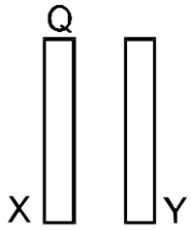
DPP-10

CONDUCTOR, IT'S PROPERTIES & ELECTRIC PRESSURE

Q.1 Two conducting plates X and Y, each having large surface area A (on one side), are placed parallel to each other as shown in figure. The plate X is given a charge Q whereas the other is neutral. Find:



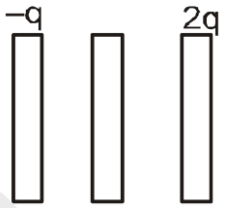
(a) The surface charge density at the inner surface of the plate X,

(b) The electric field at a point to the left of the plates,

(c) The electric field at a point in between the plates and

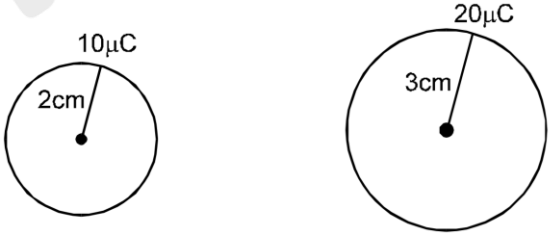
(d) The electric field at a point to the right of the plates.

Q.2 Three identical metal plates with large equal surface areas are kept parallel to each other as shown in figure. The leftmost plate is given a charge −q, the rightmost a charge 2q and the middle one remains neutral. Find the charge appearing on the outer surface of the leftmost plate.



Q.3 Two thin conducting plates (very large) parallel to each other carrying total charges σA and −2σA respectively (where A is the area of each plate), are placed in a uniform external electric field E as shown. Find the surface charge on each surface.

Q.4 Figure shows two conducting spheres separated by large distance and of radius 2 cm and 3 cm containing charges 10μC and 20μC respectively. When the spheres are connected by a conducting wire then find out following :



(i) Ratio of the final charge.

(ii) Final charge on each sphere.

(iii) Ratio of final charge densities.

(iv) Heat produced during the process.

Q.5 Two concentric hollow conducting spheres of radius a and b(b > a) contains charges Q_a and Q_b respectively. If they are connected by a conducting wire then find out following

(i) Final charges on inner and outer spheres.

(ii) Heat produced during the process.

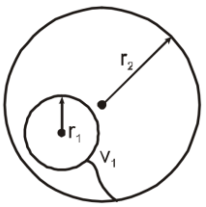
Q.6 There are two concentric metal shells of radii r_1 and $r_2 (> r_1)$. If initially, the outer shell has a charge q and the inner shell is having zero charge and then inner shell is grounded. Find :

(i) Charge on the inner surface of outer shell.

(ii) Final charges on each sphere.

(iii) Charge flown through wire in the ground.

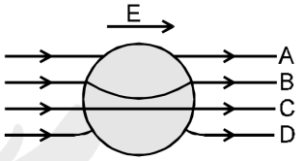
Q.7 A metal sphere of radius r_1 charged to a potential V_1 is then palced in a thinwalled uncharged conducting spherical shell of radius r_2. Determine the potential acquired by the spherical shell after it has been connected for a short time to the sphere by a conductor.



Q.8 A metallic solid sphere is placed in a uniform electric field. The lines of force follow the path(s) shown in figure as : **[JEE '96, 2/100]**

(A) A (B) B

(C) C (D) D



Q.9 A neutral spherical metallic object A is placed near a finite metal plate B carrying a positive charge. The electric force on the object will be:

(A) away from the plate B (B) towards the plate B

(C) parallel to the plate B (D) zero

Q.10 A positive point charge q is brought near a neutral metal sphere.

(A) The sphere becomes negatively charged.

(B) The sphere becomes positively charged.

(C) The interior remains neutral and the surface gets non-uniform charge distribution.

(D) The interior becomes positively charged and the surface becomes negatively charged.

Q.11 Three concentric conducting spherical shells carry charges as follows : +4Q on the inner shell, −2Q on the middle shell and −5Q on the outer shell. The charge on the inner surface of the outer shell is:

(A) 0 (B) 4Q

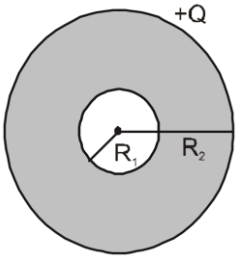
(C) – Q (D) −2Q

Q.12 A charge q is uniformly distributed over a large plastic plate. The electric field at a point P close to the centre and just above the surface of the plate is 50 V/m. If the plastic plate is replaced by a copper plate of the same geometrical dimensions and carrying the same uniform charge q, the electric field at the point P will become:

(A) zero (B) 25 V/m

(C) 50 V/m (D) 100 V/m

Q.13 Figure shows a thick metallic sphere. If it is given a charge +Q, then electric field will be present in the region



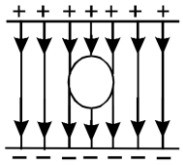
(A) $r < R_1$ only

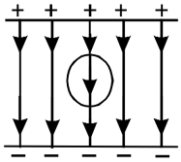
(B) $r > R_1$ and $R_1 < r < R_2$

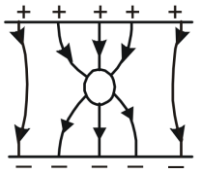
(C) $r \geq R_2$ only

(D) $r \leq R_2$ only

Q.14 An uncharged sphere of metal is placed in a uniform electric field produced by two large conducting parallel plates having equal and opposite charges, then lines of force look like:

(A) 

(B) 

(C) 

(D) 

Q.15 Two small conductors A and B are given charges q_1 and q_2 respectively. Now they are placed inside a hollow metallic conductor (C) carrying a charge Q. If all the three conductors A, B and C are connected by conducting wires as shown, the charges on A, B and C will be respectively:

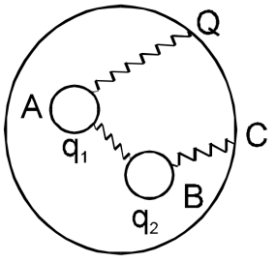
(A) $\frac{q_1+q_2}{2}, \frac{q_1+q_2}{2}, Q$

(B) $\frac{Q+q_1+q_3}{3}, \frac{Q+q_1+q_2}{3}, \frac{Q+q_1+q_2}{3}$

(C) $\frac{q_1+q_2+Q}{2}, \frac{q_1+q_2+Q}{2}, 0$

(D) $0,0, Q+q_1+q_2$

Q.16 You are travelling in a car during a thunder storm. In order to protect yourself from lightening, would you prefer to:



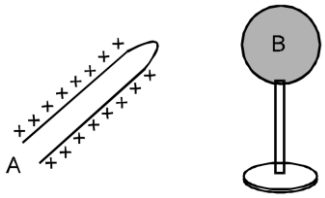
(A) Remain in the car

(B) Take shelter under a tree

(C) Get out and be flat on the ground

(D) Touch the nearest electrical pole

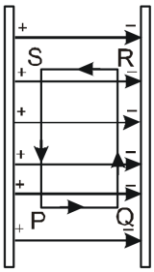
Q.17 A positively charged body 'A' has been brought near a neutral brass sphere B mounted on a glass stand as shown in the figure. The potential of B will be:



(A) Zero (B) Negative

(C) Positive (D) Infinite

Q.18 The amount of work done by electric field in joules in carrying a charge +q along the closed path PQRSP between the oppositely charged metal plates is: (where, E is electric field between the plates)



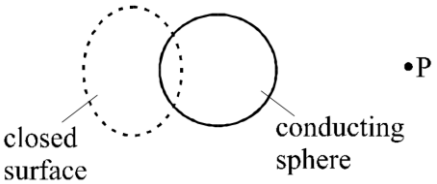
(A) zero

(B) q

(C) qE(PQ + QR + SR + SP)

(D) q/ε_0

Q.19 Figure shows a closed surface which intersects a conducting sphere. If a positive charge is placed at the point P, the flux of the electric field through the closed surface:



(A) will become positive

(B) will remain zero

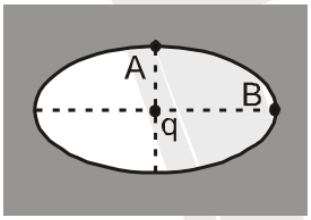
(C) will become undefined

(D) will become negative

Q.20 An ellipsoidal cavity is carved within a perfect conductor. A positive charge q is placed at the center of the cavity. The points A and B are on the cavity surface as shown in the figure.

[JEE-1999 (Scr.), 3/100]

Then :



(A) Electric field near A in the cavity = electric field near B in the cavity

(B) Charge density at A = Charge density at B

(C) Potential at A = Potential at B

(D) Total electric field flux through the surface of the cavity is q/ε_0.

ANSWER KEY

Q.1 (a) $\frac{Q}{2A}$

(b) $\frac{Q}{2\,A\varepsilon_0}$ towards left

(c) $\frac{Q}{2A\varepsilon_0}$ towards right

(d) $\frac{Q}{2A\varepsilon_0}$ towards right

Q.2 $\frac{q}{2}$

Q.3 $(\sigma - x)A, xA, -xA, (x - 2\sigma)A$

where, $x = (2\varepsilon_0 E + 3\sigma)/2$

Q.4 (i) $\frac{Q_1'}{Q_2'} = \frac{2}{3}$

(ii) $\frac{2}{5} \times 30 = 12\mu C, \frac{3}{5} \times 30 = 18\mu C$

(iii) $\frac{\sigma_1'}{\sigma_2'} = \frac{3}{2}$

(iv) $2\pi\varepsilon_0 \left(\frac{r_1 r_2}{r_1 + r_2}\right)(v_1 - v_2)^2 = 3/2$ Joules

Q.5 (i) on inner shell $= 0$, on outer shell $= Q_a + Q_b$

(ii) $\frac{KQ_a^2}{2}\left[\frac{1}{a} - \frac{1}{b}\right]$

Q.6 (i) $(r_1/r_2)q$

(ii) Charge on inner shell $= -(r_1/r_2)q$ and charge on the outer shell $= q$

(iii) Charge flown in to the earth $= (r_1/r_2)q$

Q.7 $V_2 = V_1 \frac{r_1}{r_2}$

Q.8 **(D)**

Q.9 **(B)**

Q.10 **(C)**

Q.11 **(D)**

Q.12 **(C)**

Q.13 **(C)**

Q.14 **(C)**

Q.15 **(D)**

Q.16 **(A)**

Q.17 **(C)**

Q.18 **(A)**

Q.19 **(A)**

Q.20 **(C)**