DPP

DAILY PRACTICE PROBLEMS

Class : XIIth
Date :

Solutions

Subject : PHYSICS
DPP No. : 4

Topic :- ELECTROSTATIC POTENTIAL AND CAPACITANCE

1 **(b)**

In capacitor, energy is stored in electric field between the plates.

Increase in energy

$$\Delta U = U_f - U_i$$

$$= \frac{1}{2} C V_f^2 - \frac{1}{2} C V_i^2 = \frac{1}{2} C (V_f^2 - V_i^2)$$

Given, $C = 6\mu\text{F} = 6 \times 10^{-6}$, $V_i = 10$ volt,

$V_f = 20$volt

$$\therefore \quad \Delta U = \frac{1}{2} \times 6 \times 10^{-6} [(20)^2 - (10)^2]$$

$$= 3 \times 10^{-6} \times 300 = 9 \times 10^{-4}\ \text{J}$$

2 **(c)**

6 μF and 3 μF capacitors are in series

$$\frac{1}{C_1} = \frac{1}{6} + \frac{1}{3}$$

$$C_1 = 2$$

C_1 is parallel to 2 μF capacitor

$$\therefore \quad C_{eq} = 2 + 2 = 4\mu\text{F}$$

Total energy, $U = \frac{1}{2} C V^2$

$$= \frac{1}{2} \times 4 \times (2)^2 = 8\mu\text{J}$$

3 **(b)**

Energy of second proton = PE of the system

$$= \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r}$$

$$= 9 \times 10^9 \times \frac{1.6 \times 10^{-19} \times 1.6 \times 10^{-19}}{1 \times 10^{-10}}$$

$$= 23.0 \times 10^{-19}\ \text{J}$$

4 **(c)**

Potential at a point in a field is defined as the amount of work done in bringing a unit positive test charge, from infinity to that point along any arbitrary path, *i.e.*,

$$V=\frac{W}{q_0}$$

$$\therefore \quad V=\phi=\frac{W}{Q} \qquad (\because X \ll \infty)$$

5 **(c)**

Work done $= Fs\cos\theta = F(2\pi r)\cos 90^0 = 0$.

6 **(d)**

Positive plate of all the three condensers is connected to one point (A) and negative plate of all the three condensers is connected to point (B) *ie*, they are joined in parallel.

$C_p = 3+3+3 = 9\mu$ F

7 **(d)**

Radius of big drop, $R = 3\,r$

$\left[\because \frac{4}{3}\pi R^3 = 27 \times \frac{4}{3}\pi r^3\right]$

$V=\frac{27q}{4\pi\varepsilon_0 R}=\frac{27q}{4\pi\varepsilon_0(3r)}$

$=9\left(\frac{q}{4\pi\varepsilon_0 r}\right)=9\times 10=90$ V

8 **(b)**

Potential on bubble,

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

$$\therefore \frac{V_1}{V_2}=\frac{r_2}{r_1}$$

$$\Rightarrow \frac{16}{V_2}=\frac{2}{1} \Rightarrow V_2=8\,V$$

9 **(d)**

Heat produced =energy stored in capacitor

$\frac{1}{2}CV^2=\frac{1}{2}(10\times 10^{-6})(500)^2$

$=1.25$ J

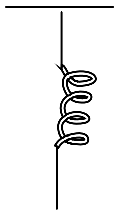
10 **(c)**

Work done is zero because all the points on the circular path are at same potential.

11 **(b)**

When a force of F Newton is applied the potential energy is given by

$$U=\frac{1}{2}Fx$$



Load
(5000N)

Energy stored by capacitor is $\frac{1}{2}CV^2$

$\therefore$ Ratio is $\frac{\frac{1}{2}Fx}{\frac{1}{2}CV^2} = \frac{5000 \times 0.2}{10 \times 10^{-6} \times (10^4)^2} = 1$

12 **(d)**

The arrangement of n metal plates separated by dielectric acts as parallel combination of $(n-1)$ capacitors.

Therefore, $C = \frac{(n-1)K\varepsilon_0 A}{d}$

Here, $C = 100$ pF

$= 100 \times 10^{-12}$F

$K = 4, \varepsilon_0 = 8.85 \times 10^{-12} \text{C}^2\text{N}^{-1}\text{m}^{-2}$

$A = \pi r^2 = 3.14 \times (1 \times 10^{-2})^2$

$d = 1 \text{ mm} = 1 \times 10^{-3}$

$$\therefore \quad 100 \times 10^{-12} = \frac{(n-1) \times 4 \times (8.85 \times 10^{-12}) \times 3.14 \times (1 \times 10^{-2})^2}{1 \times 10^{-3}}$$

or $\quad n = \frac{1111.156}{111.156} = 9.99 \approx 10$

13 **(b)**

Given, $C_1 = 6\mu\text{F}, C_2 = 12\mu\text{F}, V = 150\text{volt}$.

Total capacity, $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{6} + \frac{1}{12}$

$= \frac{2+1}{12} \frac{1}{C} = \frac{3}{12} C = 4\mu\text{F}$

Potential of 12μF capacitor

$V = \frac{q}{C}$

$V = \frac{4 \times 150}{12}$

$V = 50$ volt

14 **(a)**

Capacitance of parallel plate capacitor

$C_0 = \frac{\varepsilon_0 A}{d}$

Where $A =$ area of the plates,

$d =$ separation between the plates,

Charge stored in the capacitor

$$Q = C_0 V_0$$

When battery is disconnected, then charge remains same.

So, energy $E_1 = \frac{1}{2}\frac{Q^2}{C}$

$C =$ capacitance when plate separation is doubled.

So, $C_1 = \frac{C_0}{2}$

$$E_1 = \frac{1}{2}\frac{Q^2}{C_0/2} = \frac{Q^2}{C_0} = \frac{C_0^2 V_0^2}{C_0} = C_0 V_0^2$$

When battery is connected, then

Energy $E_2 = \frac{1}{2} C V_0^2$

where $E_2 = \frac{1}{2}\frac{C_0}{2} V_0^2 = \frac{1}{4}(C_0 V_0^2)$

$\therefore$ $\frac{E_1}{E_2} = \frac{C_0 V_0^2}{\frac{1}{4} C_0 V_0^2} = \frac{1}{4}$

$E_1 : E_2 = 4:1$

15 **(b)**

$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q_1}{r_1} + \frac{Q_2}{r_2} + \frac{Q_3}{r_3}\right)$$

$$= \frac{1}{4\pi\varepsilon_0}\left(\frac{33 \times 10^{-9}}{93 \times 10^{-3}} - \frac{51 \times 10^{-9}}{\sqrt{2} \times 93 \times 10^{-3}} + \frac{47 \times 10^{-9}}{93 \times 10^{-3}}\right)$$

$$= \frac{1}{4\pi\varepsilon_0} \times \frac{10^{-9}}{93 \times 10^{-3}}\left(33 - \frac{51}{\sqrt{2}} + 47\right)$$

$$\approx 4 \times 1000 \text{ V} = 4 \text{ kV}$$

16 **(a)**

If the plates of a parallel plate capacitor are not equal in area, then quantity of charge on the plates will be same but nature of charge will differ.

17 **(b)**

Given, $C = 2\mu\text{F}$, $C_2 = 4\mu\text{F}$, and $V = 10\text{volt}$

Capacitors are connected in series

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\therefore C = \frac{4 \times 2}{4 + 2} = \frac{4}{3}$$

The charge of combination

$$q = CV = \frac{4}{3} \times 10 = \frac{40}{3}$$

The energy of $2\mu\text{F}$ capacitor

$$E = \frac{1}{2} \times \frac{q^2}{C_1} = \frac{1}{2} \times \frac{1600}{9 \times 2} = \frac{400}{9}$$

The energy of 4μF capacitor

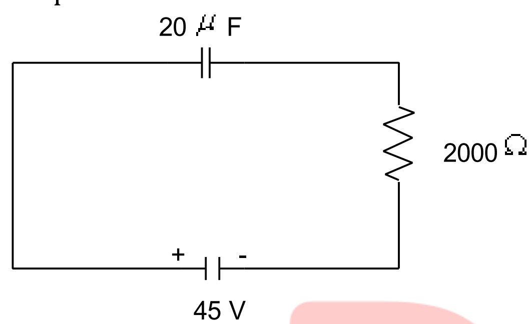
$$E_2 = \frac{1}{2} \times \frac{q^2}{C_2} = \frac{1}{2} \times \frac{1600}{9 \times 4} = \frac{200}{9}$$

The ratio of energies is

$$\frac{E_1}{E_2} = \frac{\frac{400}{9}}{\frac{200}{9}} = \frac{2}{1}$$

18 **(a)**

We know that in steady state the capacitor behaves like as an open circuit *ie*, capacitor will not pass the current.



So, the potential difference across the capacitor $= 45$ V

Hence , the final charge on the capacitor is

$$q = CV$$

Here , $C = 20\mu\text{F}$, $V = 45$ V

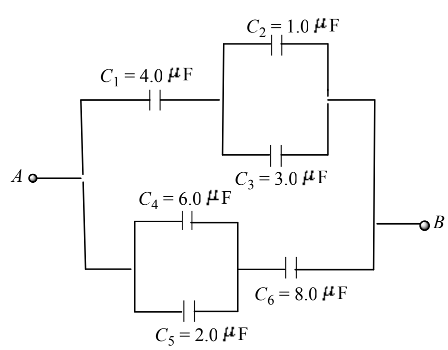
∴ $q = 20 \times 10^{-6} \times 45$

or $q = 900 \times 10^{-6}$

or $q = 9 \times 10^{-4}\text{C}$

19 **(a)**

In given figure $C_2$and C_3 are in parallel,



∴ $C' = C_2 + C_3 = 4\mu\text{F}$

As $C'$and $C_1$are in series,

$$\frac{1}{C''} = \frac{1}{C'} + \frac{1}{C_1} = \frac{1}{4} + \frac{1}{4}$$

⇒ $C'' = 2\ \mu\text{F}$

Similarly, $C_4$and C_5 are in parallel

$$C''' = 6 + 2 = 8\ \mu F$$

$C'''$and C_6 are in series

$$\frac{1}{C'''} = \frac{1}{C'''} + \frac{1}{C_6} = \frac{1}{8} + \frac{1}{8}$$

$\Rightarrow \quad C''' = \ = 4\ \mu F$

Now, C''' and C'' are in parallel.

$\therefore \quad C = 4\mu F + 2\mu F = 6\mu F$

20 **(d)**

Capacitance with air

$$C = \frac{A\varepsilon_0}{d}$$

When interspace between the plates is filled with wax, then

$$C' = \frac{KA\varepsilon_0}{2d}$$

or $\quad C' = \left(\frac{A\varepsilon_0}{d}\right)\frac{K}{2}$

or $\quad C' = C\frac{K}{2}$

$\therefore \quad 6 = 2.\frac{K}{2} \Rightarrow K = 6$

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