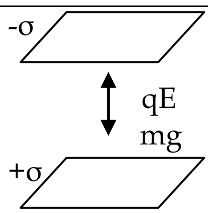
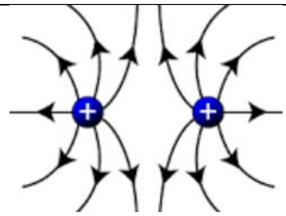
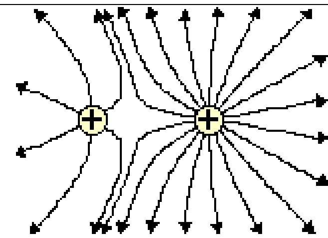
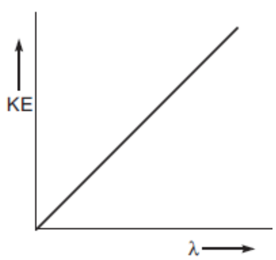
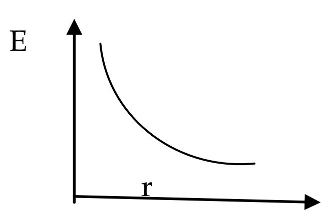
FIRST TERM EXAMINATION

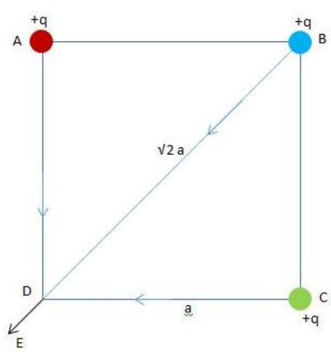
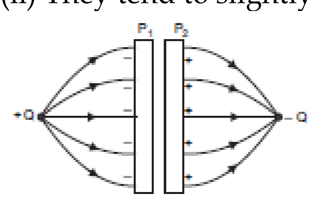
APRIL/MAY 2018

CLASS XII

Marking Scheme – PHYSICS[FIRST ASSESSMENT][THEORY]   SET 2

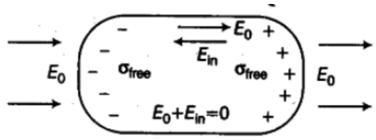
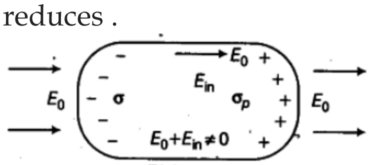
Q.NO	Answers	Marks
1	If the field lines are not normal, then the field would have a tangential component which will make electrons move along the surface creating surface currents and the conductor will not be in equilibrium.	1
2	The force will decrease.	1
3	In moving a small positive charge from Q to P, work has to be done by an external agency against the electric field. Therefore, work done by the field is negative.	1
4	(i) water or HCl or any relevant eg (ii) CH_4 or H_2	½ ½
5	zero	1
6	 mg=qE	1 1
7	Obtaining the expression $U = -pE\cos\theta$	2
8	(i) No **Reason:** At the point of intersection, there will be two different directions of electric field, which is not possible. (ii) Q1-positive , Q2-negative (Q2>Q1)	½ ½ ½ +½
9	The line joining *B* to *C* is perpendicular to electric field, so potential of *B* = potential of *C* Distance *AB* = 4 cm Potential difference between *A* and $C = E \times (AB)$ $= 5 \times 10^{3} \times (4 \times 10^{-2})$ **= 200 volt** OR	½ ½ 1
	$let\ q_1 = x \times 10^{-6} C$ $q_1 = (7 - x)10^{-6} C$ (1/2) Substituting in $F = kq_1q_2 / r^2$ $q_1 = 5\mu C, \quad q_1 = 2\mu C$	1 ½
10	(i) (ii) q_2 q_1	1+1

	 	
11	Resultant dipole moment =p $\tau = pE/2$ Torque is clockwise when viewed from above and is perpendicular to both $\vec{p}$ *and* $\vec{E}$	1 ½ ½
12	The dipole moment per unit volume is called polarisation for linear isotropic dielectrics. $\vec{p} = \chi\vec{E}$	1 1
13	Infinitely long charged wire produces a radial electric field. $E = \frac{\lambda}{2\pi\varepsilon_0 r}$ ... (1) The revolving electron experience an electrostatic force and provides necessarily centripetal force. $eE = \frac{mv^2}{r}$ ... (2) $mv^2 = \frac{e\lambda}{2\pi\varepsilon_0}$ $K = \frac{1}{2}mv^2 = \frac{e\lambda}{4\pi\varepsilon_0}$ 	½ ½ ½ ½ 1
14	(i) (a) When dipolemoment vector is parallel to electric field (b) When dipolemoment vector is antiparallel to electric field (ii) (a) electric flux remains the same (b) Electric flux becomes zero.	½ ½
15	Diagram and introduction Proving Net force acting on the dipole=0 Deriving $\tau = pE\sin\theta$ OR Diagram and introduction Deriving electric field strength at a distant point situated along the equatorial line of an electric dipole	1 1 1 1 2
16	(i) Diagram and introduction deriving expression for the electric field intensity at any point due to a thin, infinitely long wire (ii) 	½ 1 ½ 1

17	$\varphi_L = E_L.\Delta S = \Delta S\, \mathbf{E_L}\cdot \mathbf{n_L} = E_L \Delta S \cos\theta = -E_L \Delta S$, since $\theta = 180°$ $\varphi_L = -E_L a^2$ $\varphi_R = \mathbf{E_R}.\mathbf{\Delta S} = E_R \Delta S \cos\theta = E_R \Delta S$, since $\theta = 0°$ $\varphi_R = E_R a^2$ Net flux through the cube $= \varphi_R + \varphi_L = E_R a^2 - E_L a^2 = a^2 (E_R - E_L) = \alpha a^2 [(2a)^{1/2} - a^{1/2}]$ $= 1.05\ N\ m^2\ C^{-1}$ $q = \varphi\varepsilon_0$. $q = 1.05 \times 8.854 \times 10^{-12}\ C = 9.27 \times 10^{-12}\ C$.	½ ½ 1 ½+½
18	(a) $qd_1=Qd_2$ $d_1/d_2=Q/q$ (b) angle between them=0^0 (ii) by connecting them with a wire, the capacitor will be discharged and the total energy stored in the capacitor is lost in the form of heat.	1 1
19	$V(R)=\frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{R}+\frac{q}{R}\right)$, $V(r)=\frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{R}+\frac{q}{r}\right)$ Potential difference = $V(r) - V(R) = \frac{1}{4\pi\varepsilon_0}\left(\frac{1}{r}-\frac{1}{R}\right)$ Charge will flow from inner sphere to the outer shell.	½+½ ½+½ 1
20	Electric field at D due to the charge at A is, $E_A = kq/a^2$ along AD Electric field at D due to the charge at C is, $E_C = kq/a^2$ along CE Electric field at D due to the charge at B is, $E_B = kq/(2a^2)$ along BE Resultant of E_A and E_C is, $E_{AC} = [(E_A)^2 + (E_C)^2]^{1/2} = \sqrt{2}\ kq/a^2$ along BD. resultant electric field at D is, $E = E_{AC} + E_B = \sqrt{2}\ kq/a^2 + kq/(2a^2) = (2\sqrt{2} + 1)kq/(2a^2)$ along BD. 	½ ½ ½ ½ ½+½
21	(i) definition of electric flux and SI unit (ii) They tend to slightly move apart. 	½+½ 1 1
22	(a) No effect on capacitance if foil is electrically neutral. (b) If foil is connected to upper plate with a conducting wire, the effective separation between plates becomes half, so capacitance is doubled. (ii) Current passes only when there is difference in potential.	1 1 1

23	Definition of dielectric strength Let $A \rightarrow$ 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) $C_1' = C_2'$ $KC = \frac{C}{2}(K_1 + K_2)$ $K = \frac{1}{2}(K_1 + K_2)$	1 1 1
24	Electrostatic energy stored in the capacitor, $E = \frac{1}{2} CV^2$ $= \frac{1}{2} \times (600 \times 10^{-12}) \times (200)^2$ $= 1.2 \times 10^{-5}$ J Common potential V= $C_1V_1 / (C_1 + C_2)$ =100V For the combination, E=1/2 $(C_1 + C_2)$ V^2=0.6×10^{-6}J Energy lost=final-initial=0.6×10^{-6}J	½ ½ ½+½ ½+½
25	Introduction Obtaining the expression U=1/2 CV^2 $\therefore \quad C_{eq} = 100 \text{ pF}$ Now, $Q = C_{eq} \times V = 100 \times 10^{-12} \times 300 = 3 \times 10^{-8}$ coulomb Potential difference across $C_4 = \frac{Q}{C_4}$ $= \frac{3 \times 10^{-8}}{200 \times 10^{-12}}$ $= 1 \cdot 5 \times 10^2 = \mathbf{150\ V}$ OR (i) Diagram and introduction	½ 1 ½ 1 ½ ½ ½ ½

	Obtaining the expression $V = \frac{kp\cos\theta}{r^2}$ (ii) $U = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r} = 9\times10^9\times\frac{7\times(-2)\times10^{-12}}{0.18} = -0.7$ J. (iii) $W = U_2 - U_1 = 0 - U = 0 - (-0.7) = 0.7$ J.	1 2 ½ +½ 1
26	(i) diagram and introduction Proof of $E = \sigma/2\varepsilon_0$ (ii)(a) total charge is $Q + \frac{Q}{2} = \frac{3Q}{2}$. $\phi = 3Q/2\varepsilon_0$ (b)Gauss's Law-Statement (c) $E = \frac{K\left(\frac{3Q}{2}\right)}{x^2}$ electric force $F = (2Q)\times E = \frac{1}{4\pi\varepsilon_0}\times\frac{3Q^2}{x^2}$ **OR** (i) diagram and introduction for the electric field due to a uniformly charged thin spherical shell at a point To prove $(a) E = \frac{kq}{r^2}$ $(b)\ E = \frac{kq}{R^2}$ (i) **The surface charge density on the inner surface of smaller shell,** $\sigma_1 = -\frac{q}{4\pi r_1^2}$	½ 1 ½ ½ ½ 1 ½+½ ½ 1 ½ 1

	The surface charge density on the outer surface of the bigger shell, $$\sigma_2 = \frac{Q+q}{4\pi r_2^2}$$ For external points, whole charge acts at centre, so electric field at distance $x > r_2$, $$E(x) = \frac{1}{4\pi\varepsilon_0}\frac{Q+q}{x^2}.$$	1 1
27	(i) Potential energy of the charge q_1 in the external field is $U_1 = V_1 q_1$ Potential energy of the charge q_2 in the external field is $U_2 = V_2 q_2$ Potential energy between the system of two charges q_1 and q_2 due to the field produced by them is $U_{12} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}$ By the superposition principle, the potential energy of the system of two charges in an electric field is $$U = U_1+U_2+U_{12} = V_1 q_1 + V_2 q_2 + \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}$$ (ii) When a conductor is placed in an external electric field, net electrostatic field in the conductor becomes zero.  In a dielectric, the opposing field induced does not exactly cancel the external field. It only reduces .  OR (i)Introduction and diagram Deriving $C = \frac{\varepsilon_o A}{\left[(d-t)+\frac{t}{\varepsilon_r}\right]}$ (ii) capacitance increases K times p.d. between the plates becomes 1/K times Electric field decreases to 1/K times Energy decreases to 1/K times	½ ½ 1 1 ½ ½ ½ ½ 1 2 ½ ½ ½ ½