IIT PHYSICS CENTRE

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Situation:- A conducting sphere A of radius a is attached to an insulating handle. Another neutral conducting sphere B of radius b is mounted on an insulating stand. The sphere A is given a charge Q, brought into contact with sphere B and removed. A is recharged such that the charge onit is again Q, and it is again brought into contact with B and removed. This procedure is repeated n times.

1. The capacity of sphere A is

(A) $C_1 = 4\pi\varepsilon_0 a$ (B) $C_1 = 4\pi\varepsilon_0 b$ (C) $C_1 = \frac{a}{4\pi\varepsilon_0}$ (D) None.

2. Capacity of sphere B is

(A) $C_2 = 4\pi\varepsilon_0 a$ (B) $C_2 = 4\pi\varepsilon_0 b$ (C) $C_2 = \infty$ (D) None.

3. After first contact, potential of A and B are

(A) $V_A = V_B$ (B) $V_A > V_B$ (C) $V_A < V_B$ (D) None.

4. The electric charge on B is q_1 after first contact. Then

(A) $\frac{Q-q_1}{4\pi\varepsilon_0 a} = \frac{q_1}{4\pi\varepsilon_0 b}$ (B) $\frac{Q}{4\pi\varepsilon_0 a} = \frac{q_1}{4\pi\varepsilon_0 b}$ (C) $q_1 = \frac{Qb}{a+b}$ (D) $q_1 = \frac{Qa}{a+b}$

5. If total charge on sphere B after second contact is q_2. Then,

(A) $\frac{Q-(q_2-q_1)}{4\pi\varepsilon_0 a} = \frac{q_2}{4\pi\varepsilon_0 b}$ (B) $\frac{Q-(q_1+q_2)}{4\pi\varepsilon_0 a} = \frac{q_1+q_2}{4\pi\varepsilon_0 b}$

(C) $q_2 = Q\left\{\left(\frac{b}{a+b}\right)+\left(\frac{b}{a+b}\right)^2\right\}$ (D) None

6. Electric charge on sphere B after n^{th} contact is

(A) $q_n = Q\left\{\left(\frac{b}{a+b}\right)+\left(\frac{b}{a+b}\right)^2+\dots\dots\left(\frac{b}{a+b}\right)^n\right\}$ (B) $q_n = \frac{Qb}{a}\left\{1-\left(\frac{b}{a+b}\right)^n\right\}$

(C) $q_n = \frac{Qa}{b}\left\{1-\left(\frac{b}{a+b}\right)^n\right\}$ (D) None.

7. For maximum charge on sphere B,

(A) $n \to \infty$ (B) n = 1 (C) n = 2 (D) None.

8. The maximum charge on sphere B is

(A) $q_{max} = Q$ (B) $q_{max} = \frac{Qb}{a}$ (C) $q_{max} = \frac{Qa}{a}$ (D) None.

9. The maximum energy stored on sphere B is

(A) $\frac{q^2_{max}}{8\pi\varepsilon_0 b}$ (B) $\frac{Q^2 b}{8\pi\varepsilon_0 a^2}$ (C) $\frac{Q^2}{8\pi\varepsilon_0 b}$ (D) None.

10. A water drop carrying a charge of 1μC is at a potential of 3000 V. Two idential such drops combine to from a bigger drop. What is the potential at the surface of the big drop?

(a) $3(2)^{2/3}\times 10^3 V$ (b) $6(2)^{2/3}\times 10^3 V$

(c) $7(2)^{2/3}\times 10^3 V$ (d) $9(2)^{2/3}\times 10^3 V$

11. Two plates of a parallel plate capacitor are 2 cm apart. Aslab of dielectric constant 5 and thickness 1 cm is introduced between the plates with its faces parallel to them and the distance between the plates is so changed that the capacity of the capacitor remains unchanged. What is the new distance between the plates?

(A) 1 cm (b) 4.6 cm (c) 2.8 cm (d) 3.2 cm

12. A parallel plate capacitor has the space between plates filled with a medium whose dielectric constant increases uniformly with distance. If l be the distance between the plates and k_1 and k_2 be the capacity of the capacitor per unit area is

(a) $C = \frac{\varepsilon_0 (K_2 - K_1)/l}{In(K_2/K_1)}$ **(b)** $C = \frac{2\varepsilon_0 (K_2 - K_1)/l}{In(K_2/K_1)}$

(c) $C = \frac{\varepsilon_0 (K_2 - K_1)/l}{2In(K_2/K_1)}$ **(d)** $C = \frac{\varepsilon_0 (K_2 - K_1)/l}{3In(K_2/K_1)}$

13. If 125 drop chaged to 200 V each coalesce, what will be the potential of the bigger drop ? What is the ratio of energy of bigger drop to the energy of all the drops?

(a) 5 (b) 25 (c) 50 (d) 75

14. A soap bubble has a radius of 2 cm where the surface tension of the soap solution is 0.024 N/m. To what potential must the soap bubble be raised for the pressure inside It to be equal to the atmospheric pressure ?

(a) $\simeq 80,832 volt$ (b) $\simeq 50,832 volt$

(c) $\simeq 10,832 volt$ (d) $\simeq 20,832 volt$

15. A charge Q given to a spherical soap bubble of radius R and surface tension T makes the bubble to expand twice to its original radius. The charge is given by $Q = N[\pi\varepsilon_0 R^3(7AR+12T)]\frac{1}{2}$ where A is atmospheric pressure. Find value of N.

(a) 2 (b) 4 (c) 6 (d) 8

16. For an insulated soap bubble of radius R, the changed in radius dR due to a charge Q placed on it is $\frac{Q^2}{N\pi^2\varepsilon_0 PR^2}$, where P is the atmospheric pressure. Find value of N.

(a) 96 (b) 100 (c) 32 (d) 8