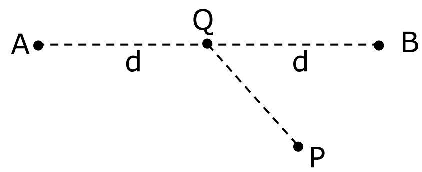
2PUC – CHAPTER 02
ELECTRIC POTENTIAL AND CAPACITANCES

1. Identify the **wrong** statement.
(a) The electrical potential energy of a system of two protons shall increase if the separation between the two is decreased.
(b) The electrical potential energy of a proton, electron system will increase if the separation between the two is decreased.
(c) The electrical potential energy of a proton, electron system will increase if the separation between the two is increased.
(d) The electrical potential energy of system of two electrons increase if the separation between the two is decreased.

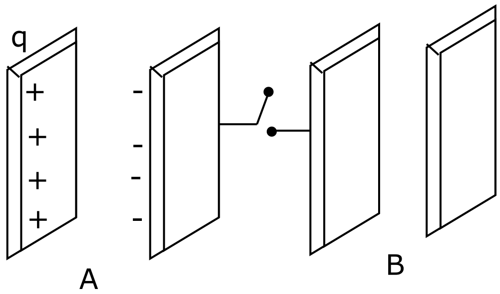
2. The work done in taking a unit positive charge from P to A is W_A and from P to B is W_B. Then
(a) $W_A > W_B$
(b) $W_A < W_B$
(c) $W_A = W_B$
(d) $W_A + W_B = 0$



3. Mark the **correct** statement.
(a) If E is zero at a certain point, then V should be zero at that point.
(b) If E is not zero at a certain point, then V should not be zero at that point.
(c) If V is zero at a certain point, then E should be zero at that point.
(d) If V is zero at a certain point, then E may or may not be zero.

4. Electric potential is given by $V = 6x - 8y^2 - 8y + 6yz - 4z^2$. Then electric force acting on 2C point charge placed origin will be
(a) 2 N (b) 6 N (c) 8 N (d) 20 N

5. Consider the situation shown in the figure. The capacitor A has a charge 'q' on it whereas B is uncharged. The charge appearing on the capacitor B a long time after the switch is closed is



(a) zero (b) q/2 (c) q (d) 2q

6. The plates of a parallel plate capacitor are pulled apart with a velocity v. If at any instant their mutual distance of separation is x, then magnitude of rate of change of capacitance with respect to time varies as
(a) 1/x (b) $1/x^2$ (c) x^2 (d) x

7. The potential function of an electrostatic field is given by $V = 2x^2$. Determine the electric field strength at the point (2m, 0, 3m).
(a) $\vec{E} = 4\hat{i}(NC^{-1})$ (b) $\vec{E} = -4\hat{i}(NC^{-1})$ (c) $\vec{E} = 8\hat{i}(NC^{-1})$ (d) $\vec{E} = -8\hat{i}(NC^{-1})$

8. Two concentric spheres of radii r_1 and r_2 carry charges q_1 and q_2 respectively. If the surface charge density (σ) is the same for the both spheres, the electric potential at the common centre will be
(a) $\frac{\sigma}{\varepsilon_0}\cdot\frac{r_1}{r_2}$ (b) $\frac{\sigma}{\varepsilon_0}\cdot\frac{r_2}{r_1}$ (c) $\frac{\sigma}{\varepsilon_0}(r_1 - r_2)$ (d) $\frac{\sigma}{\varepsilon_0}(r_1 + r_2)$.

9. A soap bubble of radius 'r' is charged to a potential V. If the radius is increased to 'nr', the potential on the bubble will become

(a) nV (b) n^2V (c) $\frac{V}{n}$ (d) $\frac{V}{n^2}$

10. A metallic sphere A of radius 'a' carries a charge Q. It is brought in contact with an uncharged sphere B of radius 'b'. The charge on sphere A now will be

(a) $\frac{aQ}{b}$ (b) $\frac{bQ}{a}$ (c) $\frac{bQ}{a+b}$ (d) $\frac{aQ}{a+b}$

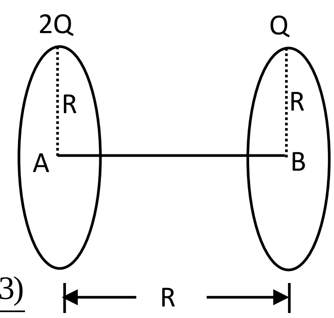
11. A metallic sphere of radius R is charged to a potential V. The magnitude of the electric field at a distance r(> R) from the centre of the sphere is

(a) $\frac{V}{r}$ (b) $\frac{Vr}{R^2}$ (c) $\frac{VR}{r^2}$ (d) zero

12. Two concentre thin metallic spheres of radii R_1 and R_2 $(R_1 > R_2)$ bear charges Q_1 and Q_2 respectively. Then potential at radius 'r' between R_1 and R_2 will be

(a) $k\left(\frac{Q_1+Q_2}{r}\right)$ (b) $k\left(\frac{Q_1}{r}+\frac{Q_2}{R_2}\right)$ (c) $k\left(\frac{Q_2}{r}+\frac{Q_1}{r}\right)$ (d) $k\left(\frac{Q_1}{R_1}+\frac{Q_2}{r}\right)$

13. In the following arrangement



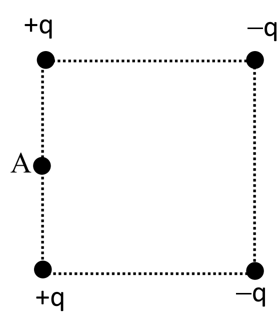
(a) $V_A = \frac{Q(2\sqrt{2}-1)}{4\pi \epsilon_0 \sqrt{2}R}$

(b) $V_B = \frac{Q(\sqrt{2}-1)}{4\pi \epsilon_0 R}$

(c) Work done in moving a charge + q from B to A, $W_{BA} = \frac{qQ(3\sqrt{2}-3)}{4\sqrt{2}\pi \epsilon_0 R}$

(d) all the options are correct.

14. Four electric charges $+q, +q, -q$ and $-q$ are placed at the corners of a square of side 2L (see figure). The electric potential at point A, midway between the two charges $+q$



(a) zero (b) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}(1+\sqrt{5})$

(c) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$ (d) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$

15. Charges 2q and 8q are placed at the end points A and B respectively of a 9 cm long straight line. A third charge 'q' is placed at a point C of AB such that the potential energy of the system is minimum. The distance of C from A is

(a) 2 cm (b) 3 cm (c) 4cm (d) 5 cm

16. A conducting sphere of radius 10 cm is charged to $10\,\mu C$. Another uncharged sphere of radius 20 cm is allowed to touch it for some time. After that if the spheres are separated, then surface density of charges, on the spheres will be in the ratio of

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

17. If identical charges $(-q)$ are placed at each corner of a cube of side b, then electric potential energy of charge $(+q)$ which is placed at centre of the cube will be

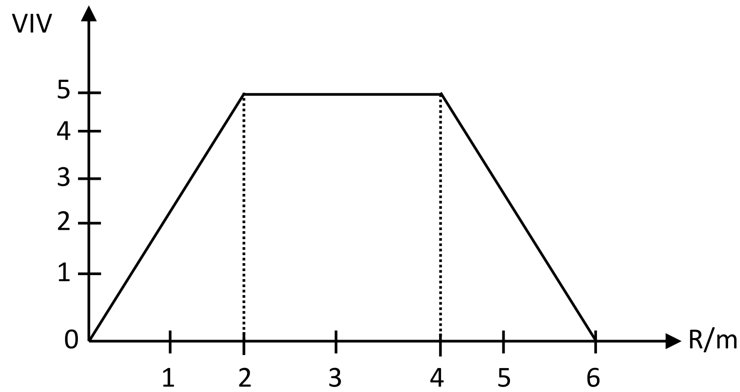
(a) $\frac{8\sqrt{2}q^2}{4\pi\varepsilon_0 b}$ (b) $\frac{-8\sqrt{2}q^2}{\pi\varepsilon_0 b}$ (c) $\frac{-4\sqrt{2}q^2}{\pi\varepsilon_0 b}$ (d) $\frac{-4q^2}{\sqrt{3}\pi\varepsilon_0 b}$

18. The variation of potential with distance R from the fixed point is shown in figure.

The electric field at R = 5 m is

(a) $2.5\ Vm^{-1}$ (b) $-2.5\ Vm^{-1}$

(c) $0.4\ Vm^{-1}$ (d) $-0.4\ Vm^{-1}$



19. The potential V is varying with 'x' as $V = \frac{1}{2}(y^2 - 4x)$ volt. The field at $x = 1m$, $y = 1m$ is

(a) $2\hat{i} + \hat{j}\ Vm^{-1}$ (b) $-2\hat{i} + \hat{j}\ Vm^{-1}$ (c) $2\hat{i} - \hat{j}\ Vm^{-1}$ (d) $-2\hat{i} + 2\hat{j}\ Vm^{-1}$

20. The concentric spheres of radii R and 2R are charged. The inner sphere has a charge of $1\mu C$ and the outer sphere has $2\mu C$ of the same sign. The potential is 9000 V at a distance 3 R from the common centre. What is value of R?

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

21. Three point charges q, 2q and 8q are to be placed on a 9 cm long straight line. Find the position of the charge q such that potential energy of this system minimum.

a) 1 cm from 2 q b) 2 cm from 2q c) 3 cm from 2 q d) 4 cm from 2q

22. Three concentric spherical shells have radii a, b and c (a < b < c) and have surface charge densities σ, $-\sigma$ and σ, respectively. If V_A, V_B and V_C denote the potentials of the three shell, then for c = a +b, we have

a) $V_C \neq V_B \neq V_A$ b) $V_C = V_A \neq V_B$ c) $V_C = V_B = V_A$ d) $V_C \neq V_B = V_A$

23. Two charges 5×10^{-8} C and -3×10^{-8} C are located 16 cm apart. At what point(s) on the line joining the two charges is the electric potential zero? Take the potential at infinity to be zero.

a) 6 cm from the charge -3×10^{-8} C b) 6 cm from the charge 5×10^{-8} C

c) 9 cm from the charge -3×10^{-8} C d) 9 cm from the charge 5×10^{-8} C

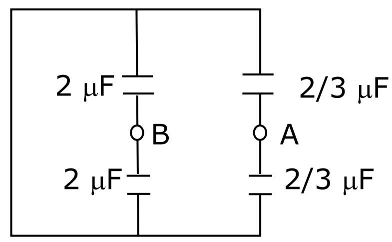
24. Two insulated metal spheres of radii 10 cm and 15 cm charged to a potential of 150 V and 100 V respectively, are connected by means of a metallic wire. What is the charge on the first sphere?

a) 1 nC b) 1.333 nC c) 1.5 nC d) 0.75 nC

25. A charge (-q) and another charge (+Q) are kept at two points A and B, respectively. Keeping the charge (+Q) fixed at B, the charge (-q) at A is moved to another point C such that ABC forms an equilateral triangle of side ℓ. The net work done in moving the charge (-q) is

a) $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{\ell}$ b) $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{\ell^2}$ c) $\frac{1}{4\pi\varepsilon_0}Qq\ell$ d) zero

26. The equivalent capacitance of the circuit across the terminals A and B is equal to



(a) $0.5\mu F$
(b) $2\mu F$
(c) $1\mu F$
(d) none of these

27. An electric field is given by E = (y$\hat{i}$ + x$\hat{i}$) NC^{-1}. The work done in moving a 1 C charge from $\vec{r}_A$ =(2$\hat{i}$ + 2$\hat{j}$) m to $\vec{r}_B$ = (4$\hat{i}$ + 2$\hat{j}$)m is

a) 2 y b) 3 y c) zero d) infinity

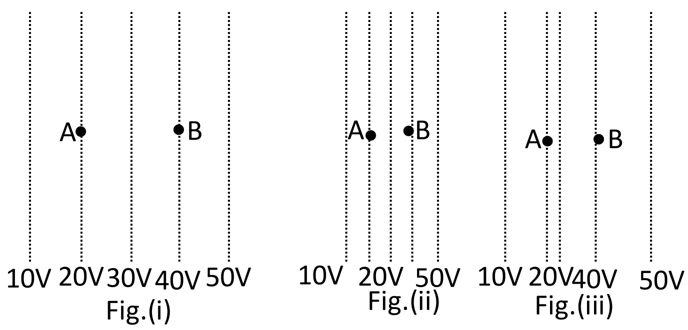
28. A capacitor of capacitance $C_1 = 1\mu F$ can withstand maximum voltage $V_1 = 6kV$ and another capacitor of capacitance $C_2 = 3\mu F$ can withstand maximum voltage $V_2 = 4kV$. When the two capacitors are connected in series, the combined system can withstand a maximum voltage of

(a) 4 kV (b) 6 kV (c) 8 kV (d) 10 kV

29. A sphere of radius r is charged to a potential V. The outward pull per unit area of its surface is given by

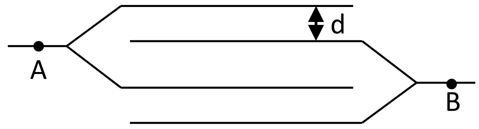
a) $\frac{4\pi\varepsilon_0 V^2}{r^2}$ b) $\frac{\varepsilon_0 V^2}{2r^2}$ c) $\frac{2\pi\varepsilon_0 V^2}{r^2}$ d) $\frac{\varepsilon_0 V^2}{4r^2}$

30. Figures shows some equipotential lined distributed in space. A charged object is moved from point A to point B.



a) The work done in Fig. (i) is the greatest
b) The work done in Fig. (ii) is least
c) The work done in Fig. (i), Fig. (ii) and Fig. (iii) is same
d) The work done in Fig. (iii) is greater than Fig. (ii) but equal to that in Fig. (i)

31. The equivalent capacity between points A and B in figure will be, while capacitance of each capacitor is 3μF.

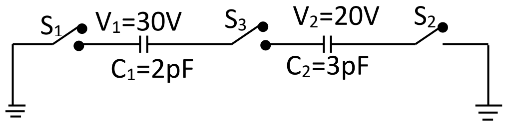


a) 2 μF b) 4 μF c) 7 μF d) 9 μF

32. The electric potential at a point (x,y) in the xy- plane is given by V = -Kxy
The electric field intensity at a distance r from the origin varies as

a) r^2 b) r c) 2r d) $2r^2$

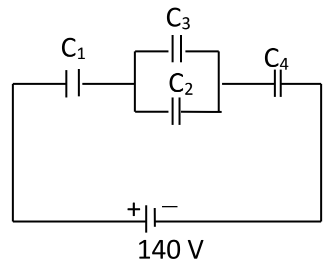
33. For the circuit shown figure, which of the following statements is true?



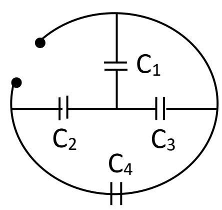
a) With S_1 closed, $V_1 = 15V$, $V_2 = 20V$
b) With S_3 closed, $V_1 = V_2$, $V_2 = 20V$
c) With S_1 and S_3 closed, $V_1 = V_2 = 0$
d) With S_1 and S_3 closed, $V_1 = 30V$, $V_2 = 20V$

34. In the circuit arrangement shown in figure, the value of $C_1 = C_2 = C_3 = 30$ pF and $C_4 = 120$ pF. If the combination of capacitors is charged with 140V DC supply, the potential differences across the four capacitors will be respectively

a) 80 V, 40V, 40V and 20V
b) 20 V, 40V, 40V and 80V
c) 35 V, 35V, 35V and 35V
d) 80 V, 20V, 20V and 20V

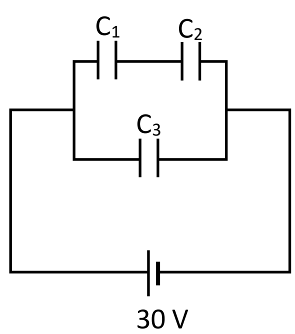


35. In the arrangement of capacitors shown in figure, each capacitor is 9 μF, then the equivalent capacitance between the points A and B is



a) 9 μF
b) 18 μF
c) 4.5 μF
d) 15 μF

36. Two capacitors $C_1 = 3\mu F$ and $C_2 = 6\mu F$ in series, are connected in parallel to a third capacitor $C_3 = 4\mu F$. This arrangement is the connected to a battery of e.m.f = 30 V, as shown. The energy lost by the battery in charging the capacitors



(a) 900 μJ
(b) 1800 μJ
(c) 2700 μJ
(d) 3600 μJ

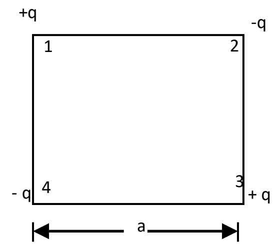
37. Two insulated metallic sphere of 3μF and 5μF capacitances are charged to 300 V and 500 V, respectively. The energy loss, when they are connected by a wire, is

a) 0.0375 J
b) 0.235 J
c) 0.375 J
d) 375 J

38. If on the concentric hollow sphere of radii r and R(>r) the charge Q is distributed such that their surface densities are same, then the potential at their common centre is

a) $\frac{Q(R^2+r^2)}{4\pi\varepsilon_0(R+r)}$
b) $\frac{Q(R+r)}{4\pi\varepsilon_0(R^2+r^2)}$
c) zero
d) $\frac{QR}{R+r}$

39. The work required to put the four charges at the corners of a square of side a, as shown in figure, is



a) $\frac{1}{4\pi\varepsilon_0}.\frac{q^2}{a}$ b) $\frac{-2.6}{4\pi\varepsilon_0}.\frac{q^2}{a}$ c) $+\frac{2.6}{4\pi\varepsilon_0}.\frac{q^2}{a}$ d) $\frac{1}{4\pi\varepsilon_0}.\frac{4q^2}{a}$

40. A parallel plate capacitor has the space between its plates filled by two slabs of thickness $\frac{d}{2}$ each and dielectric constants K_1 and K_2. d is the plate separation of the capacitor. The capacity 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) $\frac{2\varepsilon_0 A}{d}(K_1+K_2)$ d) $\frac{\varepsilon_0 A}{d}\left(\frac{K_1+K_2}{K_1K_2}\right)$

41. Six identical capacitors are joined in parallel, charged to a potential difference of 10 V, separated and then connected in series, i.e., the positive plate of one is connected to negative plate of other. Then potential difference between free plates is

a) 10 V b) 30 V c) 60 V d) $\frac{10}{6}$ V

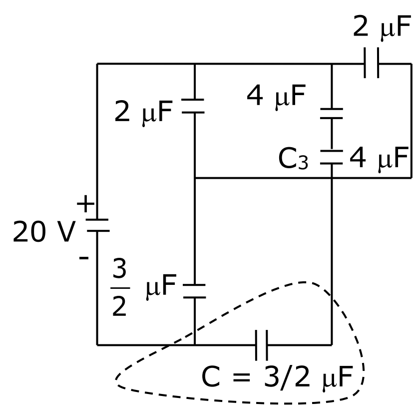
42. In figure, the battery has a potential difference of 20 V. The charge in the capacitor marked as C is

(a) 20 μC

(b) 40 μC

(c) 10 μC

(d) none of these



43. The work done in placing a charge of $8\times10^{-18}C$ on a condenser of capacity $100\,\mu F$ is

(a) $16\times10^{-32}J$ (b) $3.1\times10^{-26}J$ (c) $4\times10^{-10}J$ (d) $32\times10^{-32}J$

44. The effective capacitance of two capacitors of capacitances C_1 and C_2 (with $C_2 > C_1$) connected in parallel is $\frac{25}{6}$ times the effective capacitance when they are connected in series. The ratio C_2/C_1 is

(a) $\frac{3}{2}$ (b) $\frac{4}{3}$ (c) $\frac{5}{3}$ (d) $\frac{25}{6}$

45. Two capacitors C_1 and C_2 are charged to 120 V and 200 V respectively. It is found that by connecting them together the potential on each one can be made zero. Then

(a) $3C_1 = 5C_2$ (b) $3C_1 + 5C_2 = 0$ (c) $9C_1 = 4C_2$ (d) $5C_1 = 3C_2$

46. The energy stored in 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.

(a) $\in_0 E^2 Ad$ (b) $\frac{1}{2}\in_0 E^2 Ad$ (c) $\frac{1}{2}\frac{\in_0 E^2}{Ad}$ (d) $\frac{\in_0 E^2}{Ad}$

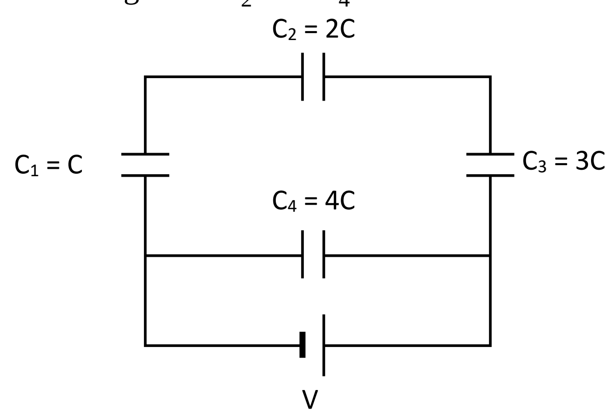
47. In how many ways one can arrange three identical capacitors taking either one or two or three capacitors together to obtain distinct effective capacitance is

(a) 4 (b) 5 (c) 6 (d) 7

48. A network of four capacitors of capacity equal to $C_1 = C$, $C_2 = 2C$, $C_3 = 3C$ and $C_4 = 4C$ are connected with a battery as shown in the figure. The ratio of the charges on C_2 and C_4 is

(a) $\frac{22}{3}$ (b) $\frac{3}{22}$

(c) $\frac{7}{4}$ (d) $\frac{4}{7}$



49. A parallel plate capacitor is connected to a cell. A metal plate of negligible thickness is inserted parallel to plates.

(A) The capacitances remains same
(B) The cell will supply more charge
(C) Equal and opposite charges will appear on two faces of metal plate.
(D) The potential difference between the plates will increase

(a) A, B (b) A, C (c) B, C (d) C, D

50. Two identical parallel plate capacitors are connected in series to a cell of 120 V. A dielectric slab (K = 3) in placed in one of the capacitor. The p.d. across the capacitors will now be

(a) 20 V, 100 V (b) 30 V, 90 V (c) 40 v, 80 V (d) 60 V, 60 V