Physics For IIT–JEE by Shiv R. Goel (B.Tech., IIT–Delhi)

DPP#17–02/06/2018 **SOLUTIONS**

1. (i) $v = \frac{Q}{C} = \frac{30}{5} = 6\ V$

(ii) $U = \frac{1}{2}CV^2 = \frac{1}{2}\ (5\times10^{-6})(6)^2 = 90\times10^{-6}\ J = 90\ \mu J$

(iii) $V_C = \frac{Q_1 + Q_2}{C_1 + C_2} = \frac{30+50}{5+10} = \frac{16}{3}V$

(iv) Heat $= \frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1 - V_2)^2$

$= \frac{1}{2}\times\frac{5\times10}{(5+10)}[6-5]^2, \left[\text{here } V_2 = \frac{50}{10} = 5V\right]$

$= \frac{5}{3}\mu J$

(v) $\frac{Q_{1f}}{Q_{2f}} = \frac{C_1}{C_2} = \frac{5}{10} = \frac{1}{2}$

(vi) $Q_{1f} + Q_{2f} = 30 + 50 = 80\ \mu C$

Solve to get $Q_{1f} = \frac{80}{3}\mu C$ and $Q_{2f} = \frac{160}{3}\mu C$

2. (i) Ratio of initial charge is of no relevance. Finally their potentials are same.

$\frac{kQ'_A}{r_A} = \frac{kQ'_B}{r_B} \Rightarrow \frac{Q'_A}{Q'_B} = \frac{r_A}{r_B} = \frac{1}{2}$

(ii) $\frac{Q'_A}{Q'_B} = \frac{r_A}{r_B} \Rightarrow \frac{\sigma_A 4\pi r_A^2}{\sigma_B 4\pi r_B^2} = \frac{r_A}{r_B}$

$\Rightarrow \frac{\sigma_A}{\sigma_B} = \frac{r_B}{r_A} = \frac{2}{1}$

4. $C = \frac{Q}{V} = \frac{12\times10^{-6}}{1200} = 10^{-8}F$

$\Rightarrow \frac{\epsilon_0 A}{d} = 10^{-8} \Rightarrow A = \frac{10^{-8}d}{\epsilon_0}$

$\Rightarrow A = \frac{10^{-8}V}{\epsilon_0 E}$

A is min if E is maximum

$A_{min} = \frac{10^{-8}V}{\epsilon_0 E_{max}} = \frac{10^{-8}\times1200}{8.85\times10^{-12}\times3\times10^6} = 0.45\ m^2$

5. $F = kx$

$\Rightarrow \frac{Q^2}{2A\epsilon_0} = kx \Rightarrow x = \frac{Q^2}{2Ak\epsilon_0}$

7.(D) Apply $U = \frac{Q^2}{2C}$

8.(B) Total charge of system will remain conserved. Total energy will remain conserved only in one case, if potential of spheres are already same before they are brought in contact. If potential are not same before they are brought in contact, then on connecting, charge will flow between them and energy will be lost in the form of heat.

9. (A) Let x charge flows from smaller to bigger sphere, finally their potential is same.

$\frac{75-x}{5cm} = \frac{75+x}{10cm} \to x = 25\ \mu C$

10. (D) If initial potential are same, then

$k\frac{q_1}{R_1} = \frac{kq_2}{R_2} \Rightarrow q_1R_2 = q_2R_1$

then on connecting in this case, no charge will flow and no energy will be dissplated, otherwise charge flows and energy is dissipated.

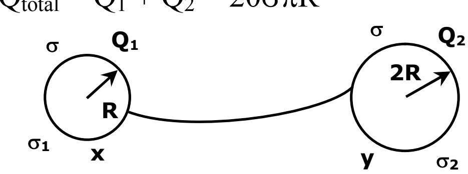
11. (D) Here both the plates of capacitor are connected and now both are at same potential (potential difference V = 0),

$C = \frac{Q}{V} = \frac{Q}{0} = \infty$

15. (A) Work will be done by external agent in pulling the plates apart and this work will convert in potential energy of condenser, hence energy of condenser increases.

17. $Q_1 = \sigma 4\pi R^2$, $Q_2 = \sigma 4\pi(2R)^2 = 16\sigma\pi R^2$

$Q_{total} = Q_1 + Q_2 = 20\sigma\pi R^2$



Let charges are x and y after connecting with wire as shown, so $x + y = 20\sigma\pi R^2$

Their potential will be same:

$\frac{kx}{R} = \frac{ky}{2R} \Rightarrow 2x = y$

Solve to get $y = \frac{40}{3}\sigma\pi R^2$

Now $\sigma_2 = \frac{y}{4\pi(2R)^2} = \frac{5}{6}\sigma$