A}{\epsilon} + \frac{q_B}{b} + \frac{q_C}{\epsilon} \right]$	
	$=\frac{1}{4\pi\varepsilon_0}\left[\frac{4\pi a^2\sigma}{c}-\frac{4\pi b^2\sigma}{c}+\frac{4\pi c^2\sigma}{c}\right]$	
	$=\frac{\sigma}{\varepsilon_0}\left[\frac{a^2}{c}-\frac{b^2}{c}+c\right]$	1
	Now, we have	1
	$V_A = V_C$	
	$\frac{\sigma}{\varepsilon_0}(a-b+c) = \frac{\sigma}{\varepsilon_0}\left(\frac{a^2}{c} - \frac{b^2}{c} + c\right)$	
	$a-b=\frac{(a-b)(a+b)}{c}$	
	or $a+b=c$	
		1
15.	Derivation of Electric field at axial point for the electric dipole	
	Diagram	1/2
	Derivation	2
	Graph E versus r	1/2
16.	On disconnecting the battery, the charge q on the plates of capacitor remains	
	unchanged, if the distance d is doubled, then (i) $E = \frac{q}{\varepsilon_{0A}} = E_0$ 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
		1

17.	Work done in moving a unit positive charge along distance $\delta \ell$ $ E_l \delta \ell = V_A - V_B$ $= V - (V + \delta V)$ $= -\delta V$	
	$E = -\frac{\delta V}{\delta \ell}$	1
	(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	1/2
	potential per unit displacement, normal to the equipotential surface at the point.	1/2
18.	KE of the electron = e $\lambda/4\pi\varepsilon_0$	2
	Graph is a straight line between KE and λ	1
19.	Let $A \rightarrow$ area of each plate.	
	Let initially $C_1 = C = \frac{\epsilon_0}{d} = C_2$	
	After inserting respective dielectric slabs:	
	$C_1' = KC \qquad \dots (i)$	1
	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)	1
	4	1
	From (i) and (ii)	
	$C_1' = C_2'$ $KC = \frac{C}{2}(K_1 + K_2)$	
	$\mathbf{KC} = \frac{1}{2} (\mathbf{K}_1 + \mathbf{K}_2)$	
	$K = \frac{1}{2} (K_1 + K_2)$	1
20.	Derivation of electric potential at any point due to dipole.	
	Diagram	1/2
24	Derivation	2 ½
21.	$C_{eq} = 100 \text{ pF}$ $V_4 = 150 \text{ V}$	2 ½
	$Q_4 = 3 \times 10^{-8} \text{ C}$	1/2
22.	Derivation of electric field due to long wire.	
	Diagram	1/2
	Derivation	2 ½
23.	$C_s = c/2$ and $C_p = 2C$	1
	$U_S = U_p$ $\frac{1}{2} C_S V_S^2 = \frac{1}{2} C_p V_p^2$	
	$V_{S}: V_{p} = 2:1$	
		2
24.	Net flux $\phi = \phi_1 + \phi_2$	
24.	where $\phi_1 = \vec{E} \cdot \vec{dS}$	
	$= 2aC dS \cos 0^\circ = 2 aC \times a^2 = 2a^3 C$	1/2
	$\phi_2 = aC \times a^2 \cos 180^\circ = -a^3 C$	1/2
	$\phi = 2a^3C + (-a^3C) = a^3C \text{ Nm}^2 \text{ C}^{-1}$	1
	Net charge $(q) = \varepsilon_0 \times \phi = a^3 C \varepsilon_0$ coulomb	1
	$q = a^3 C \epsilon_0$ coulomb.	1
	OK OK	

(i) $\phi_L = E. dA \cos 180^\circ$ $= -50 \times 1 \times 25 \times 10^{-4}$ $= -0.125 \text{Nm}^2 \text{C}^{-1}$ $\phi_R = E. dA \cos 0^\circ$ $= -50 \times 2 \times 25 \times 10^{-4}$ $= -0.250 \text{Nm}^2 \text{C}^{-1}$ $\phi_{net} = \phi_R + \phi_L$ $= 0.125 \text{Nm}^2 \text{C}^{-1}$ $\phi_{net} = \phi_R + \phi_L$ $= 0.125 \text{Nm}^2 \text{C}^{-1}$ (ii) $q = \varepsilon_0 q_{net}$ $= 1.107 \times 10^{-12} \text{C}$ 1 25. (i) Explanation of no translator motion			
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