Potential and Capacitors

1. A solid sphere of radius R is charged uniformly. At what distance from its surface is the electrostatic potential half of the potential at the center?
   (a) R (b) R/3 (c) R/2 (d) 2R
2. Two thin identical rings A and B, each of radius r metres, are placed coaxially at a distance r metres apart. If positive charges Q_A and Q_B ($Q_A > Q_B$) are spread uniformly on A and B respectively, then the work done in carrying a positive charge q from the centre of B to the centre of A is:
   (a) $\frac{q\,(Q_A-Q_B)\,(\sqrt{2}-1)}{4\pi\varepsilon_0 r\sqrt{2}}$ (b) $\frac{q\,(Q_A+Q_B)\,(\sqrt{2}+1)}{4\pi\varepsilon_0 r\sqrt{2}}$ (c) $\frac{\sqrt{2}q\,(Q_A-Q_B)}{4\pi\varepsilon_0 r}$ (d) zero
3. Charge q is given a displacement $\vec{r} = a\hat{\imath} + b\hat{\jmath}$ in an electric field $\vec{E} = E_1\hat{\imath} + E_2\hat{\jmath}$. The work done is:
   (a) $q(E_1a + E_2b)$ (b) $q(E_1 + E_2)\sqrt{a^2+b^2}$ (c) $q\sqrt{(E_1a)^2+(E_2b)^2}$ (d) $q(E_1/a + E_2/b)$
4. Two conducting spheres are far apart. The smaller sphere carries a total charge of Q. The larger sphere has a radius that is twice that of the smaller and is neutral. After the two spheres are connected by a conducting wire, the charges on the smaller and larger spheres, respectively, are:
   (a) Q/2 and Q/2 **(b)** 2Q/3 and Q/3 (c) Q/3 and 2Q/3 (d) 0 and Q
5. In a uniform electric field, equipotential surfaces must
   I. be plane surfaces.
   II. be normal to the direction of the field.
   III. be spaced such that surfaces having equal differences in potential are separated by equal distances.
   IV. have decreasing potentials in the direction of the field.
   Which of the above statements are correct?
   (a) II and IV (b) I and III (c) I, II and IV **(d)** All of these
6. P is a point on an equipotential surface S. The field at point P is E.
   I. E must be perpendicular to S in all cases.
   II. E will be perpendicular to S only if S is a plane surface.
   III. E cannot have a component along a tangent to S.
   IV. E may have a non-zero component along a tangent to S if S is a curved surface.
   Which of the above statements are correct?
   (a) I and III (b) I, II and IV (c) I and II (d) None of these
7. S_1 and S_2 are two equipotential surfaces on which the potentials are not equal.
   I. S_1 and S_2 cannot intersect.
   II. S_1 and S_2 cannot both be plane surfaces.
   III. In the region between S_1 and S_2, the field is maximum where they are closest to each other.
   IV. A line of force from S_1 to S_2 must be perpendicular to both.
   Which of the above statements are correct?
   (a) II and IV **(b)** I, III and IV (c) I and III (d) None of these
8. A parallel plate capacitor has a capacity C. The separation between the plates is doubled and a dielectric medium is introduced between the plates. If the capacity now becomes 2C, the dielectric constant of the medium is:
   (a) 2 (b) 1 **(c)** 4 (d) 8
9. A parallel-plate capacitor with air between the plates has a capacitance of 9 pF. The separation between its plates is d. The space between the plates is now filled with two dielectrics. One of the

dielectrics has a dielectric constant K_1 = 3 and thickness d/3 while the other one has dielectric constant K_2 = 6 and thickness 2d/3. Capacitance of the capacitor is now:

(a) 15 pF (b) 25 pF **(c)** 45 pF (d) 55 pF

10. A metal plate is introduced between the two plates of a charged capacitor and insulated from them. It:

    (a) divides the capacitor into two capacitors in series with each other tb) divides the capacitor into two capacitors in parallel with each other (c) is equivalent to a dielectric of zero dielectric constant **(d)** is equivalents to a dielectric of infinite dielectric constant

11. In a circuit, capacitors A and B have identical geometry and are connected in series, but a material of dielectric constant 3 is present between the plates of B. The potential differences across A and B are respectively:

    (a) 2 V, 8 V (b) 2.5 V, 7.5 V (c) 8V, 2V **(d)** 7.5 V, 2.5 V

12. The separation between the plates of a parallel plate capacitor is d. The space between the plates is filled with two dielectrics of thicknesses d_1 and d_2 ($d_1 + d_2 = d$) and dielectric constants K_1 and K_2 respectively. If a single dielectric of thickness d is to replace the two to get the same effective capacitance, its dielectric constant should be:

    (a) $\frac{dK_1K_2}{d_1K_2+d_2K_1}$ (b) $\frac{dK_1K_2}{d_1K_1+d_2K_2}$ (c) $\frac{dK_1K_2}{d_1K_2-d_2K_1}$ (d) $\frac{K_1K_2}{K_2+K_1}$

13. A parallel plat capacitor has the space between its plates filled by two slabs of thickness d/2 each and dielectric constants K_1 and K_2. d is the plate separation of the capacitor. The capacitance of the capacitor is:

    (a) $\frac{2\varepsilon_0 A}{d}\left(\frac{K_1+K_2}{K_1K_2}\right)$**(b)** $\frac{2\varepsilon_0 A}{d}\left(\frac{K_1K_2}{K_1+K_2}\right)$ (c) $\frac{\varepsilon_0 A}{d}\left(\frac{K_1+K_2}{K_1K_2}\right)$ (d) $\frac{\varepsilon_0 A}{2d}\left(\frac{K_1K_2}{K_1+K_2}\right)$

14. A battery is used to charge a parallel-plate capacitor till the potential difference between the plates becomes equal to the electromotive force of the battery. The ratio of the energy stored in the capacitor and the work done by the battery is:

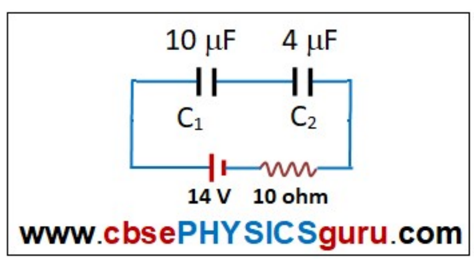
    (a) 1 **(b)** 1/2 (c) 1/4 (d) 2

15. One thousand small identical drops of water, all charged to the same potential V, are combined to form a single large drop. Then:

    (a) the potential of the large drop is 1000V (b) the electrostatic energy of the large drop is equal to the sum of the electrostatic energies of all the small drops **(c)** the electrostatic energy of the large drop is more than the sum of the electrostatic energies of all the small drops (d) the electrostatic energy of the large drop is less than the sum of the electrostatic energies of all the small drops

16. A 4 μF and a 2 μF capacitor are connected in series and charged from a battery. They store charges q1 and q_2, respectively. When disconnected and charged separately using the same battery, they have charges Q_1 and Q_2, respectively. Then:

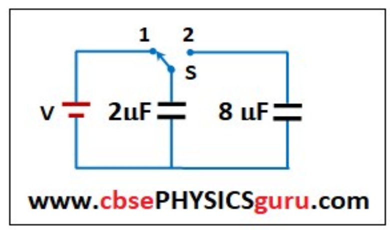
    (a) $Q_1 > Q_2 > q_2 = q_1$ (b) $Q_1 = Q_2 < q_2 < q_1$ (c) $Q_1 > q_1 = q_2 > Q_1$ (d) $Q_1 = q_1 > Q_2 = q_2$



17. In the given circuit, in steady state:

    (a) the potential difference across the capacitor C_1 is 4V (b) the potential difference across the capacitor C_2 is 4V (c) the charge on C_1 = 10 μF (d) the charge on C_2 = 4 μF

18. A 5 μF capacitor is fully charged by a 12 V battery. It is then disconnected from the battery and connected to an uncharged capacitor. The voltage across the combination becomes 3 volts. The capacity of the unchanged capacitor is:
(a) 10 μF **(b)** 15 μF (c) 20 μF (d) 30 μF
19. A 4 μF and a 2 μF capacitor are connected in series and a potential difference is applied across the combination. The 4 μF capacitor has:
(a) twice the charge of the 2 μF capacitor. (b) half the charge of the 2 μF capacitor. (c) twice the potential difference of the 2 μF capacitor. **(d)** half the potential difference of the 2 μF capacitor.
20. A parallel plate capacitor of capacitance C is connected to a battery and is charged to a potential difference V. Another capacitor of capacitance 2C is similarly charged to a potential difference 2V. The batteries are now disconnected and the capacitors are connected in parallel to each other in such a way that the positive terminal of one is connected to the negative terminal of the other. The final energy of the configuration is:
(a) zero **(b)** $\frac{3}{2}CV^2$ (c) $\frac{25}{6}CV^2$ (d) $\frac{9}{2}CV^2$
21. A parallel-plate capacitor is charged from a cell and then isolated from it. The separation between the plates is now increased.
I. The force of attraction between the plates will decrease.
II. The field in the region between the plates will not change.
III. The energy stored in the capacitor will increase.
IV. The potential difference between the plates will decrease. Which of the above statements are correct?
(a) II and III (b) I, II and III (c) I and III (d) All of these
22. A 2 μF capacitor is charged as shown in given figure. The percentage of its stored energy dissipated after the switch S is turned to position 2 is:
(a) 0% (b) 75% (c) 20% **(d)** 80%



23. A 4 μF capacitor is charged by a 200 V supply. It is then disconnected from the supply and is connected to an uncharged 2 μF capacitor. The decrease in the electrical potential energy of the system is:
(a) 8/3 x 10^{-2}J (b) 4 x 10^{-2} J (c) 8 x 10^{-2} J (d) 4 x 10^{-2}J
24. A half ring of radius R has a charge of per unit length. The potential at the center of the half ring is:
(a) kλR **(b)** k$\pi\lambda$ (c) kλ/R (d) k$\lambda\pi$/R.
25. The energy required to charge a parallel-plate condenser of plate separation d and plate area of cross-section A such that the uniform electric field between the plates is E is:
(a) $\frac{1}{2}\varepsilon_0 E^2$ **(b)** $\frac{1}{2}\varepsilon_0 E^2 Ad$ (c) $\varepsilon_0 E^2 Ad$ (d) $\frac{1}{2A}\varepsilon_0 E^2$
26. Two identical particles of mass m carry a charge Q each. Initially one is at rest on a smooth, horizontal plane and the other is projected along the plane directly towards the first particle from a large distance, with a speed v. The distance of closest approach is $1/4\pi\varepsilon_0$ times:
(a) Q^2/mv^2 (b) $2Q^2/mv^2$ (c) $3Q^2/mv^2$ **(d)** $4Q^2/mv^2$
27. Charge Q is distributed between two different metallic spheres having radii R and 2R such that both spheres have equal surface charge density. Then charge on larger sphere is:
(a) 4Q/5 (b) 3Q/5 (c) 2Q/5 (d) Q/5

28. A capacitor of 0.2 μF is charged to 600 V. After removing the charging battery, this capacitor is connected across another capacitor of 1.0 μF . The voltage across the capacitor changes to:
(a) 100 V (b) 150 V (c) 200 V (d) 400 V
29. A parallel plate air capacitor is charged to a certain potential difference. After disconnecting the battery, the distance between the plates of the capacitor is increased using an insulating handle. As a result, the potential difference between the plates:
(a) increases (b) decreases (c) does not change (d) becomes zero
30. Twenty seven water drops of the same size are charged to the same potential. If they are combined to form a big drop the ratio of the potential of the big drop to that of a small drop is:
(a) 3 (b) 6 **(c)** 9 (d) 27
31. Four identical charges are placed at the points (1, 0, 0), (0, 1, 0) (–1, 0, 0) and (0, –1, 0).
I. The potential at the origin is zero.
II. The field at the origin is zero.
III. The potential at all points on the z-axis, other than the origin, is zero.
IV. The field at all points on the z-axis, other than the origin, acts along the z-axis.
Which of the above statements are correct?
(a) II and IV (b) II and III (c) I, II and IV (d) None of these
32. A capacitor of capacitance C_1 is charged such that the electrostatic energy stored in it is U. It is now connected across an unchanged capacitor of capacitance C_2. The energy dissipated in the process is:
(a) $\frac{C_1U}{C_1+C_2}$ **(b)** $\frac{C_2U}{C_1+C_2}$ (c) $\frac{(C_1-C_2)U}{C_1+C_2}$ (d) $\frac{C_1C_2U}{2(C_1+C_2)}$
33. A dielectric slab is slowly inserted between the plates of a parallel-plate capacitor while the capacitor is connected to a battery. As it is being inserted:
(a) the capacitance, the potential difference between the plates, and the charge on the positive plate all increase. (b) the capacitance, the potential difference between the plates, the charge on the positive plate all decrease. the potential difference between the plates increases, the charge on the positive plate decreases, and the capacitance remains the same. **(d)** the capacitance and the charge on the plate increase but the potential difference between the plates remains the same.
34. The capacitance of a parallel-plate capacitor is C_0 when the region between the plates has air. This region is now filled with a dielectric slab of dielectric constant K. The capacitor is connected to a cell of emf V and the slab is taken out.
I. Charge $VC_0(K-1)$ flows through the cell.
II. Energy $V^2C_0(K-1)$ is absorbed by the cell.
III. The energy stored in the capacitor is reduced by $V^2C_0(K-1)$.
IV. The external agent has to do (1/2) $V^2C_0(K-1)$ amount of work to take the slab out.
Which of the above statements are correct?
(a) I, II and IV (b) I and III **(c)** I and IV (d) None of these