DPP
DAILY PRACTICE PROBLEMS

Class : XIIth | **Solutions** | **Subject : PHYSICS**
Date : | | **DPP No. : 1**

Topic :- ELECTROSTATIC POTENTIAL AND CAPACITANCE

1 **(d)**
The two capacitor the circuit are in parallel order, hence
$$C' = C + \frac{C}{2} = \frac{3C}{2}$$
The work done in charging the equivalent capacitor is stored in the form of potential energy.
Hence, $W = U = \frac{1}{2}C'V^2$
$$= \frac{1}{2}\left(\frac{3C}{2}\right)V^2$$
$$= \frac{3}{4}CV^2$$

2 **(d)**
If length of the foil is them
$$C = \frac{K\varepsilon_0(l \times b)}{d}$$
$$\Rightarrow 2 \times 10^{-6} = \frac{2.5 \times 8.85 \times 10^{-12}(l \times 400 \times 10^{-3})}{0.15 \times 10^{-3}}$$
$\Rightarrow$ $l = 33.9$ m.

3 **(c)**
The capacitance of air capacitor
$$C_0 = \frac{A\varepsilon_0}{d} = 3\mu\text{F} \quad \text{...(i)}$$
When a dielectric of permittivity ε_r and dielectric constant K is introduced between the plates of the capacitor, then its capacitance
$$C = \frac{KA\varepsilon_0}{d} = 15\ \mu\text{F} \quad \text{...(ii)}$$
Dividing Eq. (ii) by Eq. (i)
$$\frac{C}{C_0} = \frac{\frac{KA\varepsilon_0}{d}}{\frac{A\varepsilon_0}{d}} = \frac{15}{3}$$
$\therefore$ $K = 5$

Permittivity of the medium

$$\varepsilon_r = \varepsilon_0 K$$
$$= 8.854 \times 10^{-12} \times 5$$
$$= 44.27 \times 10^{-12}$$
$$= 0.44 \times 10^{-10} \mathrm{C^2 N^{-1} m^{-2}}$$

4 **(a)**

$$\int \vec{E}.\overrightarrow{ds} = \mathrm{NC^{-1}(M^2)}$$
$$= \mathrm{(Nm)C^{-1}(m) = JC^{-1}m = V - m}$$

5 **(c)**

As battery is disconnected, total charge Q is shared equally by two capacitors. energy of each capacitor

$$= \frac{(Q/2)^2}{2C} = \frac{1}{4}\frac{Q^2}{2C} = \frac{1}{4}U$$

6 **(a)**

Here , $t = 2$ mm, $x = 1.6$ mm,$K = ?$

As potential difference remains the same, capacity must remain the same

$$\therefore \quad x = t\left(1 - \frac{1}{K}\right)$$

$1.6 = 2\left(1 - \frac{1}{K}\right)$, which gives $K = 5$

7 **(c)**

On connecting, potential becomes equal $q \propto C \propto r$ and $\sigma = \frac{q}{A} \propto \frac{r}{r^2} \rightarrow \frac{1}{r}$

$\therefore$ Surface charge density on 15 cm sphere will be greater than that on 20 cm sphere.

8 **(a)**

The potential due to charge q at distance r is given by

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

If W be the work done in moving the charge from A to B then the potential difference (V) is given by

$$V_A - V_B = \frac{W}{q}$$

Both work (W) and charge (q) are scalar quantities hence potential difference $(V_A - V_B)$ will also be a scalar quantity.

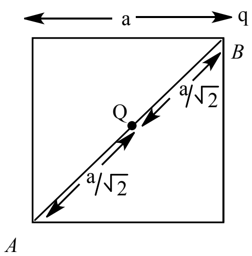
Here,

$$V_A = V_B = \frac{1}{4\pi\varepsilon_0}\frac{Q}{a/\sqrt{2}}$$

Since, $Q$is same for both,

$V_A - V_B = 0$

$W = 0$



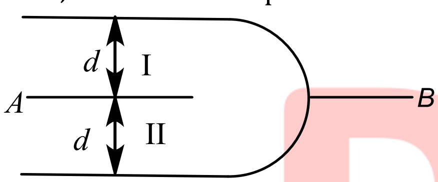
9 **(d)**

The capacity of an isolated spherical conductor of radius R is $4\pi\varepsilon_0 R$

$\therefore \quad C \propto R$

10 **(d)**

Here, we have two capacitors I and II connected in parallel order.



So, $C = C_1 + C_2$

$$= \frac{\varepsilon_0 A}{d} + \frac{\varepsilon_0 A}{d} = \frac{2\varepsilon_0 A}{d}$$

11 **(c)**

Inside a charged sphere, electric field intensity at all points is zero and electric potential is same at all the points.

Electrical potential,

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

Therefore, potential at the centre is equal to the potential at the surface.

12 **(b)**

Here, $r_1 = 10$ cm, $r_2 = 15$ cm,

$V_1 = 150$ V, $V_2 = 100$ V

Common potential

$$V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2} = \frac{4\pi\varepsilon_0(r_1V_1 + r_2V_2)}{4\pi\varepsilon_0(r_1 + r_2)}$$

$= 120$ V

$$q_1 = C_1\, V = 4\pi\varepsilon_0 r_1 V = \frac{10^{-1}}{9 \times 10^9} \times 120\text{C}$$

$= \frac{12}{9 \times 10^9} \times 3 \times 10^9 \text{ esu} = 4 \text{ esu}$

13 **(b)**

Common potential,

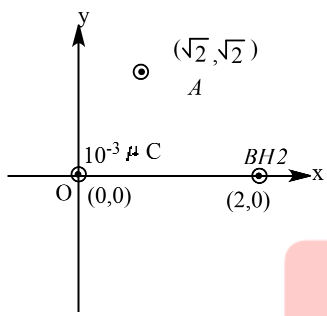
$$V = \frac{\text{total charge}}{\text{total capacity}} = \frac{Q + 0}{4\pi\varepsilon_0(r + r')}$$

$\therefore$ charge on smaller sphere

$$= 4\pi\varepsilon_0 r' \times V = \frac{Qr'}{r + r'}$$

14 **(b)**

Potential at A due to charge at O



$$V_A = \frac{1}{4\pi\varepsilon_0} \frac{(10^{-3})}{OA}$$

$$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{(10^{-3})}{\sqrt{(\sqrt{2})^2 + (\sqrt{2})^2}}$$

Potential at B due to charge at O

$$V_B = \frac{1}{4\pi\varepsilon_0} \cdot \frac{(10^{-3})}{OB}$$

$$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{(10^{-3})}{2}$$

So,

$V_A - V_B = 0$

15 **(a)**

Here, $U_1 = \frac{Q(-q)}{4\pi\varepsilon_0 r}; U_2 = \frac{Q(-q)}{4\pi\varepsilon_0 (r/2)}$

$$U_1 - U_2 = \frac{Q(-q)}{4\pi\varepsilon_0}\left[\frac{1}{r} - \frac{2}{r}\right]$$

$= \frac{Qq}{4\pi\varepsilon_0} = 9$ ...(i)

When negative charge travels first half of distance, $ie, r/4$, potential energy of the system

$$U_3 = \frac{Q(-q)}{4\pi\varepsilon_0(3r/4)} = -\frac{Qr}{4\pi\varepsilon_0 r} \times \frac{4}{3}$$

$\therefore$ work done $= U_1 - U_3$

$$= \frac{Q(-q)}{4\pi\varepsilon_0 r} + \frac{Qr}{4\pi\varepsilon_0 r} \times \frac{4}{3}$$

$$= \frac{Qq}{4\pi\varepsilon_0 r} \times \frac{1}{3} = \frac{9}{3} = 3\text{J}$$

17 **(a)**

By using $W = Q(\mathbf{E}.\Delta\mathbf{r})$

$\Rightarrow W = Q[e_1\hat{\boldsymbol{i}} + e_2\hat{\boldsymbol{j}} + e_3\hat{\boldsymbol{k}}).(a\hat{\boldsymbol{i}} + b\hat{\boldsymbol{j}})]$

$= Q(e_1 a + e_2 b)$

19 **(d)**

$E = \sigma/\varepsilon_0$, The value of E does not depend upon radius of the sphere.

20 **(b)**

Here, KE $= 100$ eV $= 100 \times 1.6 \times 10^{-19}$J

This is lost when electron moves through a distance (d) towards the negative plate.

KE = work done $= F \times s \Rightarrow qE \times s = e\left(\frac{\sigma}{\varepsilon_0}\right)d = \left(\frac{(\text{KE})\varepsilon_0}{e\sigma}\right)$

$$d = \frac{100 \times 1.6 \times 10^{-19} \times 8.86 \times 10^{-12}\text{J}}{1.6 \times 10^{-19} \times 2 \times 10^{-6}} = 4.43 \times 10^{-4}\text{m}$$

$= 0.443$ mm

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