DPP
DAILY PRACTICE PROBLEMS

Class : XIIth
Date :

Solutions

Subject : PHYSICS
DPP No. : 6

Topic :- ELECTROSTATIC POTENTIAL AND CAPACITANCE

2 **(b)**

The arrangement behaves as a combination of 2 capacitors each of capacitance $C=\frac{\varepsilon_0 A}{d}$.

Thus, equivalent capacity $=2C$

$\therefore$ total energy stored $U=\frac{1}{2}\times(2C)V^2=CV^2=\frac{\varepsilon_0 A}{d}V^2$

3 **(c)**

Here, magnetic force =electrostatic force

$$qvB=qE$$

$$v=\frac{E}{B}=\frac{\sigma}{\varepsilon_0 B}$$

The time taken by electron to travel a distance l in that space

$$t=\frac{1}{v}=\frac{l}{\frac{\sigma}{\varepsilon_0 B}}=\frac{\varepsilon_0 l B}{\sigma}$$

4 **(a)**

When charge $q_3$is at C, then its potential energy is

$$U_C=\frac{1}{4\pi\varepsilon_0}\left(\frac{q_1q_3}{0.4}+\frac{q_2q_3}{0.5}\right)$$

Where charge $q_3$is at D, then

$$U_D=\frac{1}{4\pi\varepsilon_0}\left(\frac{q_1q_3}{0.4}+\frac{q_2q_3}{0.1}\right)$$

Hence, change in potential energy

$$\Delta U=U_D-U_C$$

$$=\frac{1}{4\pi\varepsilon_0}\left(\frac{q_2q_3}{0.1}-\frac{q_2q_3}{0.5}\right)$$

but $\Delta U = \frac{q_3}{4\pi\varepsilon_0}k$

$$\therefore \frac{q_3}{4\pi\varepsilon_0}k = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_2 q_3}{0.1} - \frac{q_2 q_3}{0.5}\right)$$

$\Longrightarrow k = q_2(10-2) = 8q_2$

5 **(c)**

The arrangement shows a Wheatstone bridge.

As $\frac{C_1}{C_3} = \frac{C_4}{C_5} = 1$, therefore the bridge is balanced.

$\frac{1}{C_{s_1}} = \frac{1}{4} + \frac{1}{4} = \frac{2}{4} = \frac{1}{2}, C_{s_1} = 2\mu$ F

Similarly, $C_{s2} = 2\mu$ F

$\therefore$ effective capacitance

$= C_p = C_{s1} + C_{s2} = 2 + 2 += 4\mu$ F

6 **(b)**

The given arrangement of nine plates is equivalent to the parallel combination of 8 capacitors.

The capacity of each capacitor,

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

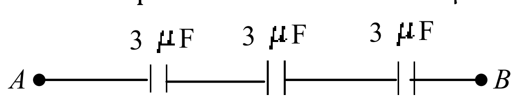
$= \frac{8.854 \times 10^{-12} \times 5 \times 10^{-4}}{0.885 \times 10^{-2}} = 0.5$pF

Hence, the capacity of 8 capacitors

$= 8C = 8 \times 0.5 = 4$ pF

7 **(a)**

The two capacitors each of value 1.5μF are in parallel. So, their equivalent capacitance



$= 1.5 + 1.5 = 3$ μF

Now, three capacitors each of value 3μF are in series. Hence, their equivalent capacitance is given by

$$\frac{1}{C} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3}$$

or $\frac{1}{C} = \frac{3}{3}$

or $c = 1\mu$F

8 **(a)**

Energy $E_1 = \frac{1}{2}C_1 V_1^2$

$= \frac{1}{2} \times 1 \times 10^{-6} \times (30)^2 = 450 \times 10^{-6}$ J

Common potential

$$V = \frac{q_1 + q_2}{C_1 + C_2}$$

$$= \frac{1 \times 30 + 0}{1 + 2} = 10 \text{ volt}$$

$$E_2 = \frac{1}{2}(C_1 + C_2)V^2$$

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

$$= 1.5 \times 100 \times 10^{-6} = 150 \times 10^{-6} \text{ J}$$

Loss of energy $= E_2 - E_1 = 300\mu\text{J}$

9 **(a)**

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{10} + \frac{1}{20} = \frac{3}{20};$$

$$C_s = \frac{20}{3} \ \mu\text{F}$$

$\therefore$ charge on each capacitor

$$= C_s V = \frac{20}{3} \times 200 = \frac{4000}{3} \mu\text{C}$$

Common potential $= \frac{\text{total charge}}{\text{total capacity}}$

$$= \frac{2 \times 4000/3}{10 + 20} = \frac{800}{9} V$$

10 **(b)**

As $\quad E = -\frac{dV}{dr}$

$$\therefore \quad + E_0 = -\frac{[V(x) - 0]}{x}$$

or $\quad V_x = -E_0 x$

11 **(b)**

The two charges form an electric dipole and for this dipole any point on y-axis is at the equatorial line. Hence, $\vec{E}$ at all point on y-axis will be in a direction opposite to $\vec{p}$ and $\vec{p}$ is along negative x-axis. So $\vec{E}$ is along positive x –axis , *ie*, along $\hat{i}$.

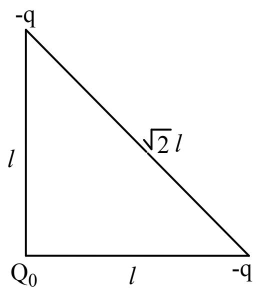
12 **(b)**

Here total electrostatic potential energy is zero

$$ie, \quad \frac{-Q_0 q}{l} - \frac{q Q_0}{l} + \frac{q^2}{\sqrt{2} l} = 0$$

On solving,

$$Q_0 = \frac{q}{2\sqrt{2}} = \frac{2q}{\sqrt{32}}$$



13 **(d)**

Potential due to charge $-q$ at A

$$V_A = \frac{1}{4\pi\varepsilon_0 k}\frac{-q}{(r^2)^{1/2}}$$

Potential due to charge $-q$ at B

$$V_B = \frac{1}{4\pi\varepsilon_0 k}\frac{-q}{(r^2)^{1/2}}$$

Potential due to charge $-q$ at C

$$V_C = \frac{1}{4\pi\varepsilon_0 k}\frac{-q}{(r^2)^{1/2}}$$

Total potential at centre.

$$V = V_A + V_B + V_C$$

$$V = 0$$

From charge configuration at the centre electric field in non zero.

14 **(d)**

Here, electric potential

$$V = 3x^2$$

Electric field,

$$E = -\frac{\partial V}{\partial x}$$

$$= -\frac{\partial}{\partial x}(3x^2) = -6x$$

$$\therefore E_{(2,\,0,1)} = -12\text{Vm}^{-1}$$

15 **(c)**

When battery remains connected

$$C' = kC$$
$$Q' = kQ$$
$$V' = V$$
$$E' = E$$
$$U' = kU$$

U and Q Both increases.

16 **(b)**

Let R and r be the radii of bigger and each smaller drop. Charge remains conserved.

Hence, charge on bigger drop

$= 27 \times$ charge on smaller drop

ie, $q' = 27q$

Now, before and after coaleseing, volume remains same.

That is,

$\frac{4}{3}\pi R^3 = 27 \times \frac{4}{3}\pi r^3$

$\therefore\ R = 3r$

Hence, capacitance of bigger drop

$C' = 4\pi\varepsilon_0 R = 4\pi\varepsilon_0(3r)$

$= 3(4\pi\varepsilon_0 r) = 3C$

17 **(c)**

$\int \vec{E}\,.\,\vec{dl} \rightarrow NC^{-1}m = JC^{-1}$

18 **(b)**

At equitorial point

$$E_e = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^3}$$

(directed from +q to –q) and $V_e = 0$.

19 **(c)**

Let Q and q be the charges on the spheres. The potential at the common centre will be

$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{R}\right) + \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r}\right)$$

$$= \frac{1}{\varepsilon_0}\left[\frac{Q}{4\pi R^2} \times R + \frac{q}{4\pi r^2} \times r\right]$$

But

$$\frac{Q}{4\pi R^2} = \frac{q}{4\pi r^2} = \sigma$$

$$\therefore V = \frac{1}{\varepsilon_0}[\sigma R + \sigma r] = \frac{\sigma}{\varepsilon_0}(R + r)$$

20 **(a)**

The potential V_1 of smaller sphere is given by

$$V_1 = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r} + \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{R} \quad ......(i)$$

The potential V_2 of bigger sphere is given by

$$V_2 = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{R} + \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{R}$$

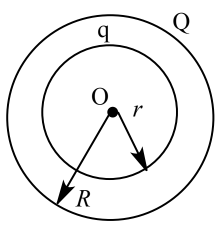
So, the potential difference between the plates

$$V = V_1 - V_2$$

Or

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r} + \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{R} - \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{R} - \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{R}$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{q}{r} - \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{R} = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r} - \frac{q}{R}\right)$$



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

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Class : XIth | **Subject : PHYSICS**
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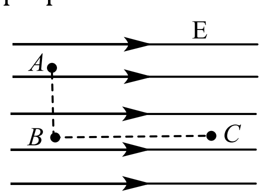
Topic :-.ELECTROSTATIC POTENTIAL AND CAPACITANCE

1. Minimum number of 8μF and 250 V capacitors are used to make a combination 16μF and 1000 V are
   a) 4 b) 32 c) 8 d) 3

2. Figure shows three points A, B and C in a region of uniform electric field **E.** The line AB is perpendicular and BC is parallel to the field lines. Then which of the following holds good?

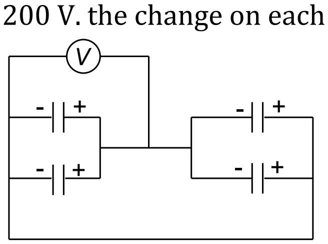


   Where V_A, V_B and V_C represent the electric potential at the points A, B and C respectively.

   a) $V_A = V_B = V_C$ b) $V_A = V_B > V_c$ c) $V_A = V_B < V_C$ d) $V_A > V_B = V_C$

3. The plates of a parallel plate capacitor with air as medium are separated by a distance of 8 mm. A medium of dielectric constant 2 and thickness 4 mm having the same area is introduced between the plates. For the capacitance to remain the same , the distance between the plates is
   a) 8 mm b) 6 mm c) 4 mm d) 12 mm

4. The four capacitors, each of 25 μF are connected as shown in figure. The DC voltmeter reads 200 V. the change on each plate of capacitor is



   a) $\pm 2 \times 10^{-3}$C b) $\pm 5 \times 10^{-3}$C c) $\pm 2 \times 10^{-2}$C d) $\pm 5 \times 10^{-2}$C

5. The energy of a charged capacitor is U. Another identical capacitor is connected parallel to the first capacitor, after disconnecting the battery. The total energy of the system of these

capacitors will be

a) $\frac{U}{4}$ b) $\frac{U}{2}$ c) $\frac{3U}{2}$ d) $\frac{2U}{4}$

6. A parallel plate capacitor having air as dielectric medium is charged by a potential difference of V volt. After disconnecting the battery, the distance between the plates of the capacitor is increased using an insulated handle. As a result ,potential difference between the plates

a) Increases b) Does not change c) Becomes zero d) Decreases

7. n Small drops of same size are charged to V volt each. If they coalesce to form a single large drop, then its potential will be

a) Vn b) Vn^{-1} c) $Vn^{1/3}$ d) $Vn^{2/3}$

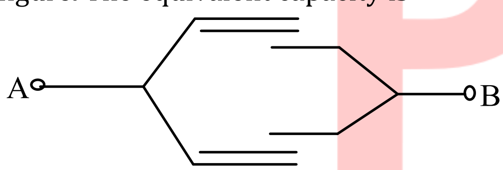
8. If a charged spherical conductor of radius 10 cm has potential Vat a point distant 5cm from its centre, then the potential at a point distant 15 cm from the centre will be

a) $\frac{1}{3}V$ b) $\frac{2}{3}V$ c) $\frac{3}{2}V$ d) 3V

9. Two capacitors of capacitance C are connected in series. If one of them is filled with dielectric substance K, what is the effective capacitance?

a) $\frac{KC}{(1+K)}$ b) $C(K+1)$ c) $\frac{2KC}{(1+K)}$ d) None of these

10. Four plates of equal area A are separated by equal distance d and are arranged as shown in the figure. The equivalent capacity is

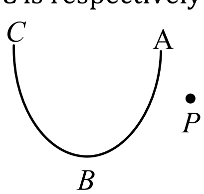


a) $\frac{2\varepsilon_0 A}{d}$ b) $\frac{3\varepsilon_0 A}{d}$ c) $\frac{3\varepsilon_0 A}{2d}$ d) $\frac{\varepsilon_0 A}{d}$

11. The energy required to charge a parallel plate condenser of plate separation d and plate area of cross-section A such that uniform electric field between the plates is E,is

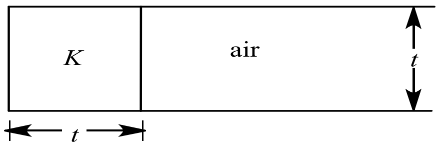
a) $\frac{1}{2}\frac{\varepsilon_0 E^2}{Ad}$ b) $\frac{\varepsilon_0 E^2}{Ad}$ c) $\varepsilon_0 E^2 Ad$ d) $\frac{1}{2}\varepsilon_0 E^2 Ad$

12. In the following diagram the work done in moving a point charge from point $P$to point A, $B$and $C$is respectively as W_A, $W_B$and W_C then



a) $W_A = W_B = W_C$ b) $W_A = W_B = W_C = 0$ c) $W_A > W_B > W_C$ d) $W_A < W_B < W_C$

13. A parallel plate capacitor with air as the dielectric has capacitance C. A slab of dielectric constant K and having the same thickness as the separation between the plates is introduced so as to fill one-fourth of the capacitor as shown in the figure. The new capacitance will be



a) $(K+3)\frac{C}{4}$ b) $(K+2)\frac{C}{4}$ c) $(K+1)\frac{C}{4}$ d) $\frac{KC}{4}$

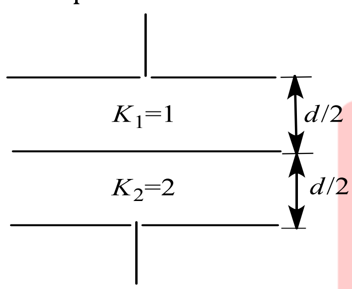
14. Two identical capacitors have the same capacitance C. One of them is charged to potential V_1 and the other to V_2. The negative ends of the capacitors are connected together. When the positive ends are also connected, the decrease in energy of the system is

a) $\frac{1}{4}C(V_1^2 - V_2^2)$ b) $\frac{1}{4}C(V_1^2 + V_2^2)$ c) $\frac{1}{4}C(V_1 - V_2)^2$ d) $\frac{1}{4}C(V_1 + V_2)^2$

15. A cylindrical capacitor has charge Q and length L. If both the charge and length of the capacitors are doubled, by keeping other parameters fixed, the energy stored in the capacitor

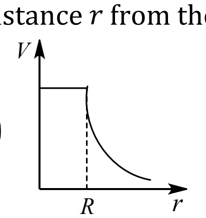
a) Remains same b) Increases two times c) Decreases two times d) Increase four time

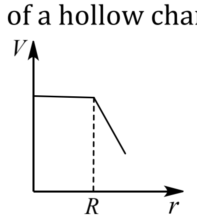
16. Two parallel plates of area A are separated by two different dielectric as shown in figure. The net capacitance is

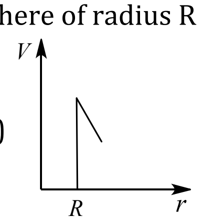


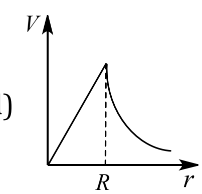
a) $\frac{\varepsilon_0 A}{2d}$ b) $\frac{\varepsilon_0 A}{d}$ c) $\frac{3\varepsilon_0 A}{d}$ d) $\frac{4\varepsilon_0 A}{3d}$

17. Which one of the following graphs figure shows the variation of electric potential V with distance r from the centre of a hollow charged sphere of radius R

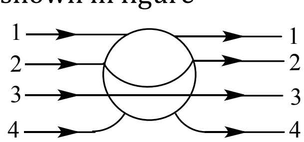
a) 

b) 

c) 

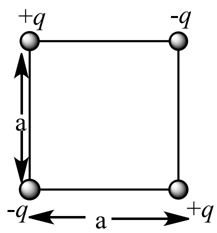
d) 

18. A metallic solid sphere is placed in a uniform electric field. The lines of force follow the paths shown in figure



a) 1 b) 2 c) 3 d) 4

19. Work required to set up the four charge configuration (as shown in the figure) is



a) $-0.21q^2/\varepsilon_0 a$ b) $-1.29q^2/\varepsilon_0 a$ c) $-1.41q^2/\varepsilon_0 a$ d) $+2.82q^2/\varepsilon_0 a$

20. How many 6 μF, 200 V condensers are needed to make a condenser of 18 μF, 600 V?

a) 9 b) 18 c) 3 d) 27