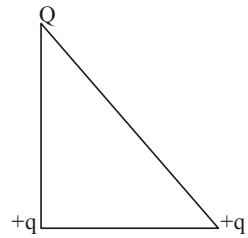
16 ELECTROSTATIC POTENTIAL AND CAPACITANCE

MCQs with One Correct Answer

1. Three charges 2 q, – q and – q are located at the vertices of an equilateral triangle. At the centre of the triangle
(a) the field is zero but potential is non-zero
(b) the field is non-zero, but potential is zero
(c) both field and potential are zero
(d) both field and potential are non-zero

2. The 1000 small droplets of water each of radius r and charge Q, make a big drop of spherical shape. The potential of big drop is how many times the potential of one small droplet ?
(a) 1 (b) 10
(c) 100 (d) 1000

3. Three charges Q, + q and + q are placed at the vertices of a right-angle isosceles triangle as shown below. The net electrostatic energy of the configuration is zero, if the value of Q is :



(a) + q (b) $\frac{-\sqrt{2}q}{\sqrt{2}+1}$
(c) $\frac{-q}{1+\sqrt{2}}$ (d) –2q

4. The electric potential V (in Volt) varies with x (in metres) according to the relation $V = (5 + 4x^2)$. The force experienced by a negative charge of 2×10^{-6} C located at $x = 0.5$ m is
(a) 2×10^{-6} N (b) 4×10^{-6} N
(c) 6×10^{-6} N (d) 8×10^{-6} N

5. The electric potential V at any point O (x, y, z all in metres) in space is given by $V = 4x^2$ volt. The electric field at the point (1 m, 0, 2 m) in volt/metre is
(a) 8 along negative X-axis
(b) 8 along positive X-axis
(c) 16 along negative X-axis
(d) 16 along positive Z-axis

6. Two conducting spheres of radii R_1 and R_2 having charges Q_1 and Q_2 respectively are connected to each other. There is
(a) no change in the energy of the system
(b) an increase in the energy of the system
(c) always a decrease in the energy of the system
(d) a decrease in the energy of the system unless $Q_1R_2 = Q_2R_1$

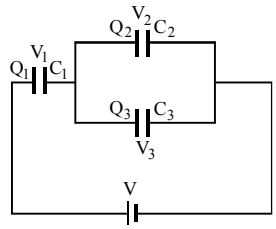
7. The potential to which a conductor is raised, depends on
(a) The amount of charge
(b) Geometry and size of the conductor
(c) Both (a) and (b)
(d) None of these

8. Calculate the area of the plates of a one farad parallel plate capacitor if separation between plates is 1 mm and plates are in vacuum
(a) 18×10^8 m^2 (b) 0.3×10^8 m^2
(c) 1.3×10^8 m^2 (d) 1.13×10^8 m^2

9. A parallel plate capacitor is charged and then isolated. What is the effect of increasing the plate separation on charge, potential, capacitance, respectively?

(a) Constant, decreases, decreases
(b) Increases, decreases, decreases
(c) Constant, decreases, increases
(d) Constant, increases, decreases

10. Three capacitors C_1, C_2 and C_3 are connected to a battery as shown. With symbols having their usual meanings, the correct conditions are



(a) $Q_1 = Q_2 = Q_3$ and $V_1 = V_2 = V$
(b) $V_1 = V_2 = V_3 = V$
(c) $Q_1 = Q_2 + Q_3$ and $V = V_1 + V_2$
(d) $Q_2 = Q_3$ and $V = V_2 + V_3$

11. A capacitor with capacitance 5μF is charged to 5 μC. If the plates are pulled apart to reduce the capacitance to 2 ¼F, how much work is done?

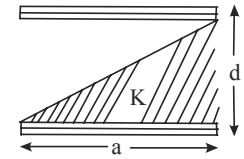
(a) 6.25×10^{-6} J (b) 3.75×10^{-6} J
(c) 2.16×10^{-6} J (d) 2.55×10^{-6} J

12. Four equal point charges Q each are placed in the xy plane at (0, 2), (4, 2), (4, – 2) and (0, – 2). The work required to put a fifth charge Q at the origin of the coordinate system will be:

(a) $\frac{Q^2}{4\pi\varepsilon_0}\left(1+\frac{1}{\sqrt{3}}\right)$ (b) $\frac{Q^2}{4\pi\varepsilon_0}\left(1+\frac{1}{\sqrt{5}}\right)$

(c) $\frac{Q^2}{2\sqrt{2}\,\pi\varepsilon_0}$ (d) $\frac{Q^2}{4\pi\varepsilon_0}$

13. A parallel plate capacitor is made of two square plates of side 'a', separated by a distance d (d<<a). The lower triangular portion is filled with a dielectric of dielectric constant K, as shown in the figure. Capacitance of this capacitor is:



(a) $\frac{K \in_0 a^2}{2d\,(K+1)}$ (b) $\frac{K \in_0 a^2}{d\,(K-1)}$ In K

(c) $\frac{K \in_0 a^2}{d}$ In K (d) $\frac{1}{2}\frac{K \in_0 a^2}{d}$

14. A parallel plate capacitor having capacitance 12 pF is charged by a battery to a potential difference of 10 V between its plates. The charging battery is now disconnected and a porcelain slab of dielectric constant 6.5 is slipped between the plates. The work done by the capacitor on the slab is:

(a) 692 pJ (b) 508 pJ
(c) 560 pJ (d) 600 pJ

15. A capacitor C is fully charged with voltage V_0. After disconnecting the voltage source, it is connected in parallel with another uncharged capacitor of capacitance $\frac{C}{2}$. The energy loss in the process after the charge is distributed between the two capacitors is :

(a) $\frac{1}{2}CV_0^2$ (b) $\frac{1}{3}CV_0^2$

(c) $\frac{1}{4}CV_0^2$ (d) $\frac{1}{6}CV_0^2$

16. Concentric metallic hollow spheres of radii R and $4R$ hold charges Q_1 and Q_2 respectively. Given that surface charge densities of the concentric spheres are equal, the potential difference $V(R) - V(4R)$ is :

(a) $\frac{3Q_1}{16\pi\varepsilon_0 R}$ (b) $\frac{3Q_2}{4\pi\varepsilon_0 R}$

(c) $\frac{Q_2}{4\pi\varepsilon_0 R}$ (d) $\frac{3Q_1}{4\pi\varepsilon_0 R}$

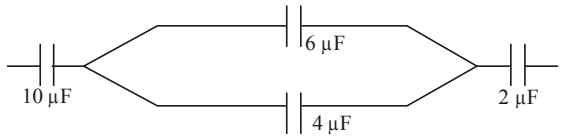
17. A solid conducting sphere, having a charge Q, is surrounded by an uncharged conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge of – 4 Q, the new potential difference between the same two surfaces is :

(a) $-2V$ (b) $2V$

(c) $4V$ (d) V

Numeric Value Answer

18. In the figure shown below, the charge on the left plate of the 10 μF capacitor is –30μC. The charge (in μC) on the right plate of the 6μF capacitor is:



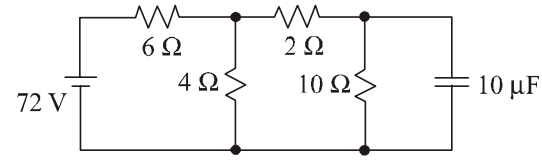
19. Voltage rating of a parallel plate capacitor is 500 V. Its dielectric can withstand a maximum electric field of 10^6 V/m. The plate area is 10^{-4} m^2. What is the dielectric constant if the capacitance is 15 pF ?

(given $\epsilon_0 = 8.86 \times 10^{-12}$ C^2 m^2)

20. A parallel plate capacitor has 1μF capacitance. One of its two plates is given +2μC charge and the other plate, +4μC charge. The potential difference (in volt) developed across the capacitor is :

21. The electric field in a region is given by $\vec{E} = (Ax + B)\hat{i}$, where E is in NC^{-1} and x is in metres. The values of constants are A = 20 SI unit and B = 10 SI unit. If the potential at $x = 1$ is V_1 and that at $x = -5$ is V_2, then $V_1 - V_2$ (in volt) is :

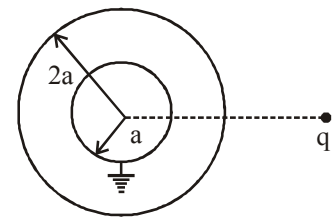
22. Determine the charge (in coulomb) on the capacitor in the following circuit:



23. The 1000 small droplets of water each of radius r and charge Q, make a big drop of spherical shape. The potential of big drop is how many times the potential of one small droplet ?

24. A hollow metal sphere of radius 5 cm is charged such that the potential on its surface is 10 V. The potential (in volt) at a distance of 2 cm from the centre of the sphere is

25. A solid conducting sphere of radius a is surrounded by a thin uncharged concentric conducting shell of radius 2a. A point charge q is placed at a distance 4a from common centre of conducting sphere and shell. The inner sphere is then grounded. The charge on solid sphere is $\frac{q}{x}$. Find the value of x.



ANSWER KEY																	
1	(b)	**4**	(d)	**7**	(c)	**10**	(c)	**13**	(b)	**16**	(a)	**19**	(8.5)	**22**	(200)	**25**	(4)
2	(c)	**5**	(a)	**8**	(d)	**11**	(b)	**14**	(b)	**17**	(d)	**20**	(1)	**23**	(100)		
3	(b)	**6**	(d)	**9**	(d)	**12**	(b)	**15**	(d)	**18**	(18)	**21**	(180)	**24**	(10)		