DPP
DAILY PRACTICE PROBLEMS

Class : XIIth **Solutions** **Subject : PHYSICS**
Date : **DPP No. : 7**

Topic :- ELECTROSTATIC POTENTIAL AND CAPACITANCE

1 **(b)**

$$\frac{1}{C_s} = \frac{1}{4} + \frac{1}{6} + \frac{1}{12} = \frac{3+2+1}{12} = \frac{6}{12} = \frac{1}{2}$$

$C_s = 2\ \mu\text{F}$

$C_p = 4 + 6 + 12 = 22\ \mu\text{F}$

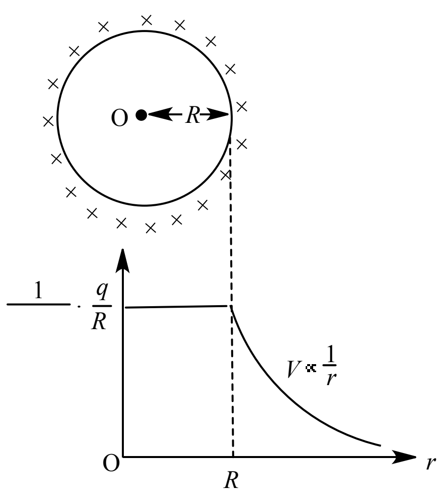
$$\frac{C_s}{C_p} = \frac{2}{22} = \frac{1}{11}$$

2 **(b)**

For neutral point $\vec{E}_A + \vec{E}_B = \vec{0}$ *or* $\vec{E}_A = -\vec{E}_B$. It is possible, in present problem, only at a point somewhere on the left of $-Q$

3 **(c)**

If we take a charge from one point to another inside a charged spherical shell, then no work will be done. This means that inside a spherical charge the potential at all points is the same and its value is equal to that on the surface, that is



$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{R}$ volt

Also outside the metallic sphere

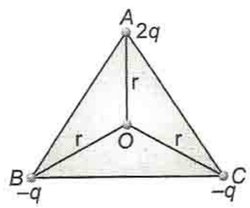
$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r}$

$V \propto \frac{1}{r}$

4 **(c)**

In an equilateral triangle distance of centroid from all the vertices is same (say$r$).

$\therefore\ V = V_1 + V_2 + V_3 = \frac{1}{4\pi\varepsilon_0}\left[\frac{2q}{r} - \frac{q}{r} - \frac{q}{r}\right] = 0$



But $\vec{E}_A = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2q}{1}$ along AO, $\vec{E}_B = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}$ along OB and

$\vec{E}_c = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}$ along OC.obviously $\vec{E}_B + \vec{E}_B$ Will also be in the direction of AO extended and hence $\vec{E}_A\ and (\vec{E}_B + \vec{E}_C)$ being in same direction will not give zero resultant.

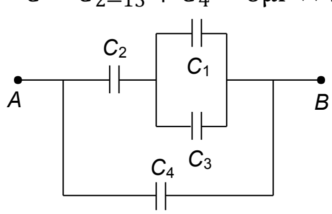
5 **(d)**

The arrangement can be redrawn as shown in the adjoining figure.

$C_{13} = C_1 + C_3 = 9 + 9 = 18\mu F$

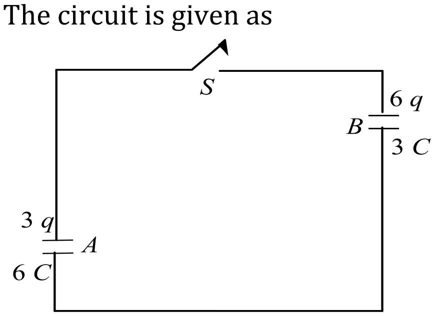
$C_{2-13} = \frac{C_2 \times C_{13}}{C_2 + C_{13}} = \frac{9\mu F \times 18\mu F}{(9 + 18)\mu F} = 6\mu F$

$\therefore C = C_{2-13} + C_4 = 6\mu F \times 9\mu F = 15\mu F.$



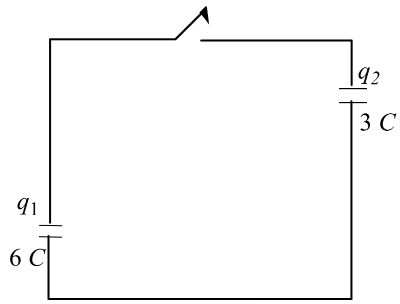
6 **(b)**

The circuit is given as



Let q_1 and q_2 be the charge after switch S has been closed.

Then, $V = \frac{q_1}{6C} = \frac{q_2}{3C}$



$\Rightarrow \quad \frac{q_1}{2} = q_2$

$\Rightarrow \quad q_1 = 2q_2$ ...(i)

But we know that, charge is conserved

$q_1 + q_2 = 3q + 6q$

or $q_1 + q_2 = 9q$ ...(ii)

On putting the value of q_1Eq. (ii)

$2q_2 + q_2 = 9q$

$\Rightarrow \quad 3q_2 = 9q$

$q_2 = 3q$

Now, from Eq. (i)

$q_1 = 2 \times 3q$

$\Rightarrow \quad q_1 = 6q$

Hence, $q_1 = 6q, q_2 = 3q$

7 **(b)**

$C_1 = \frac{K_1\varepsilon_0 A}{d/2} = \frac{2K_1\varepsilon_0 A}{d}$

$C_2 = \frac{2K_2\varepsilon_0 A}{d}$

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{d}{2K_1\varepsilon_0 A} + \frac{d}{2K_2\varepsilon_0 A}$$

$$= \frac{d}{2\varepsilon_0 A}\left(\frac{K_1 + K_2}{K_1 K_2}\right)$$

$$C_s = \frac{2\varepsilon_0 A}{d}\left(\frac{K_1 K_2}{K_1 + K_2}\right)$$

8 **(c)**

Electric potential inside a conductor is constant and it is equal to that on the surface of conductor.

9 **(a)**

Potential energy of the system

$$U=\frac{KQq}{l}+\frac{Kq^2}{l}+\frac{KqQ}{l}=0$$

$$\Rightarrow \frac{Kq}{l}(Q+q+Q)=0$$

$$\Rightarrow \quad Q=-\frac{q}{2}$$

10 **(b)**

Potential energy of charges q_1 and q_2,r distance apart

$$U=\frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r}$$

For $r=0.1$m,

$$U_1=\frac{1}{4\pi\varepsilon_0}\frac{12\times10^{-6}\times5\times10^{-6}}{0.1}$$

$$=\frac{9\times10^9\times60\times10^{-12}}{0.1}=5.4\text{ J}$$

For $r=0.06$m,

$$U_2=\frac{9\times10^9\times60\times10^{-12}}{0.06}=9\text{ J}$$

$\therefore$ Work done = (9 – 5.4) J = 3.6 J

11 **(d)**

Loss of energy $=\frac{1}{2}\frac{C_1C_2}{(C_1+C_2)}(V_1-V_2)^2$

$$=\frac{1}{2}\frac{5\times10^{-6}\times5\times10^{-6}(2000-1000)^2}{(5+5)\times10^{-6}}$$

$$=\frac{5\times5}{2\times10}=1.25\text{J}$$

12 **(c)**

In steady state no current flows through the capacitor segment. The steady current in remaining loop $I=\frac{2V-V}{2R+R}=\frac{V}{3R}$ (anti-clockwise). Now applying Kirchhoff's second law to loop containing $2V$,$2R$,C and V, we have $V_c=2V-1.2V-\frac{V}{3R}.2R-V=\frac{V}{3}$

13 **(c)**

$E\propto\frac{1}{r}$, where r is the distance from the axis.

14 **(b)**

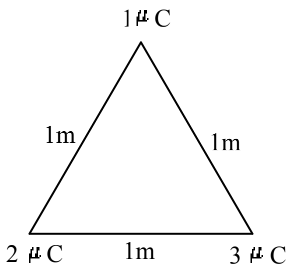
Here, $C_s=\frac{C_1C_2}{C_1+C_2}=3\mu$ F

And $C_p=C_1+C_2=16\mu$ F

Solve to get, $C_1=4\mu$ F and $C_2=12\mu$ F

15 **(c)**

When charges are placed at vertices of an equilateral triangle of side 1m, then potential energy of combination is

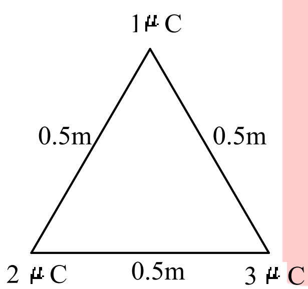


$$U_1 = \frac{1}{4\pi\varepsilon_0} . \frac{1 \times 2 \times 10^{-12}}{(1)} + \frac{1}{4\pi\varepsilon_0} . \frac{2 \times 3 \times 10^{-12}}{(1)}$$

$$+ \frac{1}{4\pi\varepsilon_0} . \frac{3 \times 1 \times 10^{-12}}{(1)}$$

$$= 11 \times \frac{1}{4\pi\varepsilon_0} \times 10^{-12} \text{J}$$

When charges are placed at vertices of an equilateral triangle of side 0.5m, then potential energy of combination is



$$U_1 = \frac{1}{4\pi\varepsilon_0} . \frac{1 \times 2 \times 10^{-12}}{(0.5)} + \frac{1}{4\pi\varepsilon_0} . \frac{2 \times 3 \times 10^{-12}}{(0.5)}$$

$$+ \frac{1}{4\pi\varepsilon_0} . \frac{3 \times 1 \times 10^{-12}}{(0.5)}$$

$$= 22 \times \frac{1}{4\pi\varepsilon_0} \times 10^{-12} \text{J}$$

$\therefore$ Work done $= \Delta U = U_2 - U_1$

$$= 22 \times \frac{1}{4\pi\varepsilon_0} \times 10^{-12} - 11 \times \frac{1}{4\pi\varepsilon_0} \times 10^{-12}$$

$$= 11 \times \frac{1}{4\pi\varepsilon_0} \times 10^{-12}$$

$= 11 \times 9 \times 10^9 \times 10^{-12} = 99 \times 10^{-3}$

$= 0.099\text{J} \approx 0.01\text{J}$

16 **(c)**

As work is done by the field, KE of the body increase by

$\text{KE} = W = E = q(V_A - V_B)$

$= 10^{-8}(600 - 0) = 6 \times 10^{-6}\ \text{J}$

17 **(a)**

The 10μF and 6μF capacitors are connected in parallel, hence resultant capacitance is

$C' = 10\ \mu\text{F} + 6\ \mu\text{F} = 16\ \mu\text{F}$

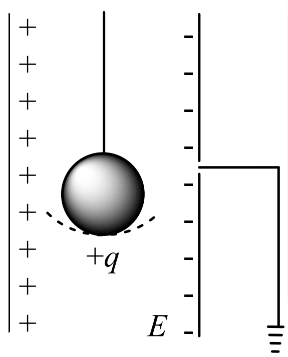
This is connected in series with 4 μF capacitor, hence effective capacitance is

$$\frac{1}{C''} = \frac{1}{16} + \frac{1}{4} = \frac{20}{16 \times 4}$$

$$\Rightarrow\ C'' = \frac{64}{20} = 3.20\mu\text{F}$$

18 **(d)**

Time period of simple pendulum in air



when it is suspended between vertical plates of a charged parallel plate capacitor, then acceleration due to electric field,

$a = \frac{qE}{m}$

This acceleration is acting horizontally and acceleration due to gravity is acting vertically.
So, effective acceleration

$$g' = \sqrt{g^2 + a^2} = \sqrt{g^2 + \left(\frac{qE}{m}\right)^2}$$

Hence, $T' = 2\pi \frac{\sqrt{l}}{\sqrt{g^2 + \left(\frac{qE}{m}\right)^2}}$

20 **(b)**

Equivalent capacitance between points B and C is

$$C' = \frac{10 \times 10}{10 + 10} + 10 = 15\mu\text{F}$$

Now equivalent capacitance between points A and C is

$$C'' = \frac{5 \times 15}{15 + 5} = \frac{75}{20}\mu\text{F}$$

Charge on capacitor of capacity 5μF is

$$Q = CV = \frac{75}{20} \times 2000 = 7500\mu C$$

(Since, potential at the point C will be zero)

Now, potential difference across capacitor of 5μF is

$$V_A - V_B = \frac{Q}{5\mu F} = \frac{7500\mu C}{5\mu C} = 1500 \text{volt}$$

As, $V_A = 2000 \text{volt}$

Hence, $V_B = 2000 - 1500 = 500$ volt.

ANSWER-KEY										
Q.	1	2	3	4	5	6	7	8	9	10
A.	B	B	C	C	D	B	B	C	A	B
Q.	11	12	13	14	15	16	17	18	19	20
A.	D	C	C	B	C	C	A	D	A	B