ELECTROSTATICS

1. **The plates of a parallel plate capacitor are charged upto 200 volts. A di-electric slab of thickness 4mm is inserted between the plates. Then to maintain the same potential difference between the plates of the capacitor, the distance between the plates is increased by 3.2mm. The di-electric constant of di-electric slab is**

   1) 1 2) 4 3) 5 4) 6

2. **Two unit negative charges are placed on a straight line. A positive charge q is placed exactly at the midpoint between these unit charges. If the system of these three charges is in equilibrium, the value of q (in C) is**

   1) 1.0 2) 0.75 3) 0.5 4) 0.25

3. **A body of mass 1 gm and carrying a charge $10^{-8}C$ passes from the point P to Q which one at electric potentials 600 V and 0V respectively. The velocity of the body at Q is 20 cm/sec. Its velocity in m/sec at 'P' is...**

   1. $\sqrt{0.028}$ 2. $\sqrt{0.056}$ 3. $\sqrt{0.56}$ 4. $\sqrt{5.6}$

4. **A charge of $1\mu C$ is divided into two parts such that their charges are in the ratio of 2: 3. These two charges are kept at a distance 1m apart in vaccum. Then, the electric force between them (in newton) is**

   1) 0.216 2) 0.00216 3) 0.0216 4) 2.16

5. **Along the x-axis, three charges $\frac{q}{2}, -q$ and $\frac{q}{2}$ are placed at x = 0, x =a and x =2a respectively. The resultant electric potential at a point 'P' located at a distance r from the charge -q $(a << r)$ is**
   ($\in_0$ is the permittivity of free space)

   1) $\frac{qa}{4\pi\in_0 r^2}$ 2) $\frac{qa^2}{4\pi\in_0 r^3}$ 3) $\frac{q\left(\frac{a^2}{4}\right)}{4\pi\in_0 r^3}$ 4) $\frac{q}{4\pi\in_0 r}$

6. **Two point charges –q and +q are located at points (0, 0-1) and (0, 0, a) respectively. The electric potential at a point (0, 0, z), where z >a is**

   1) $\frac{qa}{4\pi\in_0 z^2}$ 2) $\frac{q}{4\pi\in_0 a}$ 3) $\frac{2qa}{4\pi\in_0 \left(z^2-a^2\right)}$ 4) $\frac{2qa}{4\pi\in_0 \left(z^2+a^2\right)}$

7. **The bob of a simple pendulum is hanging vertically down from a fixed identical bob by means of a string of length *l*. If both bobs are charged with a charge 'q 'each, time period of the pendulum is (ignore the radii of the bobs)**

1) $2\pi\sqrt{\dfrac{l}{g+_{-}\left(\dfrac{q^2}{l^2m}\right)}}$ 2) $2\pi\sqrt{\dfrac{l}{g-\left(\dfrac{q^2}{l^2m}\right)}}$ 3) $2\pi\sqrt{\dfrac{l}{g}}$ 4) $2\pi\sqrt{\dfrac{l}{g-\left(\dfrac{q^2}{l^2m}\right)}}$

8. **A 20F capacitor is charged to 5V and isolated. It is then connected in parallel with an uncharged 30F capacitor. The decrease in the energy of the system will be**

1. 25J 2. 100J
3. 125J 4. 150J

9. **An infinite no.of electric charges each equal to 5 nano coulombs are placed along X-axis at x = 1 cm, x = 2cm, x = 4cm, x=8cm… and so on. In this setup, if the consecutive charges have opposite sign, then the electric field in newton/coulomb at x = 0 is**

1) 12×10^4 2) 24×10^4 3) 36×10^4 4) 48×10^4

10. **An infinitely long thin straight wire has uniform linear charge density of 1/3 coul.m^{-2}. Then the magnitude of the electric intensity at a point 18 cm away is: (given** $\in_0 = 8.0\times10^{-12}C^2/N-m^2$

1) $0.33\times10^{11}NC^{-1}$ 2) $3\times10^{11}NC^{-1}$ 3) $0.66\times10^{11}NC^{-1}$ 4) $1.32\times10^{11}NC^{-1}$

11. **Three point charges 1C, 2C, -2C are placed at the vertices of an equilateral triangle of side one metre. The work done by an external force to increase the separation of the charges 2 metres in joules is**

1) $\dfrac{1}{4\pi\in_o}$ 2) $\dfrac{1}{8\pi\in_o}$ 3) $\dfrac{1}{16\pi\in_o}$ 4) 0

12. **In a parallel plate capacitor, the capacitance**

1. increases with increase in the distance between the plates
2. decreases if a dielectric material is put between the plates
3. increases with decrease in the distance between the plates
4. increases with decrease in the area of the plates

13. A parallel plate capacitor of capacity C_0 is charged to a potential V_0.

A) The energy stored in the capacitor when the battery is disconnected and the plate separation is doubled is E_1

B) The energy stored in the capacitor when the charging battery is kept connected and the separation between the capacitor plates is doubled is E_2. Then $\frac{E_1}{E_2}$ value is

1) 4 2) $\frac{3}{2}$ 3) 2 4) $\frac{1}{2}$

14. The time in seconds required to produce a P.D at 20V across a capacitor at $1000\ \mu F$ when it is charged at the steady rate of $200\ \mu C/\sec$ is......

1. 50
2. 100
3. 150
4. 200

15. Two charges q and -q are kept apart. Then at any point on the perpendicular bisector of line joining the two charges

1) the electric field strength is zero

2) the electric potential is zero

3) both electric potential and electric field strength are zero

4) both electric potential and electric field strength are non-zero

16. There is a uniform electric field of strength $10^3 V/m$ along y-axis. A body of mass 1 g and charge $10^{-6} C$ is projected into the field from origin along the positive x-axis with a velocity 10 m/s. Its speed in m/s after 10s is (neglect gravitation)

1. 10 2. $5\sqrt{2}$ 3. $10\sqrt{2}$ 4. 20

17. If the charge on a body is increased by 2C, the energy stored in it increases by 21%. The original charge on the body in coulombs is

1. 10
2. 20
3. 30
4. 40

18. Two charges 2C and 6C are separated by finite distance. If a charge of -4C is added to each of them. The initial force of 12×10^3N will change to

1) 4×10^3N repulsion
2) 4×10^2N repulsion
3) 6×10^3N attraction
4) 4×10^3N attraction

19. **Two electric charges of $9\mu C$ and $-3\mu C$ are placed 0.16m apart in air. There will be a point P at which electric potential is zero on the line joining the two charges and in between them. The distance of P from $9\mu C$ charge is**

1. 0.14m 2.0.12m
3. 0.08m 4.0.06m

20.. **A $4\mu F$ capacitor is charged by a 200V battery. It is then disconnected from the supply and is connected to another uncharged 2 μF capacitor. During this process, Loss of energy (in J) is:**

1) Zero 2) 5.33×10^{-2} 3)4×10^{-2} 4) 2.67×10^{-2}

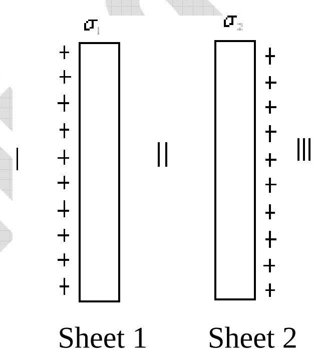
21. **A charged particle of mass $5\times10^{-6}kg$ is held stationary in space by placing it in an electric field of strength $10^6 N/C$ directed vertically downwards. The charge on the particle is**

1. $-20\times10^{-5}\mu C$ 2. $-5\times10^{-5}\mu C$ 3. $5\times10^{-5}\mu C$ 4. $20\times10^{-5}\mu C$

22. **Electric charges of $1\mu C, -1\mu C$ and $2\mu C$ are placed in air at the corners A, B and C respectively of an equilateral triangle ABC having length of each side 10 cm. The resultant force on the charge at C is** $\left(\frac{1}{4\pi\in_0}=9\times10^9 N-m^2/c^2\right)$

1. 0.9N 2. 1.8N
3. 2.7N 4. 3.6N

23. **Two parallel plane sheet 1 and 2 carry uniform charge densities σ_1 and σ_2, as shown in the figure. The magnitude of the resultant electric field in the region marked I is** $(\sigma_1>\sigma_2)$



1) $\frac{\sigma_1}{2\in_0}$ 2) $\frac{\sigma_2}{2\in_0}$ 3) $\frac{\sigma_1+\sigma_2}{2\in_0}$ 4) $\frac{\sigma_1-\sigma_2}{2\in_0}$

24. **Two unit negative charges are placed on a straight line. A positive charge 'q' is placed exactly at the mid-point between these unit charges. If the system of three charges is in equilibrium the value of 'q' (in C) is**

1) 1.0 2) 0.75 3) 0.5 4) 0.25

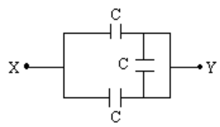
25. **A charge q is placed at the mid-point of the line joining two equal charges each of Q. If the whole system is in equilibrium, then the value of q is**

1) $-\frac{Q}{2}$ 2) $+\frac{Q}{2}$ 3) $-\frac{Q}{4}$ 4) $+\frac{Q}{4}$

26. **A charge 'Q' is placed at each corner of a cube of side 'a'. The potential at the centre of the cube is**

1) $\frac{4Q}{3\in_0 a}$ 2) $\frac{4Q}{\sqrt{3}\in_0 a}$ 3) $\frac{4Q}{\sqrt{3}\pi\in_0 a}$ 4) 0

27. **The equivalent capacity between the points X and Y in the circuit with** $C = 1\mu F$



1) $2\mu F$ 2) $3\mu F$ 3) $1\mu F$ 4) $0.5\mu F$

28. **Three charges** $1\mu C, 1\mu C$ **, and** $2\mu C$ **are kept at the vertices A, B and C of an equilateral triangle ABC of 10cm side, respectively. The resultant force on the charge at C is**

1) 0.9 N 2) 1.8 N 3) 2.72 N 4) 3.12 N

29. **The electrical potential on the surface of a sphere of radius 'r' due to a charge** $3\times10^{-6}C$ **is 500V. The intensity of electric field on the surface of the sphere is**

$\left[\frac{1}{4\pi\varepsilon_0} = 9\times10^9 Nm^2C^{-2}\right]\left(in\ NC^{-1}\right)$

1) <10 2) >20 3) Between 10 and 20 4) <5

30. **A parallel plate capacitor with air as dielectric is charged to a potential 'V' using a battery. Removing the battery, the charged capacitor is then connected across an identical uncharged parallel plate capacitor filled with wax of dielectric constant 'k'. The common potential of both the capacitor is**

1) V volts 2) kV volts

3) (k+1) V volts 4) $\frac{V}{k+1}$ volts

31. **Three identical charges of magnitude** $2\mu C$ **are placed at the corners of a right angled triangle ABC whose base BC and height BA are respectively 4cm and 3cm. Forces on the charge at the right angled corner 'B' due to the charges at 'A' and 'C' are respectively** F_1 **and** F_2**. The angle between their resultant force and** F_2 **is**

1) $Tan^{-1}\left(\frac{9}{16}\right)$ 2) $Tan^{-1}\left(\frac{16}{9}\right)$ 3) $Sin^{-1}\left(\frac{16}{9}\right)$ 4) $Cos^{-1}\left(\frac{16}{9}\right)$

32.. Energy 'E' is stored in a parallel plate capacitor 'C_1'. An identical uncharged capacitor 'C_2' is connected to it, kept in contact with it for a while and then disconnected, the energy stored in C_2 is

1) $\frac{E}{2}$ 2) $\frac{E}{3}$ 3) $\frac{E}{4}$ 4) Zero

33. Capacitance of a capacitor becomes $\frac{7}{6}$ times its original value if a dielectric slab of thickness, t=$\frac{2}{3}d$ is introduced in between the plates. 'd' is the separation between the plates. The dielectric constant of the di-electric slab is

1) $\frac{14}{11}$ 2) $\frac{11}{14}$ 3) $\frac{7}{11}$ 4) $\frac{11}{7}$

34. A parallel plate capacitor filled with a material of dielectric constant K is charged to a certain voltage. The dielectric material is removed. Then

a) The capacitance decreases by a factor K

b) The electric field reduces by a factor K

c) The voltage across the capacitor increases by a factor K

d) The charge stored in the capacitor increases by a factor K

1) a and b are true 2) a and c are true 3) b and c are true 4) b and d are true

35. Between the plates of a parallel plate capacitor of capacity C, two parallel plates of the same material and area same as the plate of original capacitor, are placed. If the thickness of these plates is equal to $\frac{1}{5}$th of the distance between the plates of the original capacitor, then the capacity of the new capacitor is

1) $\frac{5}{3}C$ 2) $\frac{3}{5}C$ 3) $\frac{3}{10}C$ 4) $\left(\frac{10}{3}\right)C$

36. Two charges of $4\mu C$ each are placed at the corners of A and B of an equilateral triangle ABC of side length 0.2m in air. The electric potential at C is $\left(\frac{1}{4\pi \in_0} = 9\times10^9\right)$

1. $9\times10^4 V$ 2. $18\times10^4 V$ 3. $36\times10^4 V$ 4. $72\times10^4 V$

37. **The capacities of three capacities are in the ratio 1: 2: 3. Their equivalent capacity when connected in parallel is $\frac{60}{11}\mu F$ more than that when connected in series. The individual capacities are..... In μF**

1. 4, 6, 7 2. 1, 2, 3 3. 2, 3, 4 4. 1, 3, 6

38. **A capacitor of capacity 10µF is charged to 40 V and a second capacitor of capacity 15µF is charged to 30 V if the capacitors are connected in parallel, the amount of charge that flows from the smaller capacitor to higher capacitor in μC is........**

1. 30 2. 60
3. 200 4. 250

39. **A parallel plate capacitor of capacity $5\mu F$ and plate separation 6cm is connected to a 1V battery and is charged. A dielectric of dielectric constant 4 and thickness 4 cm is introduced into the capacitor. The additional charge that flows into the capacitor from the battery is**

1. $2\mu C$ 2. $3\mu C$ 3. $5\mu C$ 4. $10\mu C$

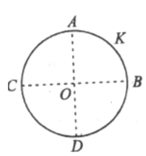
40. **Two capacitors of capacity $4\mu F$ and $6\mu F$ are connected in series and a battery is connected to the combination. The energy stored is E_1. If they are connected in parallel and if the same battery is connected to this combination the energy is E_2. The ratio $E_1 : E_2$ is**

1. 4:9 2. 9:14
3. 6:25 4. 7:12

41. **A charged sphere of diameter 4cm has a charge density of 10^{-4}C/cm^2. The work done in joules when a charge of 40nano-coulombs is moved from infinite to a point, which is at a distance of 2cm from the surface of the sphere, is [in j]**

1) 14.4π 2) 28.8π 3) 144π 4) 288π

42. **A thin conducting ring of radius R is given a charge +Q. The electric field at the centre O of the ring due to the charge on the part AKB of the ring is E. The electric field at the centre due to the charge on the part ACDB of the ring is**



1) E along KO 2) 3E along OK 3) 3K along KO 4) E along OK

43. **The electric potential at a point in free space due to charge Q coulomb is Q x 10^{11} volts. The electric field at that point is**

1) $4\pi\varepsilon_0 Q\times10^{20}\ volt/m$ 2) $12\pi\varepsilon_0 Q\times10^{22}\ volt/m$

3) $4\pi\varepsilon_0 Q\times10^{22}\ volt/m$ 4) $12\pi\varepsilon_0 Q\times10^{20}\ volt/m$

44. 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 E, is

1) $\varepsilon_0 E_2 Ad$ 2) $\frac{1}{2}\varepsilon_0 E^2 Ad$ 3) $\frac{1}{2}\varepsilon_0 E^2 / Ad$ 4) $\varepsilon_0 E^2 / Ad$

45. Three concentric spherical shells have radii a,b and c (a<b<c) and have surface charge densities σ, -σ and σ respectively. If V_A, V_B and V_C denote the potentials of the three shells, then, for

c = a+b, we have

1) $V_C = V_B \neq V_A$ 2) $V_C \neq V_B \neq V_A$ 3) $V_C = V_B = V_A$ 4) $V_C = V_A \neq V_B$

46. Three capacitors each of capacitance C and of breakdown voltage V are joined in series. The capacitance and breakdown voltage of the combination will be

1) $3C, \frac{V}{3}$ 2) $\frac{C}{3}, 3V$ 3) 3C, 3V 4) $\frac{C}{3}, \frac{V}{3}$

47. The electric potential at a point (x, y, z) is given by $V = -x^2y - xz^3 + 4$. The electric field $\vec{E}$ at that point is

1) $\vec{E} = \hat{i}2xy + \hat{j}(x^2 + y^2) + \hat{k}(3xz - y^2)$ 2) $\vec{E} = \hat{i}z^3 + \hat{j}\,xyz + \hat{k}\,z^2$

3) $\vec{E} = \hat{i}(2xy - z^3) + \hat{j}\,xy^2 + \hat{k}\,3z^2x$ 4) $\vec{E} = \hat{i}(2xy + z^3) + \hat{j}\,x^2 + \hat{k}\,3xz^2$

48. A soap bubble is given some charge then its radius

1) Decreases 2) increases

3) remains unchanged 4) may increase or decrease

49. An electric charge in uniform motion produces

1) Only an electric field

2) Only a magnetic field

3) Both electric and magnetic fields

4) Neither an electric nor a magnetic field

50. The charge of a body is +1 coulomb means

1) the body gained 6.25 x 10^{18} electrons

2) the body gained 1 electron

3) the body lost 6.25 x 10^{18} electrons

4) the body lost 1 electron

51. When positively charged body is connected to earth

1) electrons move from body to earth

2) electrons move from earth to body

3) protons move from body to earth

4) electrons move from earth to body and protons move from body to earth

52. 625 million electrons are removed from a body. The charge on it will be

1) -10^{-9}C 2) $+10^{-10}$C 3) -10^{-10}C 4) -10^{-9}C

53. Two identical metallic spheres A and B of exactly equal masses are given equal positive and negative charges respectively. Then

1) Mass of A > Mass of B 2) Mass of A < Mass of B

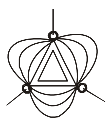
3) Mass of A = Mass of B 4) Mass of A $\frac{\geq}{<}$ Mass of B

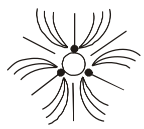
54. The electric lines of force about a negative point charge are

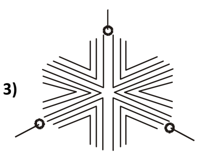
1) Circular, anticlockwise 2) circular, clockwise

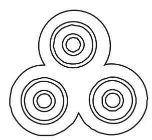
3) radial, inward 4) radial, outward

55. Three positive charges of equal value q are placed at vertices of an equilateral triangle. The resulting lines of force should be sketched as in

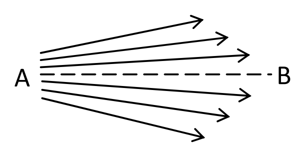
1) 

2) 

3) 

4) 

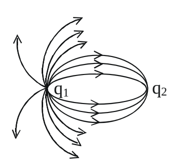
56. Figure shows the electric lines of force emerging from a charged body. If the electric field at 'A' and 'B' are E_A and E_B respectively and if the displacement between 'A' and 'B' is 'r', then



1) $E_A > E_B$ 2) $E_A < E_B$

3) $E_A = \frac{E_B}{r}$ 4) $E_A = \frac{E_B}{r^2}$

57. Figure shows lines of force for a system of two point charges. The possible choice for the charges is



1) $q_1 = 4\ \mu C, q_2 = -1\ \mu C$

2) $q_1 = 1\mu C, q_2 = -4\ \mu C$

3) $q_1 = -2\mu C, q_2 = +4\ \mu C$

4) $q_1 = 3\ \mu C, q_2 = 2\ \mu C$

58. Drawings I and II show two samples of electric field lines

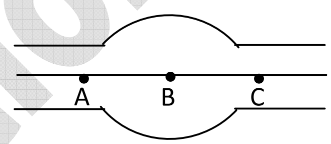
1) The electric fields in both I and II are produced by negative charge located some where on the left and positive charges located some where on the right

2) In both I and II the electric field is the same every where

3) In both cases the field becomes stronger on moving from left to right

4) The electric field in I is the same everywhere, but in II the electric field becomes stronger on moving from left to right.

59. Figure shows some of the electric field lines corresponding to an electric field. The figure suggests that



1) $E_A > E_B > E_C$

2) $E_A = E_B = E_C$

3) $E_A = E_C > E_B$

4) $E_A = E_C < E_B$

60. Two charges are placed a certain distance apart. A brass sheet is placed between them. The force between them will

1) increase 2) decrease 3) remain unchanged 4) be zero

61. Two charges are placed a certain distance apart. If a glass slab is placed between them, the force between them will

1) be zero 2) increase 3) decrease 4) remain the same

62. There are two charges +1 µC and 5 µC. The ratio of the forces acting on them will be

1) 1:5 2) 1:1 3) 5:1 4) 1:25

63. If a charge is moved against the coulombic force of an electric field

1) work is done by the electric field

2) energy is used from some outside source

3) the strength of the field is decreased 4) the energy of the system is decreased

64. A cube of side b charge q at each of its vertices. The electric field at the center of the cube will be

1) Zero 2) $\frac{32V}{b^2}$ 3) $\frac{V}{2b^2}$ 4) $\frac{q}{b^2}$

65. **'n' charges Q, 4Q, 9Q, 16Q … are placed at distances of 1, 2, 3, … metre from a point '0' on the same straight line. The electric intensity at '0' is**

1) $\frac{Q}{4\pi\varepsilon_0 n^2}$ 2) $\frac{Q}{4\pi\varepsilon_0 n}$ 3) Infinity 4) $\frac{nQ}{4\pi\varepsilon_0}$

66. **Four identical charges each of 1 µC are placed at the corner of a square of side 10 cm. The resultant field strength at the centre is**

1) 36×10^5 v/m 2) 3.6×10^5 v/m 3) 18×10^5 v/m 4) zero

67. **The electric field intensity on the surface of a charged conductor is**

1) Zero 2) directed normally to the surface

3) directed tangentially to the surface 4) directed along 45^0 to the surface

68. **If an electron has an initial velocity in a direction different from that of an electric field, the path of the electron is**

1) a straight line 2) a circle 3) an ellipse 4) a parabola

69. **An electric dipole is kept in a non-uniform electric field. It experiences**

1) a force and a torque 2) a force but not a torque

3) a torque but not a force 4) neither a force nor a torque

70. **The electric potential at a point on the axis of an electric dipole depends on the distance x of the point from the dipole and is proportional to**

1) 1/x 2) $1/x^2$ 3) x 4) $1/x^3$

71. **A number of charged liquid drops coalesce. Which one of the following quantity does not change?**

1) Charge 2) capacitance 3) potential 4) electrostatic energy

72. **A sphere A of radius 50 cm and potential 10 V is placed inside another sphere B of radius 100 cm and potential 20 V. They are connected by wire. The charge flows from**

1) A to B 2) B to A 3) no charge flows 4) Can't say

73. **A metal sphere A of radius a is charged to potential V what will be its potential if it is enclosed by a spherical conducting shell B of radius b and the two are connected by a wire?**

1) $\frac{aV}{b}$ 2) $\frac{bV}{a}$ 3) $\frac{a^2V}{b^2}$ 4) $\frac{b^2V}{a^2}$

74. **Two conducting spheres of radii r_1 and r_2 are equally charged. The ratio of their potentials is**

1) r_1^2/ r_2^2 2) r_2^2/ r_1^2 3) r_1/ r_2 4) r_2/ r_1

75. **Two conducting spheres of radii r_1 and r_2 are at the same potential. The ratio of their charges is**

1) r_1^2/ r_2^2 2) r_2^2/ r_1^2 3) r_1/ r_2 4) r_2/ r_1

76. **n small drops of the same size are charged to V volt each. If they coalesce to from a single large drop, then its potential will be**

1) V/n 2) Vn 3) $Vn^{1/3}$ 4) $Vn^{2/3}$

77. **The curves of constant potential in a region of electric field of the points A, B and C where is the electric intensity least?**

1) A

2) B

3) C

4) Same at all points

78. **An electron of mass m and charge e is accelerated from rest through a potential difference V in vacuum. Its final speed will be**

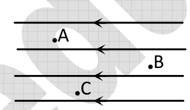
1) $\sqrt{2eV/m}$ 2) $\sqrt{eV/m}$ 3) $\sqrt{eV/2m}$ 4) $\sqrt{em}/V$

79. **Which of the following is true?**

1) joule = coulomb × volt 2) joule = coulomb / volt

3) joule = volt × ampere 4) joule = volt / ampere

80. **Following figure shows three points A, B and C in an electric field. If V_A, V_B and V_C are the potential at these points, then**



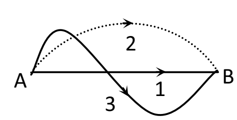
1) $V_A = V_B > V_C$

2) $V_A < V_C < V_B$

3) $V_A = V_B < V_C$

4) $V_A > V_C > V_B$

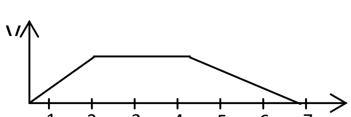
81. **In the region of an electric field a charge is moved from point A to B via three different paths as shown in fig. W_1, W_2 and W_3 denote the work done along the three paths. Then**



1) $W_1 < W_2 < W_3$ 2) $W_1 = W_2 > W_3$

3) $W_1 < W_2 = W_3$ 4) $W_1 = W_2 = W_3$

82. **The variation of potential with distance r is represented as shown. At r = 3m, the intensity of electric field is**



1) 5

2) 4

3) 2.5

4) zero

83. A capacitor works in

1) A.C. circuits only
2) D.C. circuits only
3) both the A.C. and D.C. circuits
4) neither A.C. nor D.C. circuits

84. The capacitance of a parallel plate condenser does not depend on the

1) area of the plates
2)medium between the plates
3) distance between the plates
4)metal of the plates

85. The empty space between the plates of a capacitor is filled with a liquid of dielectric constant K. The capacitance of the capacitor

1) increases by a factor K
2)decreases by a factor K
3) increases by a factor K^2
4) decreases by a factor K^2

86. In order to increase the capacity of a parallel plate condenser one should introduce, between the plates, a sheet of

1) mica
2) tin
3) copper
4) stainless steel

87. A dielectric slab is introduced between the plates of an isolated capacitor. The force between the plates will

1) increase
2) decrease
3) remain unchanged
4) become zero

88. A parallel plate condenser with oil between the plates (dielectric constant of oil = 2) has a capacitance C. If the oil is removed, the capacitance of the capacitor becomes

1) $\sqrt{2}$ C
2) 2C
3) C/ $\sqrt{2}$
4) C/2

89. Increasing the charge on the plates of a capacitor means

1) increasing the capacitance
2) increasing the potential difference between the plates
3) decreasing the potential difference between the plates
4) no change in the field between the plates

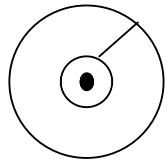
90. Two plates of a parallel capacitor are at potentials 200V and –200V. If the distance between plates is 4cm then find electric field at a distance 2cm from one plate in between plates.

1) 10^2 V/m
2) 10^6 V/m
3) 10^3 V/m
4) 10^4 V/m

91. A parallel plate condenser of area A has charge Q. Then the force on each plate is

1) $\frac{Q^2}{\varepsilon_0 A}$
2) $\frac{Q}{\varepsilon_0^2 A}$
3) $\frac{Q^2}{2\varepsilon_0 A}$
4) $\frac{2Q}{\varepsilon_0 A^2}$

92. Two spherical conductors of radii R_1 and R_2 ($R_2 > R_1$) are placed concentrically in air. The two are connected by a copper wire as shown in figure. Then the equivalent capacity of the system is



1) $4\pi\varepsilon_0(R_1+R_2)$

2) $4\pi\varepsilon_0 R_1$

3) $4\pi\varepsilon_0 R_2$

4) $\frac{4\pi\varepsilon_0 R_1 R_2}{R_2 - R_1}$

93. On connecting different condensers having different capacitances in parallel they will have the same

1) Capacity 2) potential difference

3) charge 4) energy

94. When different capacitors are connected in series, they will have same

1) Capacity 2) potential difference

3) charge 4) energy

95. Three capacitors of equal capacities are to be connected in different ways to give different capacities. The number of ways in which they can be connected is

1) two 2) three 3) four 4) eight

96. n identical condensers are joined in parallel and are charged to potential V so that energy stored in each condenser is E. If they are separated and joined in series, then the total energy and total potential difference of the combination will be

1) nE and $\frac{V}{n}$ 2) n^2E and nV 3) $\frac{E}{n^2}$ and $\frac{V}{n^2}$ 4) nE and nV

97. A parallel plate capacitor if made by stacking n equally spaced plates connected alternately. If the capacitance between any two adjacent plates is C, then the resulting capacitance is

1) C 2) nC 3) (n–1) C 4) (n+1) C

98. The type of capacitor in which polarity has to be maintained when it is connected in a circuit is

1) Variable capacitor 2) Multiple capacitor

3) Paper capacitor 4) Electrolyte capacitor

99. In electrolyte capacitor the dielectric between two plates is

1) Ammonium borate 2) Electrolyte

3) Aluminium oxide 4) Aluminium

100. Out of the following statements

[A]: As we move in the direction of the field potential goes on decreasing

[B]: If a charged body is moved with in the field work must be done

1) A is correct and B is wrong
2) A is wrong and B is correct
3) Both A and B are correct
4) Both A and B are wrong

101. Out of the following statements

[A]: The capacity of a conductor is affected due to the presence of an uncharged isolated conductor

[B]: A conductor can hold more charge at the same potential if it is surrounded by dielectric medium

1) Both A and B are correct
2) Both A and B are wrong
3) A is correct and B is wrong
4) A is wrong and B is correct

102. A free electron and a free proton are placed in a uniform electric field. Then

[A]: Both will experience same force

[B]: Both will experience same acceleration

1) A is true, B is false
2) A is false, B is true
3) Both A and B are true
4) Both A and B are false

103. Match the following:

Physical Quantity	**Unit**
1) Intensity of Electric field	**e) Coulomb**
b) Potential	**f) Volt**
c) Capacity	**g) Volt / m**
d) Charge	**h) Farad**

1) a – e , b – f , c – g , d – h
2) a – g , b – f , c – h , d – e
3) a – e , b – g , c – f , d – h
4) a – h , b – g , c – e , d – f

104. Match the following: N identical charge droplets combines into a single drop. The potential capacity energy and surface charge density of bigger drop are V, C, U, σ and each droplet one v, e, u, and σ respectively

List – I	**List – II**
1) V / v	e) $N^{1/3}$
b) C / c	f) $N^{5/3}$
c) U / u	g) $N^{4/3}$
d) σ / σ	h) $N^{2/3}$

1) a – h , b – e , c – f , d – g
2) a – g , b – e , c – f , d – h
3) a – g , b – f , c – f , d – h
4) a – g , b – f , c – h , d – e

105. Match the following:

List – I	**List – II**
1) Electrostatic pressure	**e) $\sigma^2/2\epsilon_0$**
b) Surface charge density	**f) q/A**
c) $\frac{1}{4\pi\epsilon_0}=$	**g) 9×10^9 Nm^2/c^2**
d) $\frac{1}{\sqrt{\mu_0\epsilon_0}}$	**h) 3×10^8 m/s**

1) a → e, b → f, c → g, d → h
2) a → h, b → g, c → f, d → e
3) a → f, b → e, c → h, d → g
4) a → g, b → h, c → e, d → f

106. Match the following:

List – I	**List – II**
1) coulomb force	**e) conservative force**
b) at centre of electric dipole	**f) V = 0**
c) at centre of charged hollow sphere	**g) E = 0**
d) viscous force	**h) non –conservative force**

1) a → e, b → f, c → g, d → h
2) a → h, b → g, c → f, d → e
3) a → f, b → e, c → h, d → g
4) a → g, b → h, c → e, d → f

107. **Match the following:**

List – I	**List – II**
1) Dielectric strength of air	**e) 3×10^6 V/m**
b) For air, ϵ_r	**f) 1**
c) Potential on surface of charged sphere	**g) $\frac{\sigma r}{\epsilon_0}$**
d) Force between plates of parallel plate condenser	**h) $\frac{cE^2 d}{2}$**

1) a → e, b → f, c → g, d → h   2) a → h, b → g, c → f, d → e

3) a → f, b → e, c → h, d → g   4) a → g, b → h, c → e, d → f

108. **Two conducting spheres of radii R_1 and R_2 carry charges q_1 and q_2 and have surface charge density σ_1 and σ_2, the electric field at the surface being E_1 and E_2 and the potentials V_1 and V_2. If $\sigma_1 = \sigma_2$, match the following**

List – I	**List – II**
1) q_1/q_2	d) 1
b) V_1/V_2	e) R_1^2 / R_2^2
c) E_1/E_2	f) R_2/R_1

1) a – f, b – d , c – e   2) a – d, b – e , c – f   3) a – e, b – f , c – d   4) a – d, b – f , c – e

Assertion & Reason: In each of the following questions, a statement is given and a corresponding statement or reason is given just below it. In the statements, marks the correct answer as

1. If both Assertion and Reason are true and reason is correct explanation of Assertion.

2. If both Assertion and Reason are true but reason is not the correct explanation of Assertion.

3. If Assertion is true but reason is false.

4. If both assertion and reason are false.

109. **[A]: A point charge q is lying at the centre of a cube of each side L. The electric flux emanation from each surface of the cube is $q/6\epsilon_0$.**

[R]: According to Gauss's theorem in electrostatics $\phi = q / \epsilon_0$.

110. **[A]: The capacity of a conductor, under given circumstance remains constant irrespective of the charge present on it.**

[R]: Capacity depends on size and shape of conductor and also on the surrounding medium.

111. **[A]: Positive charge always moves from a higher potential to lower potential point.**

[R]: Electric potential is a vector

112. [A]: Charge on all the condensers connected in series is the same

[R]: Capacity of capacitor is directly proportional to charge on it.

113. [A]: A charged particle free to move in an electric field always moves along an electric line of force.

[R]s: Electric line of force is the path taken by unit positive charge in an electric field.

114. [A]: Two equipotential surfaces can intersect each other where as two electric lines of force never intersect each other.

[R]: Electric potential is a scalar quantity whereas electric force is a vector quantity.

115. [A]: Conductors used for storing charged for a long time must be spherical in shape.

[R]: In case of spherical conductor charge is uniformely distributed.

KEY:

1) **3**	2) **4**	3) **1**	4) **2**	5) **2**	6) **3**	7) **3**	8) **4**	9) **3**	10) **1**
11) **4**	12) **3**	13) **1**	14) **2**	15) **2**	16) **3**	17) **2**	18) **4**	19) **2**	20) **4**
21) **2**	22) **2**	23) **3**	24) **4**	25) **3**	26) **3**	27) **1**	28) **4**	29) **1**	30) **4**
31) **2**	32) **3**	33) **1**	34) **2**	35) **1**	36) **3**	37) **2**	38) **2**	39) **3**	40) **3**
41) **1**	42) **4**	43) **3**	44) **2**	45) **4**	46) **2**	47) **4**	48) **2**	49) **3**	50) **3**
51) **2**	52) **2**	53) **2**	54) **3**	55) **3**	56) **1**	57) **1**	58) **4**	59) **3**	60) **4**
61) **3**	62) **2**	63) **2**	64) **1**	65) **4**	66) **4**	67) **2**	68) **4**	69) **1**	70) **2**
71) **1**	72) **1**	73) **1**	74) **4**	75) **3**	76) **4**	77) **1**	78) **1**	79) **1**	80) **4**
81) **1**	82) **4**	83) **3**	84) **4**	85) **1**	86) **1**	87) **3**	88) **4**	89) **2**	90) **4**
91) **3**	92) **3**	93) **2**	94) **3**	95) **3**	96) **4**	97) **3**	98) **4**	99) **4**	100) **1**
101) **1**	102) **1**	103) **1**	104) **1**	105) **1**	106) **1**	107) **1**	108) **3**	109) **1**	110) **3**
111) **3**	112) **2**	113) **2**	114) **3**	115) **1**					

SOLUTIONS

1. $C_0 = \frac{\epsilon_0 A}{d}$ After the dielectric slab of thickness‘t’ is introduced

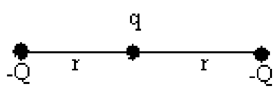
$$\Rightarrow C = \frac{\epsilon_0 A}{d' - t\left(1 - \frac{1}{K}\right)}$$

$$C = C_0$$

$$\Rightarrow d = d' - t\left(1 - \frac{1}{K}\right)$$

$$\Rightarrow K = 5$$

2. If the system of these three charges is in equilibrium if repulsive force between –Q and –Q is balanced by attraction forces between q and -Q



$$= F_1 + F_2 = 0 \Rightarrow F_1 = -F_2$$

$$\Rightarrow \frac{1}{4\pi \epsilon_0} \frac{(-Q)(-Q)}{(2r)^2} = \frac{-1}{4\pi \epsilon_0}\left[\frac{q(-Q)}{r^2}\right]$$

On solving $q = \frac{Q}{4} = 0.25$

3. According to the law of conservation of energy

Gain in KE = $\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = qV$

$$\Rightarrow u^2 = v^2 - \frac{2qV}{m}$$

4. $q_1 = \frac{2}{5}\mu C$

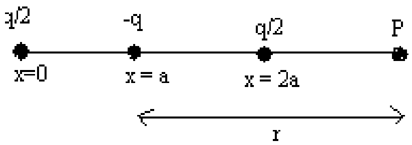
$q_2 = \frac{3}{5}\mu C$

$F = \frac{1}{4\pi\in_0}\frac{q_1q_2}{d^2}$

= 0.00216 N

5. The potential at P is V which is given by $V = V_1 + V_2 + V_3$

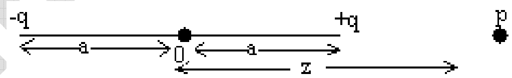
$$V = \frac{1}{4\pi\in_0}\frac{q}{2(r+a)} + \frac{1}{4\pi\in_0}\frac{-q}{r} + \frac{1}{4\pi\in_0}\frac{q}{2(r-a)}$$



$$V = \frac{1}{4\pi\in_0}\frac{q}{2}\left[\frac{1}{r+a} - \frac{2}{r} + \frac{1}{r-a}\right]$$

$= \frac{1}{4\pi\in_0}\frac{qa^2}{r^3}$ as a<<r

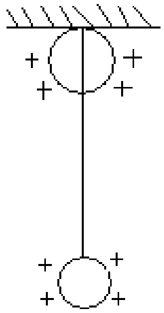
6.



Electric potential at the point P because of the charges –q and +q is $V_p = V_1 + V_2$

$$\therefore V_p = \left[\frac{1}{4\pi\in_0}.\frac{-q}{(z+a)} + \frac{1}{4\pi\in_0}.\frac{+q}{(z-a)}\right] = \frac{q}{4\pi\in_0}\left[\frac{z+a-z+a}{z^2-a^2}\right]$$

$$\Rightarrow V_p = \frac{2qa}{4\pi\in_0\left(z^2-a^2\right)}$$

7. 

Between the two charged bobs, there is only electrostatic repulsion which does not affect the motion of pendulum.

Time period $T = 2\pi\sqrt{\frac{\ell}{g}}$

8. $\Delta W = \frac{1}{2}\frac{C_1 C_2}{C_1 + C_2}(V_1 - V_2)^2$

$= \frac{1}{2}\frac{20\times 30}{(20+30)}(5-0)^2 = 150J$

For an uncharged capacitor potential = 0

9. E = Resultant electric field = $E_1 + E_2 + E_3 + ...$

$$= \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1^2} - \frac{Q_2}{r_2^2} + \frac{Q_3}{r_3^2} + ...\right]$$

$$= \frac{1}{4\pi\varepsilon_0}\left[\frac{Q}{(1\times 10^{-2})^2} - \frac{Q}{(2\times 10^{-2})^2} + \frac{Q}{(4\times 10^{-2})^2} + ...\right]$$

$$\therefore E = \frac{45}{10^{-4}}\times\frac{4}{5} = 36\times 10^4 \text{ NC}^{-1}$$

10. Magnitude of electric intensity at a point due to an infinitely long thin straight wire of uniform linear charge density λ is $E = \frac{\lambda}{2\pi\epsilon_0 r}$

$$= \frac{18\times 10^9 \times \frac{1}{3}}{18\times 10^{-2}}$$

= 0.33×10^{11} NC^{-1}

11. Initially and finally the net force is zero. (i.e.) work done by the external force is zero

12. From the relation $C = \frac{\epsilon_0 A}{d} \Rightarrow C \propto \frac{1}{d}$

Capacity increases with decrease in distance

13. A: $E_1 = \frac{Q^2}{2C_1} = \frac{Q^2}{2\left(\frac{C}{2}\right)} = \frac{Q^2}{C} = \frac{C^2V^2}{C} = CV^2$

Since as battery is disconnected charge remains same

B: $E_2 = \frac{1}{2}C_1V^2 = \frac{1}{2}\left(\frac{C}{2}\right)V^2 = \frac{CV^2}{4}$

$\therefore \frac{E_1}{E_2} = \frac{CV^2\times4}{CV^2} = 4$

14. $q = cV = 1000\times10^{-6}\times20 = 2\times10^{-2}$

$t = \frac{q}{\Delta q/\Delta t} = \frac{2\times10^{-2}}{200\times10^{-6}} = 100s$

15. Potential at any point on the perpendicular bisector of the line joining the two charges

$$V = V_1 + V_2 = \frac{1}{4\pi\epsilon_0}\frac{q}{r} + \frac{1}{4\pi\epsilon_0}\frac{-q}{r} = 0$$

[r = distance between the charges and any point on perpendicular bisector which is same for both the charges]

16. $V_x = 10m/s$

$V_y = u_y + a_y t$ = $V_y = \frac{Eq}{m}\times t$ $\left[\sin ce\ u_y = 0,\ a_y = \frac{Eq}{m}\right]$

Resultant velocity $\Rightarrow V = \sqrt{V_x^2 + V_y^2} = 10\sqrt{2}m/s$

17. Energy stored $E=\frac{1}{2}CV^2=\frac{q^2}{2C}$

$E\propto q^2$

$\Rightarrow\frac{E_1}{E_2}=\frac{q_1^2}{q_2^2}$

$\Rightarrow\frac{E_1}{\frac{121E_1}{100}}=\frac{q^2}{(q+2)^2}$

$\Rightarrow\frac{10}{11}=\frac{q}{q+2}\Rightarrow 10q+20=11q\Rightarrow q=20C$

18. Initial force between the charges

$F_{ini}=\frac{1}{4\pi\in_0}\frac{2\times 6}{d^2}=12\times 10^{+3}$ repulsive

Final force between the charges = $F_F=\frac{1}{4\pi\in_0}\frac{(2-4)(6-4)}{d^2}$

$F_F=\frac{1}{4\pi\in_0}\frac{(-2)(2)}{d^2}=\frac{+F_i}{3}=4\times 10^{+3}N$ Attraction

19. Let P be at distance x from the charge $9\mu C$. The distance of P from the charge -$3\mu C$ will be 0. 16-x

As $V_1+V_2=0\Rightarrow\frac{1}{4\pi\in_0}.\frac{9\times 10^{-6}}{x}-\frac{3\times 10^{-6}}{4\pi\in_0(0.16-x)}=0$

$\Rightarrow x=0.12m$

20. Loss of energy = initial energy – final energy

$\frac{1}{2}\frac{C_1C_2}{C_1+C_2}V^2=2.7\times 10^{-2}J$

For uncharged capacitor potential is zero.

21. As the particle is stationary net force = 0

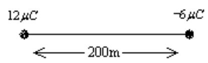
$$Eq + mg = 0$$

$$q = \frac{-mg}{E} = \frac{-(5\times10^{-6})(10)}{10^6}$$

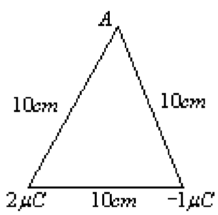
$$= -5\times10^{-5}\,\mu C$$

22. From the figure, force of repulsion between the charges at A and C

$$F_{rep} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q_1 q_2}{d^2}$$



$$= \frac{(9\times10^9)(2\times10^{-12})}{(0.1)^2} = 1.8N$$



Force of attraction between the charges at B and C also has the same magnitude of 1.8N and the angle between force of attraction and repulsion is 120^0.

$\therefore$ Resultant force = $\sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$

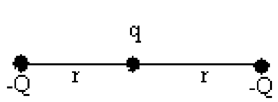
$$F_R = F = 1.8N$$

23. Applying Gauss law to the region I the Electric field intensity is

$$E = \frac{1}{2\epsilon_0}(\sigma_1 + \sigma_2)$$

Where σ_1 and σ_2 are the surface charge densities.

24. If the system of these three charges is in equilibrium if repulsive force between –Q and –Q is balanced by attraction forces between q and -Q



$= F_1 + F_2 = 0 \Rightarrow F_1 = -F_2$

$$= \frac{1}{4\pi \in_0} \frac{(-Q)(-Q)}{(2r)^2} = \frac{1}{4\pi \in_0} \left[\frac{q(-Q)}{r^2} \right]$$

On solving $q = \frac{Q}{4} = 0.25$

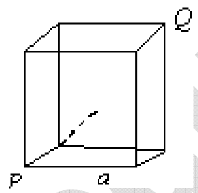
25. Potential energy of the system is equal to zero when the system is in equilibrium.

$$\frac{1}{4\pi \in_0} \frac{Qq}{x} + \frac{1}{4\pi \in_0} \frac{q(Q)}{x} + \frac{1}{4\pi \in_0} \frac{Q^2}{2x} = 0$$

$$\frac{2(Q)(q)}{x} = \frac{-Q^2}{2x}$$

$$q = -\frac{Q}{4}$$

26.



Length of the diagonal PQ of side a is

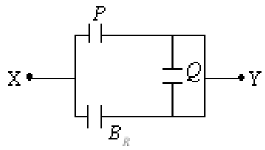
$$\sqrt{\left(\sqrt{2}a\right) + a^2} = \sqrt{\left(\sqrt{2}a\right) + a^2} = \sqrt{3}a$$

Distance of midpoint from each corner $= \frac{\sqrt{3}a}{2}$

As $V = \frac{1}{4\pi \in_0} \frac{Q}{r} \Rightarrow V = 8 \times \frac{1}{4\pi \in_0} \frac{Q}{\sqrt{3}a} \times 2$

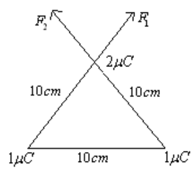
$$= \frac{4Q}{\sqrt{3}\pi \in_0 a}$$

27.



The capacitor Q is short circuited and P and R in parallel. So the resultant capacitance is equal to $2C = 2\times1 = 2\mu F$

28.



$$F_1 = F_2 = \frac{1}{4\pi\in_0}\frac{10^{-6}\times2\times10^{-6}}{\left(10\times10^{-2}\right)}$$

$$=9\times10^9\times\frac{2\times10^{-12}}{10^{-2}}=1.8N$$

The resultant force $F_R = \sqrt{F_1^2 + 2F_1F_2\cos\theta + F_2^2}$

$$F_R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos60^0}$$

$$=1.8\sqrt{3}=1.8\times1.732=3.12N$$

29. Potential on the surface of sphere

$$V = \frac{1}{4\pi\in_0}\frac{q}{R}=500$$

$$E = \frac{\left(\frac{1}{4\pi\in_0}\frac{q}{R}\right)^2}{\frac{1}{4\pi\in_0}q}$$

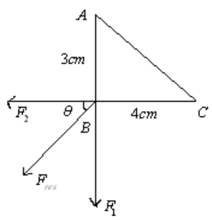
$$= \frac{25\times10^4}{27\times10^3}=\frac{250}{27}<10$$

30. If the capacity of first capacitor is ‘c’ then the capacity of second capacitor is ‘KC’.

$\therefore$ common potential = $\dfrac{C_1V_1 + C_2V_2}{C_1 + C_2} = \dfrac{CV}{C + KC}$

$= \dfrac{V}{1+K}$ volt

31. Angle made by the resultant $f_{resul\tan t}$ with f_2 is $(i.e)\tan\alpha = \dfrac{b\sin\theta}{a + b\cos\theta}$



$$\theta = \tan^{-1}\frac{F_1}{F_2}$$

$$\frac{F_1}{F_2} = \frac{\dfrac{1}{4\pi\in_0}\dfrac{q^2}{3^2}}{\dfrac{1}{4\pi\in_0}\dfrac{q^2}{4^2}} = \frac{16}{9}$$

$$\theta = \tan^{-1}\frac{16}{9}$$

32. Energy stored in the 1st capacitor

$$E = \frac{1}{2}CV^2$$

If second similar capacitor is in contact with the 1st one the potential on the second capacitor is V/2.

$\therefore$ Energy stored in second capacitor

$$= \frac{1}{2}C\left(\frac{V}{2}\right)^2 = \frac{E}{4}$$

33. $C_0 = \frac{\in_0 A}{d}$ ....(1)

$C = \frac{7}{6} C_0$ ....(2)

$C = \frac{\in_0 A}{d - t\left(1 - \frac{1}{K}\right)} = \frac{\in_0 A/d}{1 - \frac{t}{d}\left(1 - \frac{1}{K}\right)}$

$\frac{C_0}{1 - \frac{2}{3}\left(1 - \frac{1}{K}\right)} = \frac{3KC_0}{2+K}$ ....(3)

Dividing (1) and (3)

$\Rightarrow \frac{C}{C_0} = \frac{3K}{K+2} = \frac{7}{6}$

$\Rightarrow K = \frac{14}{11}$

34. i) Electric field increases by a factor K

ii) Charge decreases by a factor K

35. $C = \frac{\in_0 A}{d}$

36. Electric potential of C $\Rightarrow V = V_1 + V_2$

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1}{r} + \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_2}{r}$$

$$= 2\left[\frac{1}{4\pi \in_0}\right] \cdot \frac{q}{r} = 36 \times 10^4 V$$

37. $C_1 = C_0, C_2 = 2C_0, C_3 = 3C_0$

In parallel, $C = C_1 + C_2 + C_3 = C_0 + 2C_0 + 3C_0 = 6C_0$

In series, $C' = \frac{C_1C_2C_3}{C_1C_2 + C_2C_3 + C_3C_1}$

$= \frac{(C_0)(2C_0)(3C_0)}{(C_0)(2C_0) + (2C_0)(3C_0) + (3C_0)(C_0)} = \frac{6}{11}C_0$

Given that $C - C' = 6C_0 - \frac{6C_0}{11} = \frac{60}{11}$

$\Rightarrow C_0 = 1\mu F$

$C_1 = 1\mu F, C_2 = 2\mu F, C_3 = 3\mu F$

38. Common potential $= \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$

$= \frac{10\times40 + 15\times30}{10+15}$ = 34V

Amount of charge flowing = $10\times40 - 10\times34$

=60µC

39. $C_{air} = \frac{\in_0 A}{d}$, $C_{medium} = \frac{\in_0 A}{d - t + \frac{t}{k}}$

$\Rightarrow \frac{C_{medium}}{C_{air}} = \frac{d}{d - t + \frac{t}{k}} = \frac{6}{6 - 4 + \frac{4}{4}} = 2$

$C_m = 2(C_{air}) = 10\mu F$

Charge q = CV = 10 x 1 = 10µC

Additional charge = Final charge – Initial charge

= 10µC – 5µC

= 5µC

40. As the capacitors are connected in series

$$E_{series} = E_1 = \frac{1}{2}\left(\frac{C_1C_2}{C_1+C_2}\right)V^2$$

As the capacitors are connected in parallel

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

$$\frac{E_1}{E_2} = \frac{C_1C_2}{(C_1+C_2)} = \frac{6\times4}{(6+4)^2}$$

$$\Rightarrow E_1 : E_2 = 6:25$$

41. $\sigma = \frac{q}{4\pi R^2} \Rightarrow q = 4\pi R^2\sigma$ ....(1)

Work done = potential energy at the given distance r = 2+2 = 4cm from the centre of the sphere.

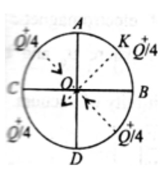
$$W = \frac{qq'}{4\pi\in_0 r} = \frac{4\pi R^2\sigma q'}{4\pi\in_0 r} \text{ ....(2)}$$

Sub. (1) in (2)

$$= \frac{4\pi\times\left(2\times10^{-2}\right)^2\times1\times\left(40\times10^{-9}\right)\times\left(9\times10^{8}\right)}{4\times10^{-2}}$$

= 14.4 πJ

42.



The field at O due to AC and BD cancel each other..

The field due to CD is acting in the direction OK and equal in magnitude to E due to AKB.

43. Electric potential at a point in free space due to charge Q is

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{r} = Q.10^{11}$$

$$\therefore \frac{1}{r} = 4\pi\varepsilon_0 .10^{11}$$

$$E = \frac{potential}{r} = Q.10^{11} \times 4\pi\varepsilon_0 .10^{11}$$

$$\Rightarrow E = 4\pi\varepsilon_0 .Q.10^{22} \text{ volt/m}$$

44: Energy stored in a fully charged capacitor is $\frac{1}{2}CV^2$

But V = E x d; Capacity of a parallel plate condenser : $C = \frac{\varepsilon_0 A}{d}$

$\therefore$ Energy stored = $\frac{1}{2}CV^2 = \frac{1}{2}\frac{\varepsilon_0 A}{d} \times E^2 .d^2 \Rightarrow$ Energy $= \frac{1}{2}\varepsilon_0 E^2 Ad$

45: Potential for a concentric shell = $\frac{1}{4\pi t_0} \cdot \frac{q}{r}$

Surface charge density = $\frac{q}{A} = \frac{q}{4\pi r^2}$

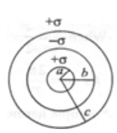
$$V_A = \frac{1}{4\pi\varepsilon_0}\left\{\frac{q_A}{a} + \frac{q_B}{b} + \frac{q_C}{c}\right\}$$

$$= \frac{4\pi}{4\pi\varepsilon_0}\left\{\frac{a^2\sigma}{a} - \frac{b^2\sigma}{b} + \frac{c^2\sigma}{c}\right\}$$

$$V_A = \frac{1}{\varepsilon_0}\left\{\frac{a^2\sigma}{a} - \frac{b^2\sigma}{b} + \frac{c^2\sigma}{c}\right\}$$

$$V_B = \frac{1}{\varepsilon_0}\left\{\frac{a^2\sigma}{b} - \frac{b^2\sigma}{b} + \frac{c^2\sigma}{c}\right\}$$

$$V_C = \frac{1}{\varepsilon_0}\left\{\frac{a^2\sigma}{c} - \frac{b^2\sigma}{c} + \frac{c^2\sigma}{c}\right\}$$



Substituting c = a+b the above equation we can prove that

$V_A = V_C > V_B$ i.e., $V_A = V_C \neq V_B$

46. Three capacitors of capacitance C each are in series.

$$\therefore \frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$\therefore$ Total capacitance, $C_{total} = \frac{C}{3}$

The charge is the same, Q when capacitors are in series.

$$V_{total} = \frac{Q}{C} = \frac{Q}{C/3} = 3V$$

47: The electric potential at a point,

$$V = -x^2y - xz^3 + 4.$$

The field $\vec{E} = -\vec{\nabla}V = -\left(\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right)$

$$\therefore \vec{E} = \hat{i}\left(2xy + z^3\right) + \hat{j}x^2 + \hat{k}\left(3xz^2\right)$$