DPP – 10

Solution

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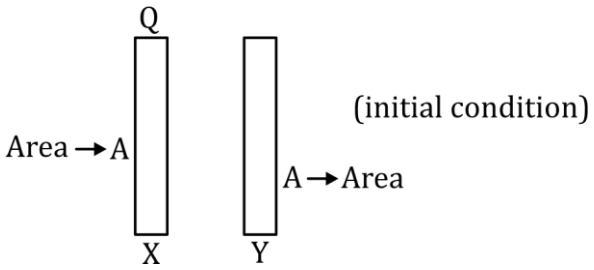
1.



(a) say surface charge densities on both sides of the plate be σ_1 and σ_2.

$\because$ Electric field due to plate is $E = \frac{\sigma}{2\varepsilon_o}$

$\therefore$ magnitudes of electric fields due to plate on each side is given by $\frac{\sigma_1}{2\varepsilon_o}$ and $\frac{\sigma_2}{2\varepsilon_o}$

Net charge developed on the each side will be $q_1 = q_2 = Q/2$

charge density on each side $= \frac{Q}{2A}$.

(b) $\because$ charge density on left side of the plate $= \frac{Q}{2A}$

$\therefore$ Electric field $= \frac{Q}{2 \times 2A\varepsilon_o} + \frac{Q}{2 \times 2A\varepsilon_o} = \frac{Q}{2A\varepsilon_o}$

(c) In between point $= \frac{Q/2}{2A\varepsilon_o} + \frac{Q/2}{2A\varepsilon_o}$

(Electric field)

$= \frac{Q}{2A\varepsilon_o}$

(d) At right of plate $= \frac{Q/2}{2A\varepsilon_o} + \frac{Q/2}{2A\varepsilon_o}$

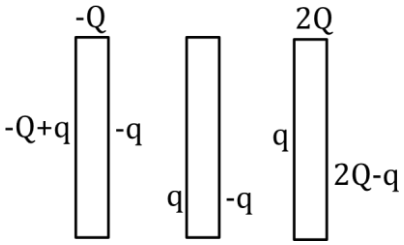
(Electric field)

$= \frac{Q}{2A\varepsilon_o}$

2.

$$E_{net} = \frac{1}{2\pi\varepsilon_o}\left[\underset{(R)}{(-Q+q)} + \underset{(L)}{(-q)} + \underset{(L)}{q} + \underset{(R)}{(-q)} + \underset{(L)}{q} + \underset{(R)}{(2Q-q)}\right]$$

↓ Right ↓ left



$$E_{net} = \frac{1}{2\pi\varepsilon_o}[-Q + q - (-q) - (q) + (-q) - (q) + 2Q - q]$$

here we are taking Right as positive and left as negative

At given point net Electric field will be zero

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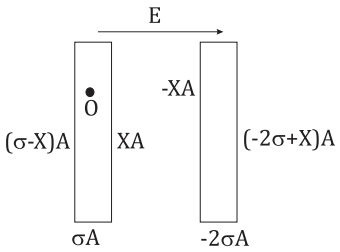
$$\frac{1}{2\pi\varepsilon_o}[-Q+q+q-q-q-q+2Q-q]=0$$

$$Q-2q=0$$

$$q=Q/2$$

3.



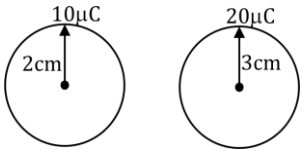
say XA change is present at inner side of plate σA

$$(\sigma-X)A, XA, -XA, (X-2\sigma)A$$

$$E_0=0=\frac{\sigma-X}{2\epsilon_0}+E-\frac{(-2\sigma+X)}{2\epsilon_0}$$

$$x=\frac{3\sigma+2\epsilon_0 E}{2}$$

4. (a) when they will be connected, their potential will be same



i.e. $\frac{q_1}{r_1}=\frac{q_2}{r_2}$

$\frac{q_1}{q_2}=\frac{2}{3}=2:3$

(ii) $q_1+q_2=30$ c

$q_1+\frac{3q_1}{2}=30$

$5q_1=60$

$q_1=12$ c $\Rightarrow$ $q_2=18$ c

(iii) charge density $\sigma\propto\frac{q}{r^2}$

$\frac{\sigma_1}{\sigma_2}=\frac{q_1}{q_2}\left(\frac{r_2}{r_1}\right)^2=\frac{2}{3}\times\frac{3^2}{2^2}$

$\frac{\sigma_1}{\sigma_2}=\frac{3}{2}=3:2$

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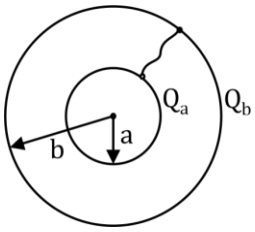
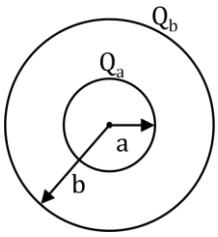
5. **(i)** If spheres are connected through a conducting wine then all charge of inner sphere will be flow at outer sphere



i.e. $Q'_a = 0$ and $Q'_b = Q_a + Q_b$.

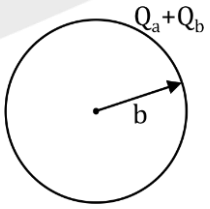
(ii)



Initially

$$U_i = \frac{KQ_a^2}{2a} + \frac{KQ_b^2}{2b} + \frac{KQ_aQ_b}{b}$$

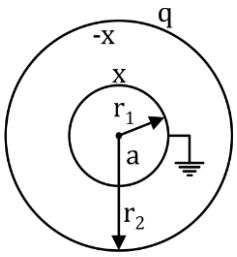
Finally



$$U_f = \frac{KQ_a^2}{2b} + \frac{kQ_b^2}{2b} + \frac{2KQ_aQ_b}{2b}$$

$$\Delta H = U_i - U_f = \frac{K\theta_a^2}{2}\left(\frac{1}{a} - \frac{1}{b}\right)$$

6.



$$\rightarrow \frac{kq}{r_2} + \frac{kx}{r_1} = 0$$

$$x = \frac{-qr_1}{r_2}$$

$$\rightarrow (1)\ -x = q\left(\frac{r_1}{r_2}\right)$$

(2) final charge

outer $\Rightarrow$ q

inner $\Rightarrow x = -q\left(\frac{r_1}{r_2}\right)$

(3) Charge flow through earthing is $= q\left(\frac{r_1}{r_2}\right)$

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7. The charge q_1 can be

writen as, $q_1 = 4\pi\varepsilon_o V_1 r_1$

After the connection the entire charge q_1 will flow from the sphere to envelope.

so $v_2 = \frac{q_1}{4\pi\varepsilon_o r_2} = \frac{q_1}{4\pi\varepsilon_o r_1}\left(\frac{r_1}{r_2}\right)$

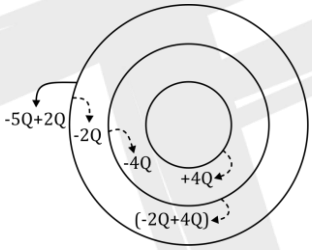
$V_2 = V\left(\frac{r_1}{r_2}\right)$

8. Electric field lines always enter into a surface perpendicularly.

9. By placing near to the charged plate, neutral plate get induced with -ve charge and force will be acting towards the first plate.

10. The charge inside the conductor is always zero and all charges are distributed on the outer surface of the conductor. When a charge is brought near outer surface will get non-uniform charge distribution.

11. Inner side of outer shell $= -2Q$



12. In both case charge density will be same so Electric field at point P will be $E = 50\ V/m$

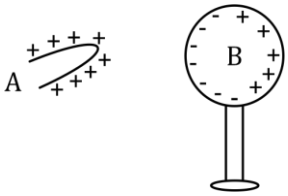
13. Net electric field will be present for $r \geq R_2$.

14. Electric field lines enter into the sphere perpendicular to the surface and as Electric field is not present in sphere so Electric lines also will not be present.

15. All charge will be present on outer surface.

16. Thunder storm will be pass through car.

17. → After Induction equal amount of Positive & negative charges polarised on the sphere. net potential of sphere due to polarised charges is zero.



→ So potential of B is positive due to + ive charge on A.

so option c is correct.

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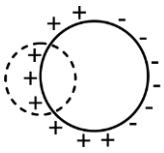
18. Electric field is a conservative field so work done in this case will be zero.

19. charged enclosed by 2nd surface is positive so, thus is positive



P

20. By gauss law flux $= q/\varepsilon_0$.

Equipotential surface mean $V_A = V_B$.