DPP
DAILY PRACTICE PROBLEMS

Class : XIIth | **Solutio** | **Subject : PHYSICS**
Date : | | **DPP No. : 2**

Topic :- ELECTROSTATIC POTENTIAL AND CAPACITANCE

1 **(d)**

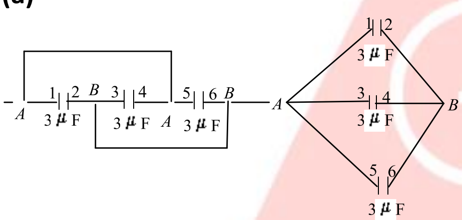
$V=\frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

$V'=\frac{1}{4\pi\varepsilon_0}\frac{q'}{r'}=\frac{1}{4\pi\varepsilon_0}\frac{nq}{n^{\frac{1}{3}}r}$

$(\because q'=nq, r'=n^{\frac{1}{3}}r)$

Or $V'=n^{2/3}V$

2 **(a)**



Here, all the three capacitors are connected in parallel. Therefore, equivalent capacitance between points A and B is

$$C_{\mathrm{eq}}=3+3+3=9\mu\mathrm{F}.$$

3 **(d)**

The net field at O.

$\mathrm{E}=2\vec{\mathrm{E}}_{\mathrm{R}}$, when $\vec{\mathrm{E}}_{\mathrm{p}}+\vec{\mathrm{E}}_{\mathrm{s}}=\vec{0}, \vec{\mathrm{E}}_{\mathrm{Q}}+\vec{\mathrm{E}}_{\mathrm{T}}=\vec{0}$ and $\vec{\mathrm{E}}_{\mathrm{R}}=\vec{\mathrm{E}}_{\mathrm{U}}$ along ROU diriction. It is possible in arrangement of (d) as shown in a joining figure.

4 **(c)**

$\frac{\varepsilon_0 A}{d}=\frac{\varepsilon_0 A}{d'-t+\frac{t}{K}}$

$\Rightarrow \quad d=d'-t+\frac{1}{K}$

$\Rightarrow \quad d'-d=t\left(1-\frac{1}{K}\right)$

Here, $d'-d=3.2$ mm, $t=4$mm

$\therefore \quad 3.2=4\left(1-\frac{1}{K}\right)1-\frac{1}{K}$

$\Rightarrow \quad \frac{3.2}{4}=1-\frac{1}{K}$

$\Rightarrow \quad 1-\frac{1}{K}=\frac{4}{5}$

$\therefore \quad K=5$

5 **(b)**

The work done in charging the capacitor (C) is stored as potential energy (U) in the vicinity of capacitor, given by.

$U = \frac{1}{2}CV^2$

This produces the heat when its plates are joint through a resistance.

Given, $C = 4\mu F = 4 \times 10^{-6} F, V = 400 volt$

$\therefore \quad U = \frac{1}{2} \times 4 \times 10^{-6} \times (400)^2$

$U = 0.32$ J

6 **(d)**

At each point on the surface of a conducting sphere the potential is equal.

So, $V_A = V_B = V_C$

7 **(a)**

Each plate is taking part in the formation of two capacitors except the plates at the ends.

These capacitors are in parallel and n plates form $(n-1)$ capaitors.

Thus, equivalent capacitance between points A and $B = (n-1)C$

8 **(d)**

Minimum capacity, $C_s = \frac{5}{10} = 0.5\ \mu F$

Maximum capacity, $C_p = 10 \times 5 = 50\ \mu F$

$\frac{C_p}{C_s} = \frac{50}{0.5} = 100$

9 **(c)**

$C = 4\varepsilon_0 R$, where $R = 6.4 \times 10^6$ m

$= \frac{6.4 \times 10^6}{9 \times 10^9} = 711\mu\, F$

10 **(c)**

Combined capacity of 1 μF and 5μF = 1 + 5=6 μF

Now, 4μF and 6μF are in series.

$\therefore \quad \frac{1}{C_s} = \frac{1}{4} + \frac{1}{6} + \frac{3+2}{12} = \frac{5}{12}$

$C_s = \frac{12}{5} \mu F$

Charge in the arm containing 4μF capacitor is

$q = C_s \times V = \frac{12}{5} \times 10 = 24\ \mu C$

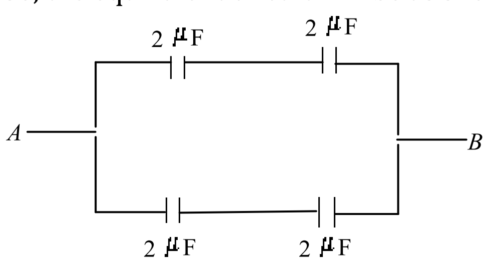
11 **(a)**

Due to additional charge of $-3Q$ given to external spherical shell, the potential difference between conducting sphere and the outer shell will not change because by presence of charge on outer shell, potential everywhere inside and on the surface of the shell will change by same amount. Therefore, the potential difference between sphere and shell remain unchanged.

12 **(a)**

The figure is a balanced Wheatstone bridge, so diagonal capacitor will be ineffective.

So, the equivalent circuit will be as shown in the figure.



Equivalent capacitance of upper arms in series

$C_1 = \frac{2 \times 2}{2+2} = 1\mu F$

Similarly, for lower arm

$$C_2 = 1\mu\text{F}$$
$$\therefore\ C_{AB} = C_1 + C_2$$
$$= 1 + 1 = 2\mu\text{F}$$

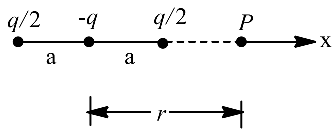
13 **(a)**

When metal sphere is placed inside a charged parallel plate capacitor, the electric lines of force will not enter the metallic conductor as $E = 0$inside a charged conductor. Moreover, the surface of a charged conductor is an equipotential surface and hence, electric lines of force are always perpendicular to equipotential surface.

14 **(b)**

$As\ r \gg a$, so $r > 2a$

So, potential at point p



$$V = \frac{1}{4\pi\varepsilon_0}\left[\frac{\frac{q}{2}}{r+a} - \frac{q}{r} + \frac{\frac{q}{2}}{r-a}\right]$$
$$= \frac{1}{4\pi\varepsilon_0}\frac{q}{2}\left[\frac{1}{r+a} - \frac{2}{r} + \frac{1}{r-a}\right]$$
$$= \frac{q}{8\pi\varepsilon_0}\left[\frac{r(r-a) - 2(r^2 - a^2) + r(r+a)}{r(r^2 - a^2)}\right]$$
$$= \frac{q}{8\pi\varepsilon_0}.\frac{2a^2}{r(r^2 - a^2)}$$
$$= \frac{qa^2}{4\pi\varepsilon_0 r^3} \qquad (\text{as } r \gg a)$$

15 **(b)**

The electric field between the plates is

$$E = \frac{V}{d}$$

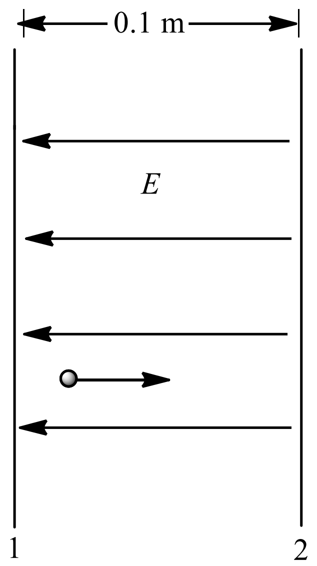
or $\qquad V = Ed$ or $V \propto d$

Hence, if the plates are pulled apart the potential difference increases.

16 **(a)**

Since $V_2 > V_1$, so electric field will point from plate 2 to plate 1.

The electron will experience an electric force, opposite to the direction of electric field, and hence move towards the plate 2.



Use work-energy theorem to find speed of electron when it strikes the plate 2.

$$\frac{m_e v^2}{2} - 0 = e(V_2 - V_1)$$

Where v is the required speed.

$\therefore \quad \frac{9.11\times10^{-31}}{2} v^2 = 1.6 \times 10^{-19} \times 20$

$\Rightarrow \quad v = \sqrt{\frac{1.6 \times 10^{-19} \times 40}{9.11 \times 10^{-31}}} = 2.65 \times 10^6 \text{ms}^{-1}$

17 **(d)**

Since, the proton is moving against the direction of electric field so, work is done by the proton against electric field. It implies that electric field does negative work on the proton.
Again, proton is moving in electric field from low potential region to high potential region hence, its potential energy increases.

18 **(a)**

The potential at the centre of the sphere is 80 V because it remains same at each point under the metallic hollow sphere.

19 **(d)**

The capacitance of a parallel plate capacitor with dielectric (oil) between its plates is

$C = \frac{K\varepsilon_0 A}{d}$ ...(i)

where symbols have their usual meanings. when dielectric (oil) is removed, so capacitance

$C = \frac{\varepsilon_0 A}{d}$ ...(ii)

Comparing Eqs. (i) and (ii), we get

$C = KC_0$

$\Rightarrow C_0 = \frac{C}{K} = \frac{C}{2}$ $(\because K = 2)$

20 **(a)**

Here, $E = \frac{\sigma}{\varepsilon_0}$ $and\ t = \frac{1}{u}$

Along Y-axis, $u = 0, a = \frac{f}{m} = \frac{eE}{m}$

$$s = d = \frac{1}{2}at^2 = \frac{1}{2}\frac{eE}{m}t^2 = \frac{1}{2}\frac{e\sigma}{m\varepsilon_0}\frac{l^2}{u^2}$$

$$\sigma = \frac{2d\varepsilon_0 mu^2}{el^2}$$

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