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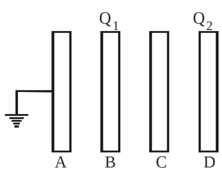
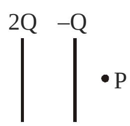
(CAPACITOR)

1. What will be the charge on earthed side of plate A ?



(A) $\frac{Q_1+Q_2}{2}$ (B) $\frac{Q_1-Q_2}{2}$ (C) Zero (D) None

2. In the figure shown the plates of a parallel plate capacitor have unequal charges. Its capacitance is 'C'. P is a point outside the capacitor and close to the plate of charge –Q. The distance between the plates is 'd'. Select incorrect alternative :



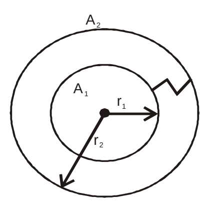
(A) A point charge at point 'P' will experience electric force due to capacitor.

(B) The potential difference between the plates will be 3Q/ 2C.

(C) The energy stored in the electric field in the region between the plates is $9Q^2/8C$.

(D) The force on one plate due to the other plate is $Q^2/2\pi\varepsilon_0 d^2$.

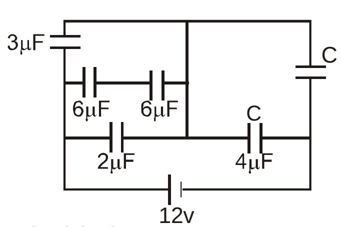
3. Two spherical conductors A_1 and A_2 of radii r_1 and r_2 are placed concentrically in air. The two are connected by a copper wire as shown in figure.



Then the equivalent capacitance of the system is : [3min.]

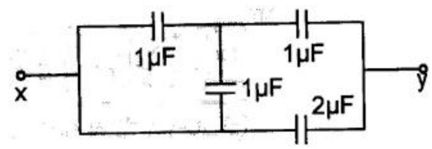
(A) $\frac{4\pi\varepsilon_0 K r_1 r_2}{r_2-r_1}$ (B) $4\pi\varepsilon_0(r_2+r_3)$ (C) $4\pi\varepsilon_0 r_2$ (D) $4\pi\varepsilon_0 r_1$

4. In the circuit shown in Fig. charge that passes through the battery is 48 μC. Charge on capacitor C and the potential difference across it are :



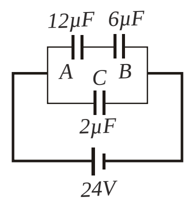
(A) 24 μC, 6V (B) 32 μC, 8V (C) 18 μC, 3V (D) 12.5 μC, 4.5V

5. The equivalent capacitance between x & y is : [3 min.]



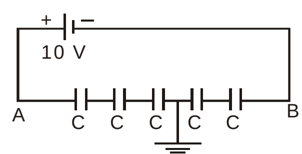
(A) $\frac{5}{6}$ μF (B) $\frac{7}{6}$ μF (C) 8/3 μF (D) 1 μF

6. For the circuit shown in figure the charges on three capacitors A, B and C are respectively, [3 min.]



(A) 96 μC, 96 μC and 48 μC (B) 32 μC, 64 μC and 48 μC
(C) 64 μC, 32 μC and 48 μC (D) 32 μC, 32 μC and 48 μC

7. In the following circuit (Figure) the potentials at points A and B will be respectively [3 min.]



(A) 10 V, 0 V (B) 5 V, –5 V (C) 4 V, –6 V (D) 6 V, – 4 V

8. A parallel plate capacitor of capacitance 1 μF is charged to a voltage of 10V. Another parallel plate capacitor of capacitance 2 μF is charged to a voltage of 20 V. The capacitors are then connected in parallel in such a way that the positive terminal of one is connected to the negative terminal of the other. The final energy stored in the combination is

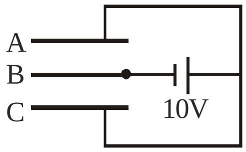
(A) 1.0×10^{-4} J (B) 1.5×10^{-4} J
(C) 2.0×10^{-4} J (D) 2.5×10^{-4} J

9. **n** identical charged particles are placed on the vertices of a regular polygon of **n** sides of side length **a**. One of the charge particle is released from polygon. When this particle reaches a far of distance, another particle adjacent to the first particle is released. The difference of kinetic energies of both the particles at infinity is **k**. Magnitude of charge is

(A) $\sqrt{4\pi\varepsilon_0 ak}$ (B) $\frac{k}{4\pi\varepsilon_0 a}$

(C) $\frac{k}{a}$ (D) $\sqrt{ka}$

10. Three plates A, B and C each of area 0.1 m^2 are separated by 0.885 mm from each other as shown in the figure. A 10 V battery is used to charge the system.
The energy stored in the system is



(A) 1 μJ (B) 10^{-1} μJ
(C) 10^{-2} μJ (D) 10^{-3} μJ

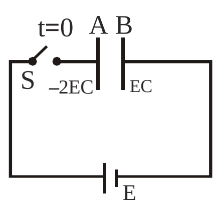
11. Charge (-q) are placed at the verticles of an equilateral triangle of slide ℓ and chagre Q > o is placed at the centroid. The negative charges are in equilibrium.

(A) The value of Q = $\frac{q}{\sqrt{3}}$ (B) The value of Q = -q

(C) Negative charges are in stable equilibrium for motion in the plane
(D) Negative charges are in unstable equilibrium for motion in the plane

12. Over a certain region of space, the electric potential is $v = 5x - 3x^2y + 2yz^2$. (neglect gravity)
(A) If an electron is released from rest at origin it starts to move along negative x-axis.
(B) The magnitude of electric field at point P(1,0, -2) is 7.07 N/C.
(C) If an proton is released from rest at origin, it starts to move along negative x- axis.
(D) The slope of electric lines of force at the origin is zero.

13. A parallel plate capacitor of capacitance 'C' has charges on its plates initially as shown in the figure. Now at t = 0, the switch 'S' is closed. Select the correct alternative(s) for this circuit diagram.



(A) In steady state the charges on the outer surfaces of plates 'A' and 'B' will be same in magnitude and sign.
(B) In steady state the charges on the outer surfaces of plates 'A' and 'B' will be same in magnitude and opposite in sign.
(C) In steady state the charges on the inner surfaces of the plates 'A' and 'B' will be same in magnitude and opposite in sign.
(D) The work done by the cell by the time steady state is reached is $\frac{5E^2C}{2}$.

14. A parallel plate air capacitor is connected to a battery. The quantities charge, voltage, electric field and energy associated with this capacitor are given by $_0$, V_0, E_0 and U_0 respectively. A dielectric slab is now introduced to fill the space between the plates with battery still in connection. The corresponding quantities now given by Q, V, E and U are related to the previous one as
(A) $Q > Q_0$ **(B)** $V > V_0$
(C) $E > E_0$ **(D)** $U > U_0$

15. A parallel plate capacitor is charged and the charging battery is then disconnected. If the plates of the capacitor are moved farther apart by means of insulating handles:
(A) the charge on the capacitor increases.
(B) the voltage across the plates increases.
(C) the capacitance increases.
(D) the electrostatic energy stored in the capacitor increases

16. A parallel plate capacitor of plate area A and plate separation d is charged to potential difference V and then the battery is disconnected. A slab of dielectric constant K is then inserted between the plates of the capacitor so as to fill the space between the plates. If Q, E and W denote respectively, the magnitude of charge on teach plate, the electric field between the plates (after the slab) is inserted), and work done on the system, in question, in the process of inserting the slab, then

(A) $Q = \frac{£_0 AV}{d}$ **(B)** $Q = \frac{£_0 KAV}{d}$

(C) $E = \frac{V}{Kd}$ **(D)** $W = \frac{£_0 AV^2}{2d}\left[1 - \frac{1}{K}\right]$

17. A dielectric slab of thickness d is inserted in a parallel plate capacitor whose negative plate is at x = 0 and positive plate is at x = 3d. The slab is equidistant from the plates. the capacitor is given some charge. As x goes from 0 to 3d,
(A) the magnitude of the electric field remains the same. **(B)** the direction of the electric field remains the same.
(C) the electric potential increases continuously.

18. In each situation of column-I some changes are made to a charged capacitor under conditions of constant potential difference or constant charge. Condition of constant potential difference means that the a cell is connected across the capacitor and condition of constant charge means that the capacitor is isolated. Match the conditions in column-I with corresponding results in column-II.

Column-I
(A) For a capacitor maintained at constant potential difference, the separation between plates is increased
(B) For a capacitor maintained at constant charge, the separation between the plates is increased.
(C) For a capacitor maintained at constant potential difference, area of the both the plates is doubled.
(D) For a capacitor maintained at constant charge, area of both plates is doubled.

Column-II
(P) Then electric field inside the capacitor decreases in comparison to what it was before the charge.
(Q) Then electric field inside the capacitor remains same.
(R) Then potential energy stored in the capacitor decreases in comparison to what it was before

the change.

(S) The potential energy stored in the capacitor increases in comparison to what it was before the change.

Codes:

(A) P-2,3	Q-3	R- 3	s- 1,4
(B) P-3	Q-1	R- 3	s- 4
(C) P-2,3	Q-1,4	R- 2,3	s- 2,3
(D) P-1,3	Q-2,4	R- 2,4	s- 1,3

Assertion- Reason Type

(A) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for statement-1

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for statement-1

(C) Statment-1 is True, Statement -2 is false

(D) Statement-1 is False, Statement-2 is True

19. Statement -1 : A capacitor can be given only a limited quantity of charge

Statement -2 : The capacity of a capacitor is inversely proportional to the distance between the plates.

(A) A (B) B (C) C (D) D

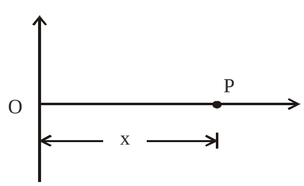
20. Statement -1 : Capacity of a parallel plate capacitor increases when distance between the plates is decreased.

Statement -2 : Capacitance of capacitor is inversely proportional to distance between them.

(A) A (B) B (C) C (D) D

Comprehension Type (One Option Correct)

COMPREHENSION



The electric potential at point P is

$$V=1.8\times10^4\left[\frac{8}{\sqrt{\frac{27}{2}+x^2}}-\frac{1}{\sqrt{\frac{3}{2}+x^2}}\right]$$

21. The expression for electric field is

(A) $1.8\times10^4 x\left[8\left(\frac{27}{2}+x^2\right)^{-3/2}-\left(\frac{3}{2}+x^2\right)^{-3/2}\right]$

(B) $\frac{1.8\times10^4}{x^3}\left[8\left(\frac{27}{2}+x\right)^{1/2}-\left(\frac{3}{2}+x\right)^{1/2}\right]$

(C) $\frac{1.8\times10^4}{x}\left[8\left(\frac{27}{2}+x^2\right)^{-1/2}-\left(\frac{3}{2}+x^2\right)^{-1/2}\right]$

(D) None of these

22. A particle of mass 6×10^{-4} kg and charge 0.1 μC moves

The least value of v_0 for which the particle will cross the origin is

(A) 1 m/s (B) 2 m/s (C) 3 m/s (D) 4 m/s

23. The kinetic energy of the origin for least value of v_0 is

(A) 3×10^{-4} J (B) 5×10^{-4} J

(C) 10 Joule (D) 2.7×10^{-4} J

24. At x = 0, the particle is

(A) in stable equilibrium (B) in unstable equilibrium

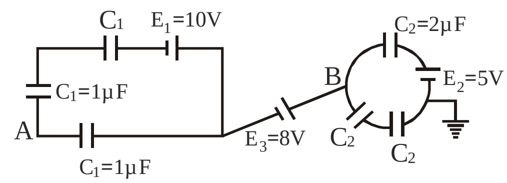
(C) not in equilibrium (D) in neutral equilibrium

25. At $x=\pm\sqrt{5/2}$ the particle is

(A) in stable equilibrium (B) in unstable equilibrium

(C) in neutral equilibrium (D) not in equilibrium

26. In the circuit shown in fig., cells are ideal. Find the magnitude of potentials of points A.

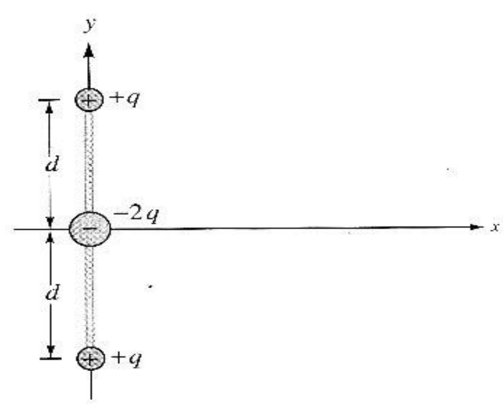


27. Two point charges each carrying a positive charge of 5e are seperated by a distance 2d. An electron describes a circular path due to the attaraction of the charges in a plane bisecting perpendicularly the line joining the two point charges. If the radius of the circular path described by the electron is R. The orbital speed of the electron

is $Re\sqrt{\frac{n}{2® m£_0\left(R^2+d^2\right)^{3/2}}}$. Find the value of n.

28. A charge distribution consisting of three point charges q, -2q, and q located along the y- axis as shown in figure is called an electric quadrupole. Electric field on x-axis at distance x (x >> d) is

$E=\frac{1}{4®£_0}\frac{nqd^2}{x^4}\hat{i}$. Find the value of n.



Subjective Type

29. A particle of charge q and mass m moves rectilinearly under the action of an electric field E = A – Bx where B is a + ve constant and x is a distance from the point where the particle was initially at rest. Calculate

(a) Distance travelled by the particle till it comes to rest and

(b) Acceleration at that moment.

30. The separation between the plates of a charged parallel-plate capacitor is increased. Which of the following quantities will change?

(A) charge on the capacitor

(B) potential difference across the capacitor

(C) energy of the capacitor

(D) energy density between the plates.

31. A very small earthed conducting spherre is at a distance 'a' from a point charge '$+q_1$' and at a distance b from a point charge '$+q_2$' (a < b). At a certain instant, the sphere starts expanding so that its radius grows according to law R = vt. Assuming that the point charges and the centre of the sphere are at rest, and in due time the initial point charges get into the expanding sphere without touching it (through small hole). Determine the time dependence current 'I' through earthing wire.

(A) $I = V\left(\frac{q_1}{a} + \frac{q_2}{b}\right)$ for t < $\frac{q}{v}$

(B) $I = V\left(\frac{q_1}{a} + \frac{q_2}{b}\right)$ for all the values of t.

(C) $I = 0 \, , t \geq \frac{b}{v}$

(D) $I = \frac{q_2 v}{b}$ for $\frac{q}{v} \leq t \leq \frac{b}{v}$

32. A spherical gaussian surface surrounds a point charge 'q'.

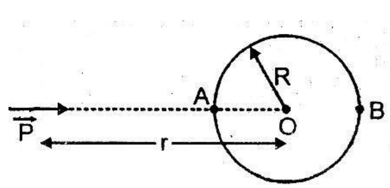
(A) flux through surface tripled, if charge is tripled

(B) Electric flux becomes double if volume is doubled

(C) Electric flux does not change if the gaussian sur face is changed to a cube.

(D) Eletric flux through the spherical gaussain sur face does not change if the charge is moved to an other location inside the gaussain surface.

33. An ideal dipole of dipole moment $\vec{p}$ is placed in fornt of an uncharged conducting sphere of radius R as shown



(A) The potential at point A is $\frac{KP}{(r - R)^2}$

(B) The potential at point A is $\frac{KP}{r^2}$

(C) The potential due to dipole at point B is $\frac{KP}{(r + R)^2}$

(D) The potential due to dipole at point B is $\frac{KP}{r^2}$

34. **Column I**

(P) Spherical charged conductor

(Q) Spherical conductor having uniform volume distribution of charge

(R) Charged ring

(S) Infinite sheet of charge

Column II

(1) At the surface electric field is continuous and maximum

(2) At the surface electric field is discontinuous.

(3) Electric field is uniform

(4) At the centre electric field is zero

Codes:

(A) P-1 Q-2 R- 2 S-2

(B) P-2,4 Q-1,4 R- 4 S-3

(C) P-2 Q-1 R- 4 S-3

(D) P-2 Q-1 R- 1 S-2

35. Referring to Fig.match Column-I with Column - II :

Column-I

(P) Capacitor 5C in Fig. A

(Q) Capacitor 1.5 C in Fig. B

(R) Capacitor 8C in Fig. C

(S) Capacitor 2C in Fig. C

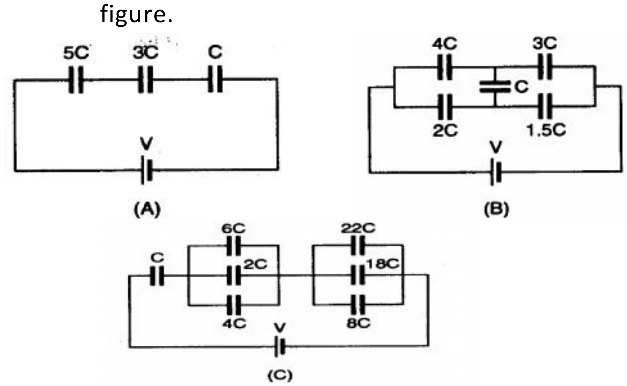
Column-II

(1) Potential difference across no other capacitor in the given figure is more than the potential difference across this capacitor

(2) Potential difference across no other capacitor in the given figure is less than the potential difference across this capacitor

(3) No other capacitor in the given figure stores an amount of charge smaller than that stored in this capacitor

(4) Charge in this capacitor is more than the charge in any other capacitor in the given figure.



Codes:

(A) P-1 Q-2 R- 1 S-2

(B) P-3 Q-1 R- 2 S-4

(C) P-2,3 Q-1 R- 2,3 S-2,3

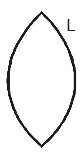
(D) P-4 Q-4 R- 4 S-3

Assertion- Reason Type

(A) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for statement-1
(C) Statment-1 is True, Statement -2 is false
(D) Statement-1 is False, Statement-2 is True

36. **Statement -1 :** When a thin transparent sheet is placed infront of one of the slits in Young's double slit experiment, the fringe of zero order shifts to some other position.
Statement -2 : On placing a thin transparent sheet infront of a slit, the position of zero path difference on the screen changes.

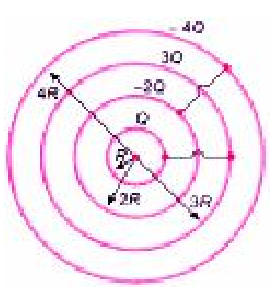
37. **Statement - 1 :** A lens L (shown in the figure) and kept in a surrounding medium X has a power + 10 D. If the same lens is kept in a surrounding medium Y, its power is found to be +12.5 D. Also if the same lens is placed in a surrounding medium Z, its power is now measured to be – 3.5 D; then $m_Z > m_X > m_Y$.
Statement - 2 : In different surroundings, power of a given lens has different values but the same sign.



Comprehension Type (One Option Correct)

COMPREHENSION

Four concentric hollow spheres of radii R, 2R, 3R and 4R has given the charges as shown in figure. Then, the conductors 1 and 3, 2 and 4 are connected by conducting wires (both the connections are mode at the same time).



38. The charge on inner surface of 3rd conductor, is
(A) –6Q/5 (B) 6Q/5 (C) –2Q (D) +2Q

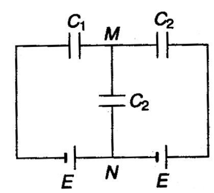
39. the charge on 4th conductor, is
(A) $+\frac{22Q}{5}$ (B) $+\frac{11Q}{3}$ (C) $-\frac{11Q}{3}$ (D) $-\frac{22Q}{5}$

40. The potential of Conductor 1, is
(A) $\frac{3Q}{40®£_0R}$ (B) $-\frac{19Q}{40®£_0R}$
(C) $-\frac{3Q}{40®£_0R}$ (D) $\frac{19Q}{40®£_0R}$

41. The potential of Conductor 2, is
(A) $-\frac{Q}{8®£_0R}$ (B) $\frac{Q}{8®£_0R}$
(C) $\frac{Q}{32®£_0R}$ (D) $-\frac{Q}{32®£_0R}$

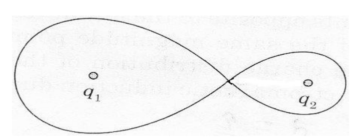
42. A circular leaf of gold of radius b is laid on the surface of a charged conducting sphere of radius 'a' (b<<a) and charge 'Q'. The decrease in energy of sphere after removing the leaf $\frac{Q^2b^2}{2n®£_0a^3}$. Find the value of n.

43. The potential difference between points M and N of the system shown in figure is 11n volt. If the emf is equal to E = 110 volts and the capacitance ratio $\frac{C_2}{C_1}$ is 2, then the value of n is



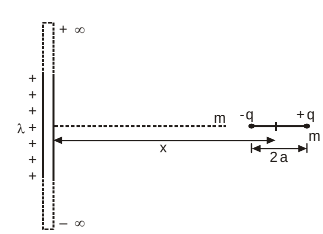
44. Two charge particles of opposite sign and magnitude Q each are projected directly away from each other with the same speed $\left(\frac{3Q^2}{32®£_0mr}\right)^{1/2}$ where r is the initial distance between the particles. Their masses are m and 2m. The maximum distance between them is nr. Find the value of n.

45. Two point like charges $q_1 = 4.0nC$ and $q_2 = 1.0nC$ are fixed in free space. At every point on the curve shown, the net electrostatic potential V created by these charges is 900 volts. Find the seperation r between the charges.



Subjective Type

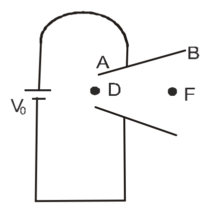
46. In the figure shown,an electric dipole is placed at a distance x from an infinitely long rod of linear charge density λ.



(a) Find the net force acting on the dipole.
(b) What is the work done in rotating the dipole through 180°.

(c) If the dipole is slightly rotated about its equilibrium position, find the time period of oscillation. Assume that the dipole is linearly re - strained.

47. In the given figure, a capacitor of non-parallel plates is shown. The plates of capacitor are connected by a cell of emf V_0. If ± denotes surface charge density and E denotes electric field, then:



(A) $\pm_A > \pm_B$ (B) $E_F > E_D$

(C) $E_F = E_D$ (D) $\pm_A = \pm_B$

48. A charge is distributed with a density ª over the length L along a radius vector drawn from the point where a point charge q is located. The distancebetween q and the nearest point on linear charge is R. The electrical force experienced by the linear charge due to q is :

(a) $\frac{q ª L}{4®£_0 R^2}$ (b) $\frac{q ª L}{4®£_0 R(R+L)}$

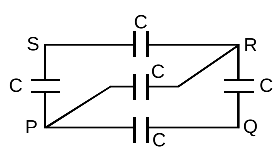
(c) $\frac{q ª L}{4®£_0 RL}$ (d) $\frac{q ª L}{4®£_0 L^2}$

49. For circuit shown equivalent capacitance between S and Q is :

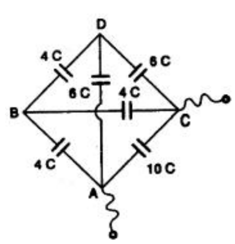
(A) C

(B) C/2

(C) 2C (D) 3C/2

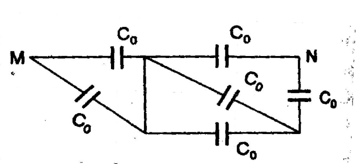


50. The equivalent capacitance between the points A and C is given by :



(A) $\frac{10}{3}$ C (B) 15C (C) $\frac{3}{10}$ C (D) 20 C

51. The equivalent capacitance between points M and N is

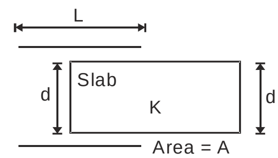


(A) $\frac{10}{11} C_0$ (B) $2C_0$ (C) C_0 (D) none

52. Inside two identical capacitors, two identical dielectric slabs are introduced as shown in figure. What will happen, if slab of capacitor B is pulled out, with the battery remain connected?

(A) During the process charge flows a to b.
(B) Finally charge on B will be less than charge on A
(C) During the process work done by external force F appear as heat in the circuit.
(D) None of the above.

53. Between the plates of parallel plate capacitor, a dielectric slab of dielectric constant K is inserted. Plates have area A and distance between the plate is d and charge on the plate is Q. If the inserted length is x and the edge effect is ignored then the force on the slab is: (Given : $C_0 = £_0 A/d$)



(A) attractive and equal to $\frac{Q}{2C_0 L}(K-1)$

(B) repulsive and equal to $\frac{Q}{2C_0 L}(K-1)$

(C) attractive and equal to $\frac{Q^2}{2C_0 L} \times \frac{(K-1)}{\left[1+\frac{x}{L}(K-1)\right]^2}$

(D) repulsive and equal to $\frac{Q^2}{2C_0 L} \times \frac{(K-1)}{\left[1+\frac{x}{L}(K-1)\right]^2}$

54. Two concentric metallic shells of radius R and IR. out of which the inner shell is having charge Q and outer shell is uncharged. If they are connected with a conducting wire, then:

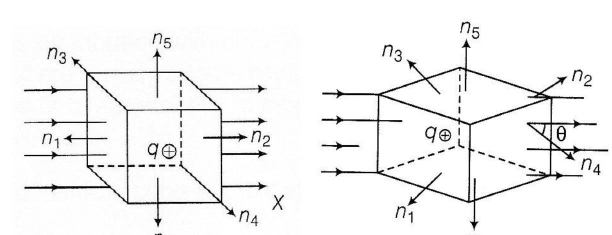
(a) Q amount of charge flow from inner to outer shell

(b) $\frac{Q}{e}$ number of electrons flow from outer to inner shell where $e = 1.6 \times 10^{-19} C$ (ABC)

(c) $\frac{KQ^2}{4R}$ amount of heat is produced in the wire

(d) $\frac{KQ^2}{2R}$ amount of heat is produced in the wire

55. An imaginary cube of side a is in region of uniform electric field E. The cube is then truned by angle ¯ about a vertical axis. Correct options are



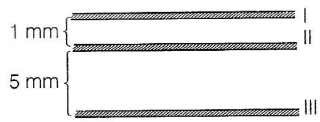
(A) flux through surface 1 $\phi_{E_1} = -Ea^2\cos\theta$

(B) flux through surface 2 $\phi_{E_2} = Ea^2\cos\theta$

(C) flux through surface 3 $\phi_{E_3} = 0$

(D) flux through surface 4 $\phi_{E_4} = Ea^2\sin\theta$

56. Three large, thin and charged sheets are placed parallel to each other. Surface I has a charge density of 6.5n C/m^2 and surface II has a charge density of -2.0n C/m^2 and surface III has a charge density of 5.0n C/m^2. Then,



(A) the net field between I and II is zero
(B) the net field between II and III is zero
(C) sheet I experiences a force of $1.1\times10^{-6}\ N/m^2$
(D) sheet II experiences a force of $1.7\times10^{-7}\ N/m^2$

57. An electric dipole of dipole moment p and moment of inertia I is placed in an uniform electric field E. It displaced by some angle θ and released, then
(A) dipole soon acquires its stable equilibrium position
(B) dipole undergoes SHM if θ is small, releasing oscillation energy into heat and acquires stable equilibrium position
(C) time period of oscillation does not depends on mass of dipole
(D) frequency of dipole is inversely proportional to $\sqrt{I}$.

58. Three capacitors each of 6 μF are avilable then,

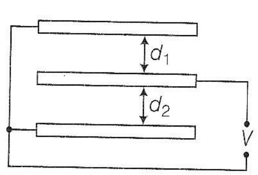
(A) minimum capacity obtained is 3 μF

(B) minimum capacity obtained is 2 μF

(C) maximum capacity obtained is 12 μF

(D) maximum capacity obtained is 18 μF

59. Three conducting plates, each of area A are connected as shown in figure:



(A) If the middle plate, can be moved (changing the values, of d_1 and d_2), the minimum capacitance will be $\dfrac{4\varepsilon_0 A}{d_1+d_2}$

(B) The total capacitance will be $\dfrac{\varepsilon_0(d_1+d_2)}{(d_1d_2)}$

(C) Both capacitors have their low voltage plates at the same potential (the outer plates) which are connected

(D) Both capacitors have their high voltage plates at the same potential (the middle plates) which are connected

60. Match the information given in Column I with Column II and mark the correct code given below

Column - I

(P) For an infinitely long line charge, electric field at a distance r from the line is

(Q) For a uniformly charged non-conducting sphere electric field at a distance r from centre is (R = radius of sphere)

(R) A spherical charged conductor of radius R, with a concentric cavity of radius R/2, electric field at a distance r from the centre is

(S) A spherical charged conductor of radius R, with a cavity of radius R/2, has a point charge q (q > 0) at its centre. Electric field at a distance r from the centre is

Column - II

(1) inversely proportional to r^2 when r < R/2

(2) radially outward and inversely proportional to r

(3) inversely proportional to r^2 when r > R.

(4) increases with r, reaches a maximum, then decreases.

Codes:

	(i)	(ii)	(iii)	(iv)
(A)	q	s	r	p
(B)	s	q	r	p
(C)	q	s	p	r
(D)	q	r	s	p

61. If we have N-different charges in space, then potential energy of system can be calculated by summing all pairs. Now, consider a cube of side a with a charge -e at each of its corner and a charge +2e at its centre. Match the Column I with Column II.

Column - I

(i) PE of charge pairs which are at a distance a.

(ii) PE of charge pairs which are at a distance $\sqrt{3/2}$ a.

(iii) PE of charge pairs which are at a distance $\sqrt{2}$ a.

(iv) PE of charge pairs which are at a distance $\sqrt{3}$ a.

Column - II

(p) - 18.475 ke^2/a

(q) 12 ke^2/a

(r) 8.485 ke^2/a

(s) 2.309 ke^2/a

Codes:

	(i)	(ii)	(iii)	(iv)
(A)	p	q	r	s
(B)	q	p	r	s

(C) p q s r
(D) s r p q

Assertion- Reason Type

(A) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for statement-1
(C) Statment-1 is True, Statement -2 is false
(D) Statement-1 is False, Statement-2 is True

62. **Statement -1 :** Field of a infinite length charged wire can be found using Gauss` law.
Statement -2 : As wire of a cylinderical shape, Gauss` surface chosen will also be cylinderical.
(A) A (B) B (C) C (D) D

63. **Statement -1 :** Electric field decays at same rate for a dipole as for a point charge.
Statement -2 : Electric field varies in inverse proportion to square fo distance from a charge.
(A) A (B) B (C) C (D) D

Comprehension Type (One Option Correct)

COMPREHENSION

Two fixed charges -2Q and Q are located at the points (-3a, 0) and (+3a, 0) in the XOY plane.

64. Locus of all the points with V = 0 in XY - plane
(A) is a straight line of slope 4a
(B) is a circle of radius 4a
(C) is an ellipse of semi-major axis 4a.
(D) is a parabola with focal length 4a.

65. If a particle with charge +q is released at point (5a, 0), then it
(A) oscillates between points (a, 0) and (9a, 0)
(B) crosses the point (9a, 0)
(C) remains stationary at (5a, 0)
(D) rotates in a circle of radius 2a

66. Potential function V(x) due to the charges
(A) does not have any minima for x > 9a
(B) does not have any minima at a
(C) have a maxima at x = a
(D) have a minima at x = a

COMPREHENSION

A sensor to find liquid level in a tank is a cylindrical capacitor of length with outer and inner conductor radii R_0 and R_i respectively. When a liquid fills the tank up to height h, (h $\leq l$), from tank`s bottom the dielectric in lower part is liquid (k_l) and dielectric in upper part is vapour of liquid (k_v)

67. When liquid fills the tank up to height h, the capacity of capacitor is

(A) $\frac{2®£_0 l}{\ln(R_0 l R_i)}\left\{(k_l - k_v)\frac{h}{l} + k_v\right\}$

(B) $\frac{2®£_0 l}{\ln(R_0 l R_i)}\left\{(k_v - k_l)\frac{h}{l} + k_l\right\}$

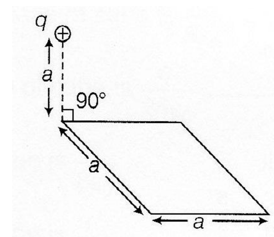
(C) $\frac{2®£_0 l}{\ln(R_i l R_0)}\left\{(k_v + k_l)\frac{h}{l} + k_v\right\}$

(D) $\frac{2®£_0 l}{\ln(R_i l R_0)}\left\{(k_v - k_l)\frac{h}{l} + k_v\right\}$

68. If l = 2m, R_0 = 5mm, R_i = 4.5 mm, k_l = 1.4, k_v = 1.0. Then, capacitance of capacitor when tank is fully filled is
(A) $4.5\times10^{-9}F$ (B) $7.5\times10^{-9}F$
(C) $3.5\times10^{-9}F$ (D) $1.5\times10^{-9}F$

69. Value of capacitance of capacitor when tank is completely empty is
(A) $2.5\times10^{-9}F$ (B) $3.5\times10^{-9}F$
(C) $1\times10^{-9}F$ (D) $1.1\times10^{-9}F$

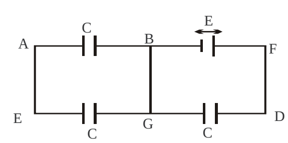
70. A charge q is placed just a distance above a square sheet of size a $\times$ a as shown below.



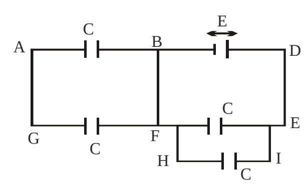
If flux through the square is $\frac{q}{k£_0}$, find $\frac{k}{6}$

Subjective Type

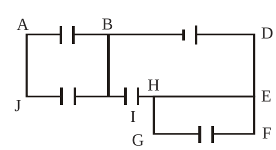
71. Calculate the potential difference across D and G plates.



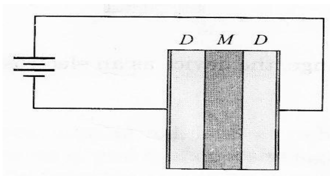
72. What is the equivalent capacitance of the system ?



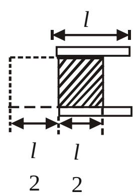
73. What is the charge and potential difference across **I** capacitor ?



74. Plates of a parallel plate capacitor have area A and distance between them is d. Potential difference V between them is maintained by a battery. Two identical dielectric slabs (D) and a metal slab (M) each of equal thickness are inserted in the capacitor as shown in the figure. Relative permittivity of each of the dielectric slab is $£_r$. Find expression for modulus of the force of electrostatic interaction on either of the plates.



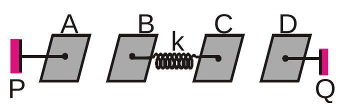
75. A capacitance C is charged by a battery of emf V and then disconnected. The work done by an external agent to insect a dielectric of dielectric strength k of half the length of the capacitor is



(A) $\frac{1}{2}CV^2\left(\frac{k-1}{k+1}\right)$ (B) $\frac{1}{2}CV^2\left(\frac{1-k}{k+1}\right)$

(C) $\frac{1}{4}CV^2(k-1)$ (D) $\frac{1}{4}CV^2(1-k)$

76. Four identical conducting plates are placed parallel to each other at equal separation as shown below :



Plates A and B are fixed while B and D are connected with the help of a conducting spring of spring constant k. Initially, the spring is in relaxed posiion and B and C are at rest, now the spring is compressed slightly by displacing B and C and then plates B and C are released to perform SHM. Now the capacitance of the system across PQ [Mass of each plates is m]

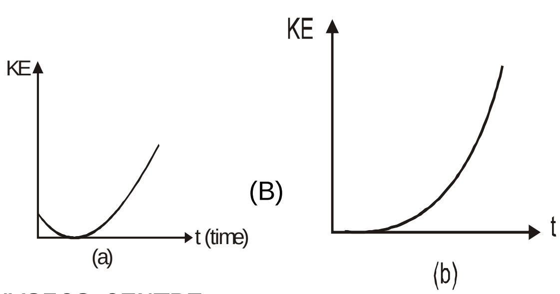
(A) remains constant (B) increases continuously

(C) decreases continuously

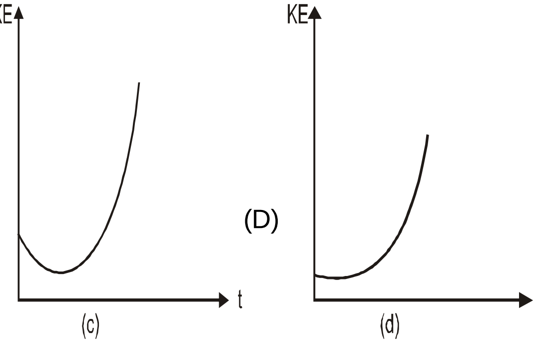
(D) is varying sinusoidally with frequency $\frac{1}{2®}\sqrt{\frac{2k}{m}}$

77. An electron is either released from rest or projected with some initial velocity in a uniform electric field. Neglect any other force on the electron apart from electrostatic force. Which of the graphs shown in fig could possibly represent the change in kinetic energy of the electron during its course of motion ? Explain the situation in each case.

(A) (B)



(C) (D)



78. Draw electric field lines for charge distributions given below-

(A) Two equal point charges placed at a separation.

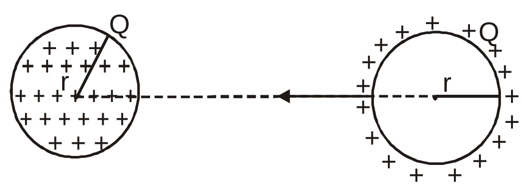
(B) Two point charges 2q and $-q$ placed at a separation.

(C) Three point charges, each equal to +q placed at the vertices of an equilateral triangle.

79. There is a ball of radius r having uniformly distributed volume charge Q on it and there is a spherical shell of radius r having uniformly distributed surface charge Q on it. The two spheres are far apart.

(A) A point charge q is moved slowly from the centre of the shell (through a small hole in it.) to the centre of the ball. Find work done by the external agent in the process.

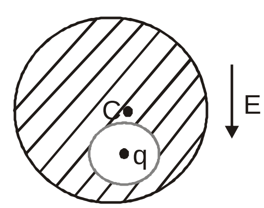
(B) The two sphere are brought closer so that their centers are separated by 4r. Now calculate the amount of work needed in slowly moving a point charge q from the centre of the shell to the centre of the ball. Assume that charge on one ball does not alter the charge distribution of the other. Does your answers in (A) and (B) differ ? Why ?



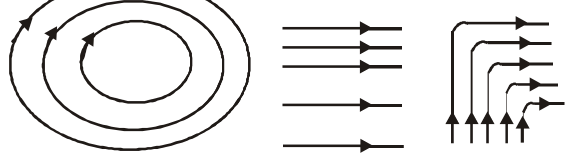
80. A neutral spherical conductor has a cavity. A point charge q is located inside it. It is in equilibrium. Anexternal electric field (E) is switched on that is directed parallel to the line joining the centre of the sphere to the point charge.

(A) What is the direction of acceleration of the charge particle inside the cavity after E is switched on.

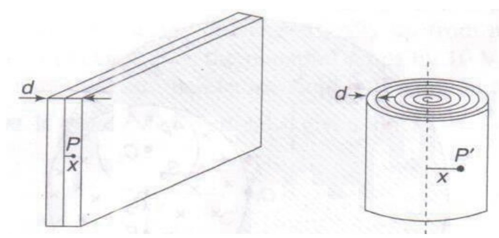
(B) How is the induced charges on the wall of the cavity affected due to the external field.



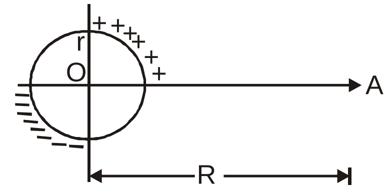
81. There configuration of electrostatic field lines have been shown in the figure. Are these configuration possible. Explain your answer.



82. A non conducting sheet of thickness d and large surface area contains a uniformly distributed charges of density ρ throughout its volume. The electric field at a point P inside the sheet at a distance x from the central plane is E_1. Now the sheet is rolled to form a large solid cylinder. Field at a point P' inside the cylinder at a distance x from its axis is E_2. Find the ratio $\frac{E_1}{E_2}$



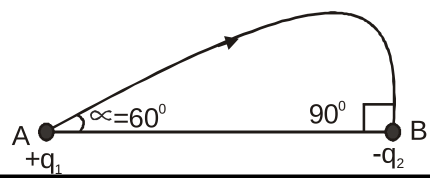
83. A ring of radius r has a uniformly spread charge +q on quarter of its circumference. The opposite quarter of the ring carries a charge $-q$ uniformly spread over it. Find the electric potential at a point A shown in the figure. Point A is at a distance R (>> r) from the centre of the ring.



84. Two point charges + q_1 and - q_2 are placed at A and B respectively. An electric line of force emerges from q_1 making an angle $\theta = 60°$ with line AB and terminates at - q_2 making an angle of $90°$ with the line AB.

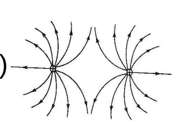
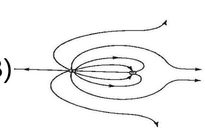
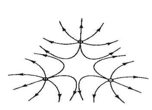
(A) Find $\left|\frac{q_1}{q_2}\right|$

(B) Find the maximum value of angle θ at which a line emitted from q_1 terminates on charge q_2.



ANSWER—KEY

1. (C) **2.** (D) **3.** (C) **4.** (A) **5.** (C) **6.** (A) **7.** (D) **8.** (B) **9.** (A) **10.** (B) **11.** (AC) **12.** (BCD) **13.** (ACD) **14.** (AD) **15.** (BD) **16.** (ACD) **17.** (BC) **18.** (D) **19.** (B) **20.** (A) **21.** (A) **22.** (C) **23.** (D) **24.** (A) **25.** (B) **26.** (8) **27.** (5) **28.** (3) **29.** $x = 0, x = \frac{2A}{B}, a = -\frac{qA}{n}$ **30.** (BC) **31.** **(ACD)** **32.** **(ACD)** **33.** **(BC)** **34.** (B) **35.** (C) **36.** (A) **37.** (C) **38.** (B) **39.** (D) **40.** (C) **41.** (A) **42. n =** 8 **43. n =** 2 **44.** n = 2 **45.** 9.0 cm **46.** $\frac{-\lambda q a}{\pi \varepsilon_0 x^2}, \frac{2\lambda q a}{\pi \varepsilon_0 x}, \sqrt{\frac{8\lambda^3 \varepsilon_0 m a x}{\lambda q}}$ **47.** (A) **48.** (B) **49.** (A) **50.** (B) **51.** (A) **52.** (A) **53.** (C) **54.** (ABC) **55.** (ABD) **56.** (CD) **57.** (BD) **58.** (BD) **59.** (AC) **60.** (A) **61.** (B) **62.** (A) **63.** (D) **64.** (B) **65.** (B) **66.** (B) **67.** (A) **68.** (D) **69.** (D) **70.** 4 **71.** E **72.** 2C **73.** CE, E **74.** $F = \frac{1}{2}\varepsilon_0 A\left(\frac{3\varepsilon_r V}{2d}\right)^2$ **75.** [B]

76. [D] 77. All graph are possible **78.** (A)  (B)  Field lines will appear to be radial at a large distance (C)  **79.** For both (a) and (b) $W = \frac{Qq}{8\pi\varepsilon_0 r}$ **80.** (A) No acceleration (B) Not affected **81.** None of the configurations are possible **82.** 2 : 1 **83.** $V = \frac{qr}{\pi^2\varepsilon_0 R^2}$ **84.** (A) $\left|\frac{q_1}{q_2}\right| = \frac{2}{1}$ (B) $\theta_{max} = 90°$