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TEST ID: 54
PHYSICS

3.ELECTROSTATICS,8.ELECTROSTATICS

Single Correct Answer Type

1. When an electric dipole is placed in a uniform electric field, it experiences
a) force only
b) torque only
c) both force and torque
d) neither a force nor a torque

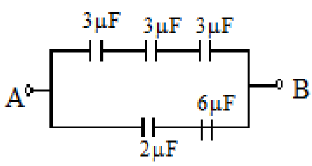
2. If σ is the surface charge density of a charge for charged sphere of radius R kept in a medium of dielectric constant k then electric intensity at a distance r from its centre is $r > R$, $\varepsilon_0 =$ permittivity of free space
a) $\sigma r^2/\varepsilon_0 kR^2$ b) $\sigma r/\varepsilon_0 kR$
c) $\frac{\sigma R^2}{\varepsilon_0 kr^2}$ d) $\frac{\sigma R}{\varepsilon_0 kr}$

3. To reduce the capacity of a parallel plate capacitor, separation between the plates is
a) Reduced and area of the plates decreased
b) Decreased and area of the plates increased
c) Increased and area of the plates decreased
d) Increased and area of the plates increased

4. In van de graff generator, in order to avoid leakage of charge the:
a) inner ;surface of sphere is made smooth
b) outer surface of sphere is made rough
c) outer surface of sphere is made smooth
d) inner surface of sphere is made rough

5. A metal sphere of radius 10 cm is charged to a potential of 100 V. The outward pull per unit area of the surface is
a) 4.4×10^{-6} N/m^2 b) 2.4×10^{-6} N/m^2
c) 4.4×10^{6} N/m^2 d) 4.2×10^{-6} N/m^2

6. In the given figure one 3 μF capacitor has got 600 μJ of energy. Then the potential difference across 2 μF capacitor is



a) 45 V b) 60 V c) 40 V d) 15 V

7. Dielectrics are
a) Conducting substances
b) Non-conducting substances
c) Combustible substances
d) Preservative substances

8. Two conducting spheres of radius r_1 and r_2 are equally charged. The ratio of their intensities will be:
a) $\frac{r_2}{r_1}$ b) $\frac{r_1}{r_2}$ c) $\left(\frac{r_2}{r_1}\right)^2$ d) $\left(\frac{r_1}{r_2}\right)^2$

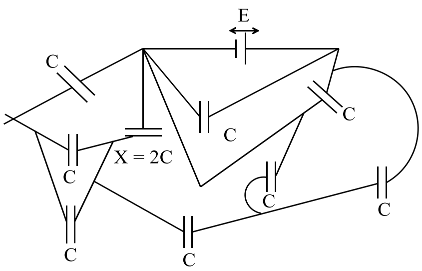
9. The space or region surrounding the static charge in which unit positive charge experiences electric force is
a) gravitational field b) electric field
c) magnetic field d) none of these

10. The charge deposited per unit area of the surface is called:
a) Linear charge density
b) Surface charge density
c) Volume charge density
d) All of these

11. An infinite line charge produces a field of 7.182×10^8 N/C at a distance of 2 cm. The linear charge density is
a) 7.27×10^{-4}C/m b) 7.98×10^{-4}C/m
c) 7.11×10^{-4}C/m d) 7.04×10^{-4}C/m

12. A parallel plate condenser is made by stacking P equally spaced plates connected alternately. If the capacity between any two plates is C, then the resultant capacity is :
a) C / P b) PC c) (P – 1)C d) (P + 1)C

13. What is the charge on X?



a) $\frac{CE}{2}$ b) $\frac{CE}{3}$ c) $\frac{CE}{4}$ d) $\frac{CE}{5}$

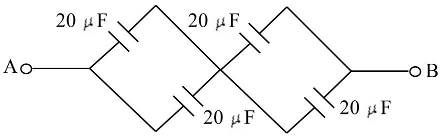
14. The maximum charge that can be conveyed to a conducting sphere of diameter 20 cm (breakdown field of air $= 2 \times 10^6$Vm^{-1}) is

a) $\frac{5}{9} \times 10^{-6}$C   b) $\frac{2}{9} \times 10^{-5}$C
c) 10^{-9} C   d) 10^{-7} C

15. A capacitor of 4 μF charged to 50 V is connected to another capacitor of 2 μF, charged to 100 V. The total energy of the combination is
a) $(4/3) \times 10^{-2}$J   b) $(3/2) \times 10^{-2}$J
c) 3×10^{-2}J   d) 2.67×10^{-2}J

16. An infinite line of charge produces a field of 9×10^4N/C at a distance of 4 cm. The linear charge density is
a) 2×10^{-7} C m^{-1} b) 10^{-7} C m^{-1}
c) 9×10^4 C m^{-1} d) None of these

17. Four capacitors are connected as shown in figure. The equivalent capacitance between A and B is



a) 80 μF   b) 40 μF   c) 10 μF   d) 20 μF

18. The bodies gets charged when rubbed with each other due to transfer of
a) Photons   b) Atoms
c) Molecules   d) Electrons

19. The electric field near a conducting surface having a uniform surface charge density σ is given by
a) $\frac{\sigma}{\varepsilon_0}$ and is parallel to the surface
b) $\frac{2\sigma}{\varepsilon_0}$ and is parallel to the surface
c) $\frac{\sigma}{\varepsilon_0}$ and is normal to the surface
d) $\frac{2\sigma}{\varepsilon_0}$ and is normal to the surface

20. Frictional electricity is produced on two bodies due to :
a) Loss of electrons by one body
b) Loss of proton by one body
c) Loss of electrons by one body and equal number of electrons gained by other body
d) Loss of proton by one body and equal number gained by other body

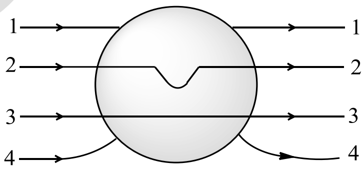
21. A 5 μF capacitor is connected in series with a 10 μF capacitor. When a 300 Volt potential difference is applied across this combination, the energy stored in the capacitors is
a) 15 J   b) 1.5 J   c) 0.15 J   d) 0.10 J

22. In air, a charged soap bubble radius 'r' is in equilibrium having outside and inside pressures being equal. The charge on the drop is (ε_0 = permittivity of free space, T = surface tension of soap solution)
a) $4\pi r^2\sqrt{\frac{2T\varepsilon_0}{r}}$ b) $4\pi r^2\sqrt{\frac{4T\varepsilon_0}{r}}$
c) $4\pi r^2\sqrt{\frac{6T\varepsilon_0}{r}}$ d) $4\pi r^2\sqrt{\frac{8T\varepsilon_0}{r}}$

23. A point charge causes an electric flux of -200 Nm^2/C to pass through spherical Gaussian surface of 10 cm radius centered on the charge. If the radius of the Gaussian surface is doubled, the total electric flux passing through the surface is
a) -200 Nm^2/C   b) -100 Nm^2/C
c) $+200$ Nm^2/C   d) -50 Nm^2/C

24. A string is compressed by 2 mm by a force of 8 N and a condenser is charged through a potential difference of 200 V possess a charge of 0.1 C; then the ratio of energy stored in the two bodies is
a) 1   b) 1/2   c) 3/2   d) 2/1

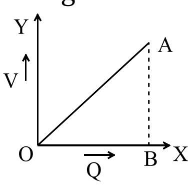
25. A metallic solid sphere is placed in a uniform electric field. The lines of force follow the path(s) shown in figure as



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

26. A metal sphere of radius 10 cm is given a charge of 12 μC. The force acting on unit area of its surface is
a) 5.15×10^2 N/m^2 b) 5.15×10^3 N/m^2
c) 515×10^{-2}N/m^2 d) 5.15×10^{-3} N/m^2

27. Charge Q on a capacitor varies with voltage V as shown in the figure, where Q is taken along the X-axis and V along the Y-axis. The area of triangle OAB represents



a) Capacitance
b) Capacitance reactance
c) Magnetic field between the plates
d) Energy stored in the capacitor

28. Which of the following expression represent a volt?
a) joule / coulomb   b) erg / coulomb

c) coulomb / joule   d) coulomb / erg

29. The number of electrons to be put on a spherical conductor of radius 0.1 m to produce an electric field of 0.036 N/C just above its surface is
a) 2.7×10^5 b) 2.6×10^5 c) 2.5×10^5 d) 2.4×10^5

30. The electric field intensity at a point near and outside the surface of a charged conductor of any shape is 'E_1'. The electric field intensity due to uniformly charged infinite thin plane sheet is 'E_2'. The relation between 'E_1' and 'E_2' is
a) $2E_1 = E_2$ b) $E_1 = E_2$ c) $E_1 = 2E_2$ d) $E_1 = 4E_2$

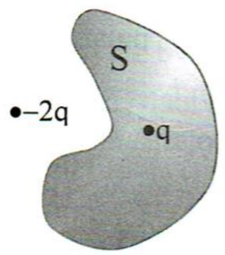
31. The S.I. unit of capacitance of capacitor is
a) Henry   b) Ohm   c) Farad   d) Volt

32. The electric flux through a hemispherical surface of radius R placed in a uniform electric field E parallel to the axis of the circular plane is
a) $(2\pi R)E$ b) $(\pi R^2)R$
c) $\left(\frac{4}{3}\pi R^3\right)E$ d) $\left(\frac{2}{3}\pi R^3\right)E$

33. Eight dipoles of charges of magnitude e are placed inside a cube. The total electric flux coming out of the cube will be
a) $\frac{8e}{\varepsilon_0}$ b) $\frac{16e}{\varepsilon_0}$ c) $\frac{e}{\varepsilon_0}$ d) Zero

34. Eight electric dipoles of charges of magnitude e are placed inside a cube. The electric flux coming out of cube will be :
a) $8\, e/\epsilon_0$ b) $16\, e/\epsilon_0$ c) e/ϵ_0 d) Zero

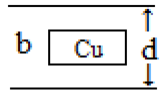
35. In the diagram, the total electric flux through the closed surface S is



a) Zero   b) $\frac{q}{\varepsilon_0}$ c) $\frac{2q}{\varepsilon_0}$ d) $\frac{3q}{\varepsilon_0}$

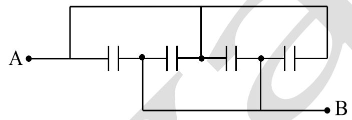
36. Condensers of capacity 4 μF, 5 μF and 6 μF are connected first in series. The effective capacitance is C_1. When they are connected in parallel, the effective capacitance is C_2. Then the ratio C_2/C_1 will be
a) 10   b) 11   c) 12   d) $\frac{37}{4}$

37. A slab of copper of thickness b is inserted in - between the plates of parallel plate capacitor as shown in figure. The separation of the plates is d. If b = d/2, then the ratio of capacities of the capacitor after and before inserting the slab will be:



a) 1: 1   b) 2: 1   c) 1: 2   d) $\sqrt{2}$: 1

38. Four condenser are joined as shown in the adjoining figure. The capacity of each is 8 μF. The equivalent capacity between the points A and B will be

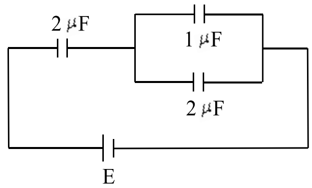


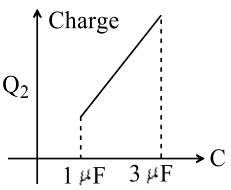
a) 32 μF   b) 2 μF   c) 8 μF   d) 16 μF

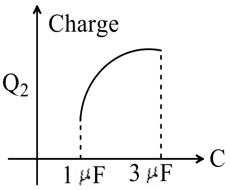
39. Van de Graff generator produces:
a) high voltage & high current
b) high voltage & low current
c) high current and low voltage
d) low current & low voltage

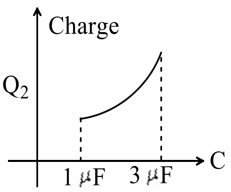
40. The ability of a conductor to store electrical charge is called as
a) Capacitance   b) Resistance
c) Inductance   d) Reactance

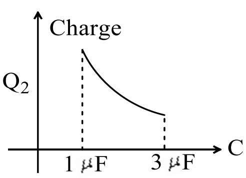
41. In the given circuit, charge Q_2 on the 2 μF capacitor changes as C is varies from 1 μF to 3 μF. Q_2 as a function of C is given properly by : (Figures are drawn schematically and are not to scale)



a)


b)


c)


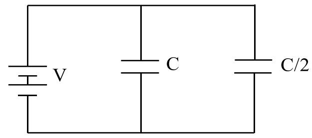
d)


42. A capacitor of capacitance C is charged to a potential V. The flux of the electric field through a closed surface enclosing the

capacitor is

a) $\frac{CV}{\varepsilon_0}$ b) $\frac{2CV}{\varepsilon_0}$ c) $\frac{CV}{2\varepsilon_0}$ d) Zero

43. Two condensers, one of capacity C and the other of capacity C/2, are connected to a V-volt battery is shown



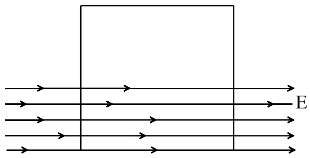
The work done in charging fully both the condensers is

a) $2CV^2$ b) $\frac{1}{4}CV^2$ c) $\frac{3}{4}CV^2$ d) $\frac{1}{2}CV^2$

44. A charge $Q = 18\ \mu C$ is placed at the centre of a cube of edge 55 cm. The electric flux through one of the faces of the cube is

a) Q/ε_0 b) $Q/2\varepsilon_0$ c) $Q/4\varepsilon_0$ d) $Q/6\varepsilon_0$

45. A square surface of side L metres is in the plane of the paper. A uniform electric field $\vec{E}$(volt/m), also in the plane of the paper, is limited only to the lower half of the square surface, (see Figure). The electric flux is S.I. units associated with the surface is



a) Zero b) EL^2
c) $EL^2/(2\varepsilon_0)$ d) $EL^2/2$

46. A capacitor of capacitance 6μF is charged upto 100 volt. The energy stored in the capacitor is

a) 0.6 joule b) 0.06 joule
c) 0.03 joule d) 0.3 joule

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

a) Mica b) Tin
c) Copper d) stainless steel

48. An infinite sheet carrying a uniform surface charge density σ lies on the xy-plane. The work done to carry a charge q from the point $\vec{A} = a(\hat{\imath} + 2\hat{\jmath} + 3\hat{k})$ to the point $\vec{B} = a(\hat{\imath} - 2\hat{\jmath} + 6\hat{k})$ (where a is a constant with the dimensions of length and ε_0 is the permittivity of free space) is

a) $\frac{3\sigma aq}{2\varepsilon_0}$ b) $\frac{2\sigma aq}{\varepsilon_0}$ c) $\frac{5\sigma aq}{2\varepsilon_0}$ d) $\frac{3\sigma aq}{\varepsilon_0}$

49. Two conducting spheres of radii r_1 and r_2 are charged to the same surface charge density. The ratio of electric field near their surface is

a) r_1^2/r_2^2 b) r_2^2/r_1^2 c) r_1/r_2 d) 1:1

50. A condenser is connected across another charged condenser The energy in two condensers will be

a) Equal to the energy in the initial condenser
b) Less than that in the initial condenser
c) More than that in the initial condenser
d) More or less depending upon the relative capacities of the two condensers

51. The electric field required to keep a water drop of mass m just to remain suspended when charged with one electron is :

a) mg b) emg c) mg/e d) me/g

52. Which of the following is not a polar molecule?

a) HCl b) H_2O c) CO_2 d) N_2O

53. In parallel arrangement of capacitors
i. the p.d. across individual capacitor is same
ii. the charge is shared by the capacitor is the ratio of the capacitance
iii. the resultant capacitance is equal to sum of the capacitance of capacitors used

a) Only statement (i) is correct
b) Only statement (ii) is correct
c) Only statement (iii) is correct
d) All three statements are correct

54. The capacity of a parallel plate condenser is 12 μF. Its capacity, when the separation between plates is doubled and area is halved will be

a) 3 μF b) 12 μF c) 8 μF d) 6 μF

55. A parallel plate condenser is made by stacking n equally spaced plates connected together alternatively. If the capacitance between any two consecutive unconnected plates is C, then the combined capacitance is

a) C b) n C
c) $(n + 1)C$ d) $(n - 1)C$

56. During the process of charging a capacitor, some work is done which is stored in the form of

a) Heat energy b) Potential energy
c) Kinetic energy d) Electrostatic energy

57. The electrostatic energy stored in 1 litre volume of air when it is placed in uniform electric field of intensity 10^3 V/m is

a) 44.25×10^{-9} J b) 4.425×10^{-9} J
c) 44.25×10^{-6} J d) 44.25×10^{-5} J

58. A parallel plate air capacitor of capacitance C is connected to a cell of emf V and then disconnected from it. A dielectric slab of

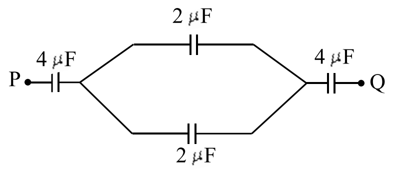
dielectric constant K, which can just fill the air gap of the capacitor, is now inserted in it. Which of the following is incorrect?

a) The potential difference between the plates decreases K times
b) The energy stored in the capacitor decreases K times
c) The change in energy stored is $\frac{1}{2}CV^2\left(\frac{1}{K}-1\right)$
d) The charge on the capacitor is not conserved

59. The dimensions of $(1/2)\ \varepsilon_0 E^2$ (ε_0: permittivity of free space; E : electric field) are
a) $[M^1L^1T^{-1}]$ b) $[M^1L^2T^{-2}]$
c) $[M^1L^{-1}T^{-2}]$ d) $[M^1L^2T^{-1}]$

60. If the number of condensers are connected in series, then their resultant capacitance is
a) lower than the lowest individual capacity
b) higher than the highest individual capacity
c) equal to the sum of the individual capacity
d) cannot be predicted

61. The capacitance between the points P and Q in the following circuit is



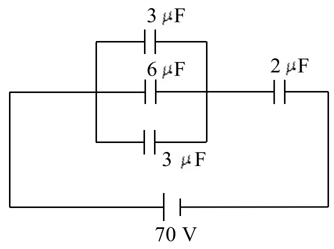
a) 3.5 μF b) 3 μF c) 2 μF d) $\frac{4}{3}$ μF

62. The plates of a charged capacitor are connected to a voltmeter. If the distance between the plates is increased, then the reading of the voltmeter
a) Decrease b) Increases
c) Remains the same d) Reduces to zero

63. A dielectric is introduced between thy elements of the condenser kept at a constant potential difference. Then the charge on condenser
a) Decrease
b) increase
c) remains unchanged
d) may increase or decrease

64. A spherical conductor of radius 2 cm is uniformly charged with 3 nC. What is the electric field at a distance of 3 cm from the centre of the sphere?
a) $3 \times 10^6\ V\ m^{-1}$ b) $3\ V\ m^{-1}$
c) $3 \times 10^4\ V\ m^{-1}$ d) $3 \times 10^{-4}\ V\ m^{-1}$

65. In the given circuit, the potential difference across the 2 μF capacitor is



a) 10 V b) 25 V c) 45 V d) 60 V

66. Which of the following represents electric polarisation?
a) $P = \frac{1}{\sigma_p}$ b) $P = \sigma_p$
c) $P = \sigma_p E$ d) $P = \varepsilon_0 \sigma_p$

67. If ΔV be the change in potential between two neighbouring point Δr apart, then the electric intensity E is given by
a) $V \times \Delta r$ b) $-\frac{\Delta r}{\Delta V}$ c) $-\frac{\Delta V}{\Delta r}$ d) $\left(\frac{\Delta V}{\Delta r}\right)^2$

68. The mechanical stress of a charged conductor is directly proportional to
a) Square of surface charge density
b) Square of electric intensity
c) Both 'a' and 'b'
d) Neither 'a' nor 'b'

69. The ability of a conductor to store electrical charge is called as
a) capacitance b) resistance
c) inductance d) reactance

70. The intensity of electric field at a point due to charged conductor of any shape or plane charged sheet is
a) independent of distance of that point
b) depends on distance of that point
c) independent of charge density and surrounding medium
d) none of these

71. If the area of each plate of a parallel plate condenser is A, the distance between the plates is d, the dielectric medium between the plates is k and the charge on the plates is q, the intensity of electric field between the two plates will be :
a) $\frac{\varepsilon_0 kA}{d}$ b) $\frac{q}{\varepsilon_0 kA}$ c) $\frac{\varepsilon_0 kA}{q}$ d) $\frac{Kq}{\varepsilon_0 Ad}$

72. Electric charge on a body at rest produces
a) electric field
b) magnetic field
c) deficiency of electrons
d) Both 'a' and 'b'

73. Three capacitors of capacitance 3 μF, 10 μF

and 15 μF are connected in series to a voltage source of 100 V. The charge on 15 μF is

a) 50 μC b) 100 μC c) 200 μC d) 280 μC

74. The charge in uniform motion, produces

a) electric field b) magnetic field
c) both' a' and 'b' d) neither' a' nor 'b'

75. A parallel plate capacitor is charged by connecting its plates to the terminal of a battery. The battery remains connected and a glass plate is interposed between the plates of the capacitor, then

a) The charge on the plates will be reduced
b) The potential difference between the plates will be reduced
c) The charge on the plates will increase
d) The potential difference between the plates will increase

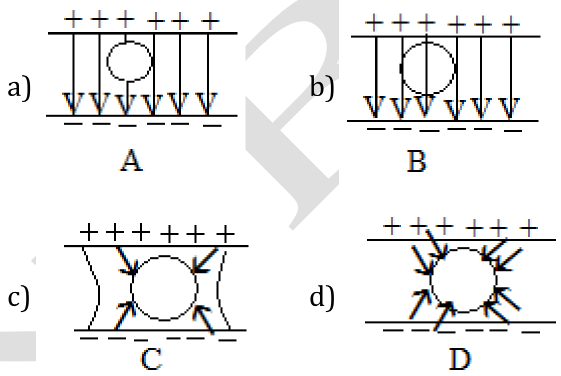
76. The charge on 48 μF capacitor is increased from 0.1 C to 0.5 C. The energy stored in the capacitor increases by

a) 2.42×10^{-6} J b) 250 J
c) 2500 J d) 2.5×10^{6} J

77. A 12 pF capacitor is connected to a 50 V battery. How much electrostatic energy is stored in the capacitor?

a) 1.5×10^{-8} J b) 2.5×10^{-7} J
c) 3.5×10^{-5} J d) 4.5×10^{-2} J

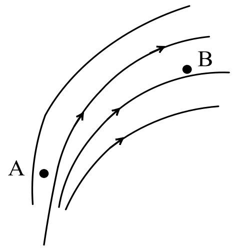
78. An uncharged sphere of metal is placed in between two charged plates as shown. The lines of force look like:



79. Induced surface density of a medium with dielectric is represented as

a) $\sigma_i = \sigma(1 + k)$ b) $\sigma_i = \sigma\left(1 - \frac{1}{k}\right)$
c) $\sigma_i = \sigma\left(1 + \frac{1}{k}\right)$ d) $\sigma_i = \sigma\left(\frac{1}{k} - 1\right)$

80. The figure shows electric lines of force in a region. If E_A and E_B are electric fields at points A and B separated by distance r, then



a) $E_A > E_B$ b) $E_A = E_B/r$
c) $E_A < E_B$ d) $E_A = E_B^2/r$

81. Van de Graff generator is used to

a) carry out radioactive disintegration
b) produce ac voltage
c) convert ac into dc voltage
d) produce total internal reflection

82. What is the flux through a cube of side ‘a’ if a point charge of q is at one of its corner?

a) $\frac{2q}{\varepsilon_0}$ b) $\frac{q}{8\varepsilon_0}$ c) $\frac{q}{\varepsilon_0}$ d) $\frac{q}{2\varepsilon_0}6a^2$

83. Electric lines of force about a sphere rich in electrons are:

a) circular clockwise b) circular anticlockwise
c) radially outward d) radially inward

84. The property acquired by the material body when it is rubbed with another body is

a) Charge b) Mass
c) Resistance d) Inductance

85. A cylinder of radius R and length L is placed in a uniform electric field E parallel to the cylinder axis. The total flux from the top and bottom faces of the cylinder is

a) $2\pi R^2 E$ b) $\pi R^2 E$ c) Zero d) $\frac{\pi R^2 E}{2}$

86. The equivalent capacity of n identical capacitors each of capacity C connected in parallel is

a) n C b) (n –1) C c) n^2 C d) C/n

87. The earth has volume ‘V’ and Surface Area ‘A’ then capacitance would be

a) $4\pi\varepsilon_0 \frac{A}{V}$ b) $4\pi\varepsilon_0 \frac{V}{A}$
c) $12\pi\varepsilon_0 \frac{V}{A}$ d) $12\pi\varepsilon_0 \frac{A}{V}$

88. If the number of condensers are connected in series then

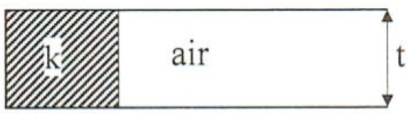
a) charge on each condenser is same and potential is different
b) potential is same but charge is different
c) both charge and potential is same
d) both charge and potential is different

89. If S is the surface area of charged conductor on which the surface density of charge is σ and k

is the dielectric constant of the medium around it, then outward force acting on the surface of the conductor is

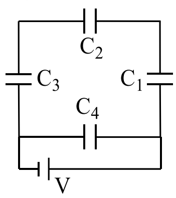
a) $\frac{\sigma^2}{2\varepsilon_0 k}$ b) $\frac{\sigma}{\varepsilon_0 k}S$ c) $\frac{\sigma^2}{2\varepsilon_0 k}S$ d) $\frac{\sigma^2}{\varepsilon_0 k}S$

90. A parallel plate capacitor with air as the dielectric has capacitance C. A slab of dielectric constant k and having the same thickness as the separation between the plates is introduced so as to fill one-fourth of the capacitor as shown in the figure. The new capacitance will be



a) $(k+3)\frac{C}{4}$ b) $(k+2)\frac{C}{4}$
c) $(k+1)\frac{C}{4}$ d) $\frac{kC}{4}$

91. A network of four capacitors of capacities equal to $C_1 = C, C_2 = 2C, C_3 = 3C$ and $C_4 = 4C$ are connected to a battery as shown in the figure



The ratio of the charge on C_2 and C_4 is

a) $\frac{22}{3}$ b) $\frac{3}{22}$ c) $\frac{7}{4}$ d) $\frac{4}{7}$

92. Two conducting spheres of radii r_1 and r_2 are charged to the same surface charge density. The ratio of electric field near their surface is

a) r_1^2/r_2^2 b) r_2^2/r_1^2 c) r_1/r_2 d) 1:1

93. A dielectric is introduced between the elements of the condenser kept ,at constant potential difference. Then the charge on the condenser:

a) Increases
b) Decreases
c) Remains same
d) First increases and then decreases

94. The surface charge density of a conductor is 12×10^{-12} C/m^2. If the conductor surrounded by a medium of dielectric constant 3.14, the magnitude of electric field just outside the conductor is

$(\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \text{Nm}^2/\text{C}^2)$

a) 0.18 V/m b) 0.36 V/m
c) 0.43 V/m d) 3.6 V/m

95. A sphere of radius ‘R’ contains charge density $\rho(r) = A(R - r)$, for $0 < r < R$. The total electric charge inside the sphere is Q. Then A in terms of Q and R is given by

a) $\frac{2Q}{\pi r^2}$ b) $\frac{3Q}{\pi r^4}$ c) $\frac{Q}{\pi r^4}$ d) $\frac{5Q}{\pi r^2}$

96. When a conducting slab wholly fills the space between the two plates of a capacitor, it's Capacitance

a) becomes infinite
b) becomes four times the original one
c) remains same
d) becomes zero

97. The outer sphere of a spherical air capacitor is earthed. For increasing its capacitance,

a) Vacuum is created between two spheres
b) Dielectric material is filled between two spheres
c) The space between two spheres is increased
d) The earthing of the outer sphere is removed

98. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will

a) Be doubled b) Increase four times
c) Be reduced to half d) Remain the same

99. Magnitude of work done during the charging of a condenser from q = 0 to q = Q is

a) $W = \frac{C^2}{Q}$ b) $W = \frac{Q^2}{C}$ c) $W = \sqrt{\frac{Q}{C}}$ d) $W = \frac{Q}{C}$

100. The path traced by a unit positive charge in an electric field is

a) electric line of force b) magnetic line of force
c) both 'a' and 'b' d) neither' a' nor 'b'

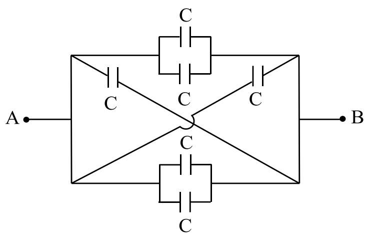
101. A cube of side l is placed in a uniform field E, where $E = E\hat{i}$. The net electric flux through the cube is

a) Zero b) l^2E c) $4l^2E$ d) $6l^2E$

102. A parallel plate capacitor is charged and then disconnected from the charging battery. If the plates are now moved farther apart by pulling them by means of insulating handles, then

a) The energy stored in the capacitor decreases
b) The capacitance of the capacitor increases
c) The charge on the capacitor decreases
d) The voltage across the capacitor increases

103. Six capacitors, each of capacitance of 2 μF, are connected as shown in the figure. The effective capacitance between A and B is



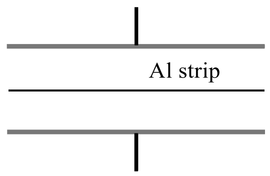
a) 12 μF b) $\frac{8}{3}$ μF c) 3 μF d) 6 μF

104. The law, which gives the force between two electric charges, is
a) Ohm's law b) Ampere's law
c) Faraday's law d) Coulomb's law

105. An electric field $\vec{E} = (2\hat{i} + \hat{j})\frac{N}{C}$ exists in space. The potential difference $(V_P - V_Q)$ between two points whose positions vectors $\vec{r}_P = \hat{i} + 2\hat{j}$ and $\vec{r_Q} = 2\hat{i} + \hat{j} + \hat{k}$ is
a) 1 V b) −2 V c) −3 V d) +4 V

106. Electric intensity at a place due to a charge is a ________ quantity
a) Vector b) Scalar
c) Unitless d) Dimensionless

107. As shown in the figure, a very thin sheet of aluminium is placed in between the plates of the condenser. Then the capacity



a) Will increase
b) Decrease
c) Remains unchanged
d) May increase or decrease

108. Electric lines of force originate from positive charge and terminate on
a) positive charge b) neutral charge
c) negative charge d) none of these

109. Cylinder is charged by 10 mC. Length of cylinder is 1 km and radius is 1 mm. Surface charge density of cylinder is
a) 1.59×10^{-4} C/m^2 b) 1.59×10^{-6} C/m^2
c) 1.59×10^{-3} C/m^2 d) 1.59×10^{-2} C/m^2

110. Three capacitors, 3 μF, 6μF and 6μF are connected in series to a source of 120 V. The potential difference, in volts, across the 3 μF capacitor will be
a) 24 b) 30 c) 40 d) 60

111. The charge deposited per unit length of cylinder is called as :
a) Linear charge density
b) Surface charge density
c) Volume charge density
d) All of these

112. The surface density of charge on the surface of a charged conductor in air is 0.885 μC/m^2. If $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2, then the outward force per unit area of the charged conductor is
a) 5×10^{-2}N/m^2 b) 4.425×10^{-2}N/m^2
c) 8.85×10^{-2}N/m^2 d) 5×10^{-3}N/m^2

113. The equivalent capacity of number of condensers can be increased if they are connected in
a) series
b) parallel
c) both series and parallel
d) neither series nor parallel

114. The energy density of air medium is 44.25×10^{-8} J/m^3. The intensity of the electric field in the medium is
a) 300 N/C b) 3 N/C
c) 305 N/C d) 316.2 N/C

115. A charge 2q is placed at the mouth of a conical flask. The electric flux through the flask will be
a) Zero b) $\frac{Q}{\varepsilon_0}$ c) $\frac{Q}{2\varepsilon_0}$ d) $< \frac{Q}{2\varepsilon_0}$

116. A capacitor $C_1 = 4$ μF is connected in series with another capacitor $C_2 = 1$ μF. The combination is connected across d.c. source of 200 V. The ratio of potential across C_2 to C_1 is
a) 2 : 1 b) 4 : 1 c) 8 : 1 d) 16 : 1

117. Which of the following is not a solid dielectrics?
a) Ceramic b) Glasses c) Mica d) Magnesia

118. A parallel plate capacitor has a capacity C. If a medium of dielectric constant k is introduced between plates, the capacity of capacitor becomes
a) $\frac{C}{k}$ b) $\frac{C}{k^2}$ c) k^2C d) kC

119. The number of tubes of force originating from a – charge of magnitude q are
a) $\frac{q}{\epsilon_0 k}$ b) $\frac{q}{\epsilon_0}$ c) $q \epsilon_0 k$ d) $\frac{\epsilon_0 k}{q}$

120. In a charged capacitor, the energy resides
a) In the positive charges
b) In both the positive and negative charges
c) In the field between the plates
d) Around the edges of the capacitor plates

121. A parallel plate capacitor with air between the plates has a capacitance of 8 pF. The separation between the plates is now reduced

by half and the space between them is filled with medium of dielectric constant 5. The value of capacitance of a capacitor in the second case is

a) 0.8 pF b) 3.2 pF c) 80 pF d) 40 pF

122. The electric field in a region is radially outward with magnitude $E = A\gamma_0$. The charge contained in a sphere of radius γ_0, centered at the origin is

a) $\frac{1}{4\pi\varepsilon_0}A\gamma_0^3$ b) $4\pi\varepsilon_0 A\gamma_0^3$

c) $\frac{4\pi\varepsilon_0 A}{\gamma_0}$ d) $\frac{1}{4\pi\varepsilon_0}\frac{A}{\gamma_0^3}$

123. If the number of condensers are connected one after another then this type of combination of condensers is

a) condensers in series
b) condensers in parallel
c) condensers in series and parallel
d) none of these

124. When one electron is taken towards the other electron, then the electrostatic energy of the system

a) decreases b) increases
c) remains unchanged d) becomes zero

125. Electric field of an isolated charged metallic sphere at any interior point is

a) Zero b) One
c) Proportional to field d) Infinite

126. n identical droplets are charged to V volt each. If they coalesce to form a single drop, then its potential will be

a) $n^{2/3}V$ b) $n^{1/3}V$ c) nV d) V/n

127. A capacitor of capacitance 5 μF is being charged from a d.c. source of 20 V. The capacitance as a function of potential is given by (10V + 4) volt. The energy stored in the capacitor is

a) 10400 J b) 14000 J c) 10040 J d) 10000 J

128. A solid cylindrical insulator of uniform density having length 4 and radius 2 contains charge Q. Find the value of the electric field at a distance L along the axis from one end. (L = length of insulator)

a) $\frac{Q}{16\pi\varepsilon_0}(2-\sqrt{17})$

b) $\frac{Q}{32\pi\varepsilon_0}(2+\sqrt{5})$

c) $\frac{Q}{16\pi\varepsilon_0}(\sqrt{5}-\sqrt{17})$

d) $\frac{Q}{16\pi\varepsilon_0}(2-\sqrt{17}+\sqrt{5})$

129. Inside a hollow spherical conductor, the potential

a) is constant
b) varies directly as the distance from the centre
c) varies inversely as the distance from the centre
d) varies inversely as the square of the distance from the centre

130. The maximum electric flux can passed through the surface when electric intensity would be inclined to the surface by an angle of:

a) 180° b) 90° c) 0° d) 360°

131. In Van de Graff generator, potential difference is of the order of

a) 10^9 volt b) 10^{13} volt c) 10^{12} volt d) 10^7 volt

132. Choose the correct relation between polarisation and electric susceptibility of dielectric material

a) $P = \frac{\chi}{E}$ b) $P = \chi/E^2$ c) $P = \chi E$ d) $P = \chi^2 E$

133. Which of the following will not change if dielectric slab is introduced in a charged condenser?

a) Charge b) Potential c) Capacity d) Energy

134. A wire is bent to form a semi circle such that the radius of the semicircle is R. The charge per unit length is λ. The total electric field at the centre will be

a) $2\lambda/\pi\varepsilon_0 R$ b) $\lambda/2\pi\varepsilon_0 R$
c) $2\lambda/\pi\varepsilon_0 R^2$ d) $\lambda/\pi\,\varepsilon_0^2\,R$

135. A parallel plate capacitor is charged. If the plates are pulled apart

a) the potential difference increases
b) the capacitance increases
c) the total charge increases
d) the charge and the potential difference remain the same

136. The number of tubes of force emerging normally through unit area of sphere's surface drawn around a charge q in a medium of permittivity ∈ is $\frac{q}{4\pi\epsilon r^2}$ It is also called as

a) Electric intensity b) Coulomb's force
c) Electric potential d) None of these

137. A parallel plate capacitor of 6 μF is connected across 18 V battery and charged. The battery is then disconnected and oil of dielectric constant

k = 2.1 is introduced between the plates. What will be the charge on capacitor?

a) 51.4 μC b) 108 μC
c) 8.5 μC d) 92.5×10^2 C

138. The relation between electric charge, electric potential and capacity is

a) $C = \frac{Q}{V}$ b) $C = \frac{V}{Q}$ c) $V = QC$ d) $C = \frac{Q^2}{V}$

139. A 2 μF capacitor is charged to 100 volt and then its plates are connected by a conducting wire, the heat produced is

a) 1 J b) 0.1 J c) 0.01 J d) 0.001 J

140. The magnitude of an electric intensity at a point which is at a distance 'r' from the centre of a charged spherical conductor of radius 'R' in terms of the surface charge density 'σ' is given by 'E' where

a) $E = \frac{\sigma}{k\varepsilon_0 r^2}$ b) $E = \frac{\sigma R}{k\varepsilon_0 r^2}$
c) $E = \frac{\sigma R^2}{k\varepsilon_0 r^2}a$ d) $E = \frac{\sigma^2 R}{k\varepsilon_0 r^2}$

141. Fight drops of mercury of equal radii possessing equal charges combine to form a big drop. Then the capacitance of bigger drop compared to each individual small drop is

a) 8 times b) 4 times c) 2 times d) 32 times

142. A spherical conductor of radius 2 m is charged to a potential of 120 V. It is now placed inside another hollow spherical conductor of radius 6 m. Calculate the potential to which the bigger sphere would be raised

a) 20 V b) 60 V c) 80 V d) 40 V

143. The unit of charge density of a charged conductor is

a) Coulomb/m b) Coulomb/m^2
c) Coulomb/m^3 d) Coulomb

144. In bringing an electron towards another electron electrostatic P. E. of the system:

a) Increases b) Decreases
c) Remains same d) Becomes zero

145. Artificial transmutation is the process in which

a) Bombardment of highly energetic particles on nucleus of an element causes it to form some other element
b) Bombardment of lower energy particles on nucleus causes it to get transformed into other element
c) Energetic particles become inactive
d) Energetic particles become reactive

146. The total number of electric lines of force passing normally through a given area is,

a) electric flux b) magnetic flux
c) flux density d) none of these

147. A conductor of capacity 10 μF is at a potential of 10 V. If the potential increases by 1 V, the increase in energy is

a) 1 μJ b) 210 μJ c) 105 μJ d) 10.5 μJ

148. A parallel plate capacitor is charged to a certain potential difference. A slab of thickness 3 mm is inserted between the plates and it becomes necessary to increase the distance between the plates by 2.4 mm to maintain the same potential difference. The dielectric constant of the slab is

a) 3 b) 5 c) 1.8 d) 2.438

149. The electric lines of force do not passes through

a) metals b) conductors
c) semiconductors d) all of these

150. The dimensions of electric intensity are

a) $[M^0L^0T^1A^1]$ b) $[M^1L^3T^{-3}A^{-1}]$
c) $[M^1L^1T^{-3}A^{-1}]$ d) $[M^1L^{-1}T^3A^1]$

151. A point charge causes an electric flux of –200 Nm^2/C to pass through spherical Gaussian surface of 10 cm radius centered on the charge If the radius of the Gaussian surface is doubled total electric flux passing through the surface is

a) – 200 Nm^2/C b) – 100 Nm^2/C
c) + 200 Nm^2/C d) – 50 Nm^2/C

152. While a capacitor remains connected to a battery and dielectric slab is inserted between the plates, then

a) Potential difference between the plates is changed
b) Charge flows from the battery to the capacitor
c) Electric field between the plates increases
d) Energy stored in the capacitor decreases

153. The maximum value of dielectric constant for conductor (metals) is :

a) Zero b) One
c) Infinity d) in between 0 & 1

154. A capacitor of 20 μF charged up to 500 volts in connected in parallel with another capacitor of 10 μF which is charged up to 200 V. The common potential is

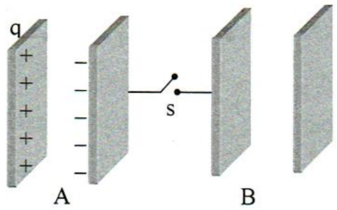
a) 500 V b) 400 V c) 300 V d) 200 V

155. The ratio of charge given to the conductor, to the increase in its potential due to this charge is called:

a) Capacity of conductor

b) Resistance of conductor
c) Reactance of conductor
d) Impedance of conductor

156. 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

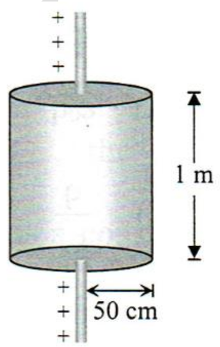


a) Zero b) q/2 c) q d) 2q

157. The capacity of a parallel plate condenser depends upon
a) area of the plate only
b) distance between the two plates only
c) permittivity constant of a dielectric medium only
d) all of these

158. Gauss' law helps in
a) Determination of electric force between point charges
b) Situations where Coulomb's law fails
c) Determination of electric field due to symmetric charge distribution
d) Determining electric potential due to symmetric charge distribution

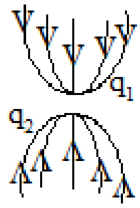
159. Electric charge is uniformly distributed along a long straight wire of radius 1mm. The charge per cm length of the wire is Q coulomb. Another cylindrical surface of radius 50 cm and length 1m symmetrically encloses the wire as shown in the figure. The total electric flux passing through the cylindrical surface is



a) $\frac{Q}{\varepsilon_0}$ b) $\frac{100Q}{\varepsilon_0}$ c) $\frac{10Q}{(\pi\varepsilon_0)}$ d) $\frac{100Q}{(\pi\varepsilon_0)}$

160. If an isolated metallic conductor is positively charged, then its mass will
a) Increase
b) Decrease
c) remain same
d) reduce to half of its original mass

161. The below figure gives electric lines of force due to two charges q_1 and q_2 What are the sings of the two changes?



a) Both are positive
b) Both are negative
c) q_1 is positive and q_2 is negative
d) q_2 is positive and q_2 is negative

162. If σ is the surface density of charge on a conductor and k is dielectric constant of medium around it, then electric intensity at a point close to it is :
a) $\frac{\sigma}{K \in_0}$ & *parallel to the surface*
b) $\frac{2\sigma}{K \in_0}$ & *parallel to the surface*
c) $\frac{\sigma}{K \in_0}$ & *normal to the surface*
d) $\frac{2\sigma}{K \in_0}$ & *normal to the surface*

163. A 4 μF capacitor is charged to 400 V. If its plates are joined through a resistance, then heat produced in the resistance will be
a) 0.16 J b) 0.32 J c) 0.64 J d) 1.28 J

164. The total electric flux through a cube when a charge 8q is placed at one corner of the cube is
a) $\varepsilon_0 q$ b) $\frac{\varepsilon_0}{q}$ c) $\frac{q}{\varepsilon_0}$ d) $\frac{q}{4\pi\varepsilon_0}$

165. If the number of condensers are connected in series, then
a) charge on each condenser is same and potential is different
b) potential is same but charge is different
c) both charge and potential are same
d) both charge and potential are different

166. Two concentric spherical conducting shells of radii R and 2R carry charges Q and 2Q respectively. When both the shells are connected by a conducting wire, the change in potentials on the outer shells is $\left(k = \frac{1}{4\pi\varepsilon_0}\right)$
a) Zero b) $\frac{kQ}{R}$ c) $\frac{2kQ}{R}$ d) $\frac{3kQ}{R}$

167. The properties of electric lines of force tubes of

force and tubes of induction are
a) Never similar
b) Approximately similar
c) Exactly similar
d) none of these

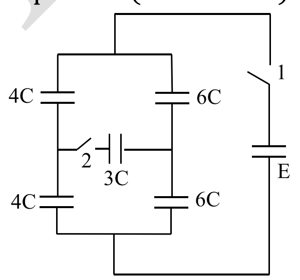
168. A parallel plate capacitor is charged to a potential different of 50 V. It is discharged through a resistance. After 1 second, the potential different between plates becomes 40 V. Then
a) Fraction of stored energy after 1 second is 16/25
b) Potential difference between the plates after 2 seconds will be 32 V
c) Potential difference between the plates after 2 seconds will be 20 V
d) Fraction of stored energy after 1 second is 4/5

169. A dielectric is introduced between the elements of the condenser kept at a constant potential difference, then the charge on condenser
a) Decreases
b) Increases
c) Unchanged
d) may increase or decrease

170. Which of the following mathematical statement of Gauss theorem (q – charge ∈ permittivity of medium around a charge q)
a) T.N.E.F = q / ∈ b) T.N.E.F. = q
c) T.N.E.I. = q∈ d) T.N.E.I. = ∈/q

171. The radius between electric intensity E_s and E_c at a point out Side of sphere and charged cylinder of length ℓ at the same distance r from their respective centre and axis is:
a) $E_s = \frac{E_c\ell}{2r}$ b) $E_s = \frac{E_c\ell r}{2}$
c) $E_s = \frac{E_c}{2\ell}$ d) $E_s = \frac{E_c r}{2\ell}$

172. Calculate the energy stored in the 6C capacitor when Switch-1 is closed. Switch-2 is closed now. Find the energy stored in the 3C capacitor (in S.I. units)



a) Zero b) 12 c) 15 d) 18

173. One group of limited number of lines of force forming a tube like structure in dielectric medium is
a) tube of force b) tube of induction
c) tube of air d) none of these

174. The capacity of spherical conductor of radius R ca,.'rrying charge Q situated in a medium of permitivity ($\in = k\in_0$)is :
a) $4\ \pi k\in_0 R^2$ b) $4\ \pi k\in_0 R$
c) $4\ \pi k\in_0/R^2$ d) $4\ \pi k\in_0/R$

175. There is force of repulsion between two like charges, because electric lines of force
a) exert lateral pressure on one another
b) exert normal pressure on one another
c) exert no pressure on one another
d) none of these

176. In S.I. system, coulomb–meter is unit of
a) electric intensity
b) electric potential
c) electric flux
d) electric dipole moment

177. Van de Graff generator is used to produce high energetic charged particles of energy of about
a) 10 MeV b) 50 MeV c) 100 MeVd) 0.5 MeV

178. The Gaussian surface needed for calculating the electric field due to a charge distribution is
a) any surface around the charge distribution
b) only spherical surface
c) any closed surface around the charge
d) only cylindrical surface

179. Two charges are placed at a distance, if glass slab is placed between them then the force between them will :
a) Decreases b) Increases
c) Remains same d) Becomes infinite

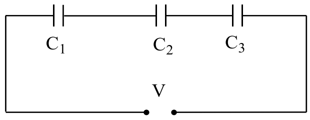
180. A cylinder of radius 5 mm and surface charge density of 2 $\mu C/m^2$ is surrounded by a medium of dielectric constant 6.28. The magnitude of electric field at a point 2 m away from the axis of the cylinder is ($\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ Nm^2/C^2$)
a) 180 V/mb) 50 V/m c) 90 V/m d) 45 V/m

181. The total number of tubes of induction passing normally through unit area is called as
a) electric flux b) flux density
c) electric intensity d) both 'b' and' c'

182. Two parallel metal plates 2.0 cm apart, are connected to a 200 V battery. A proton with a positive charge 1.6×10^{-19} C is located between the plates. The electric field intensity between the plates is

a) 5000 V/m b) 10000 V/m
c) $3.2 \times 10^{-6} \frac{V}{m}$ d) 50,000 V/m

183. In the figure, three capacitors, each of capacitance 6 pF, are connected in series. The total capacitance of the combination will be



a) 9×10^{-12}F b) 6×10^{-12}F
c) 3×10^{-12}F d) 2×10^{-12}F

184. The dot product of E and normal area ds, calculated over the closed surface, is
a) electric field b) electric flux
c) electric potential d) all of these

185. If a positively charged body is connected to earth, its potential becomes:
a) Zero b) Infinity
c) Positive d) Negative

186. A capacitor of 30 μF charged up to 500 volt is connected in parallel with another capacitor of 15 μF which is charged up to 300 V. The common potential is
a) 433 V b) 450 V c) 333 V d) 350 V

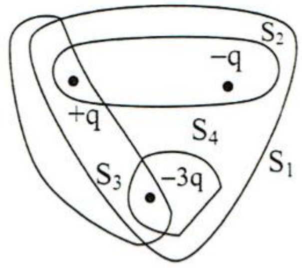
187. Three identical condensers are connected in parallel. The combination is connected in series with one identical condenser. If resultant capacity 3.75 μF, then the capacity of individual condenser is
a) 3 μF b) 5 μF c) 9 μF d) 14 μF

188. The distance between the plates of parallel plate capacitor is d. A metal plate of thickness d/2 is placed between the plates. The capacitance would then be :
a) unchanged b) Zero
c) single d) doubled

189. A capacitor works in :
a) D.C. circuits
b) A.C. circuits
c) Both in A.C. & D.C.
d) Neither in A.C. nor in D.C. circuit

190. An air capacitor of capacity C = 10 μF is connected to a constant voltage battery of 12 V. Now the space between the plates is filled with a liquid of dielectric constant 5. The charge that flows now from battery to the capacitor is
a) 120 μC b) 699 μC c) 480 μC d) 24 μC

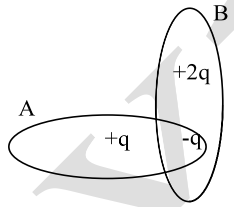
191. Four closed surfaces S_1, S_2, S_3 and S_4 together with charges +q, −q and −3q are shown. Through which one of the surfaces is the net flux zero?



a) S_1 b) S_2 c) S_3 d) S_4

192. A hollow sphere of charge does not produce an electric field at any
a) interior point b) outer point
c) beyond 2 m d) beyond 10 m

193. What is T.N.E.I through the surface A and B respectively?

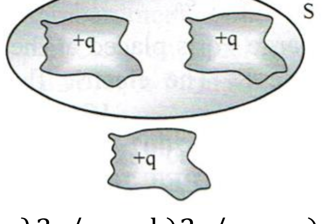


a) (q, 2q) b) (−q, −2q)
c) (0, q) d) (q, 0)

194. The product of electric intensity and permittivity constant of a dielectric medium is called
a) total normal electric induction
b) normal electric induction
c) electric potential
d) electric energy

195. Two parallel metal plates having charges +Q and – Q face each other at a certain distance between them. If the plates are now dipped in kerosene oil tank, the electric field between the plates will
a) Become zero b) Increase
c) Decrease d) Remain same

196. Shown below is a distribution of charges. The flux of electric field due to these charges through the surface S is



a) $3q/\varepsilon_0$ b) $2q/\varepsilon_0$ c) q/ε_0 d) Zero

197. Van de Graff generator is used for the production of
a) High potential difference
b) Low potential difference

c) Moderate potential difference
d) High temperature

198. When dielectric is inserted in the space between plates of a capacitor, then
a) Magnitude of charge increases
b) Magnitude of charge decreases
c) Charge remains the same
d) Charge becomes zero

199. Which of the following instruments works on the principle of action of sharp points?
a) Van de Graff generator
b) Cyclotron
c) Dynamo
d) Induction coil

200. A point charge +q is placed at the centre of a cube of side L. The electric flux emerging from the cube is
a) $\frac{q}{\varepsilon_0}$ b) Zero c) $\frac{6qL^2}{\varepsilon_0}$ d) $\frac{q}{6L^2\varepsilon_0}$

N.B.Navale

Date : 28.03.2025
Time : 03:00:00
Marks : 200

TEST ID: 54
PHYSICS

3.ELECTROSTATICS,8.ELECTROSTATICS

: ANSWER KEY :

1)	b	2)	c	3)	c	4)	c	105)	a	106)	a	107)	c	108)	c
5)	a	6)	a	7)	b	8)	c	109)	c	110)	d	111)	a	112)	b
9)	b	10)	b	11)	b	12)	c	113)	b	114)	d	115)	b	116)	b
13)	d	14)	b	15)	b	16)	a	117)	d	118)	d	119)	a	120)	c
17)	d	18)	d	19)	c	20)	c	121)	c	122)	b	123)	a	124)	b
21)	c	22)	d	23)	a	24)	a	125)	a	126)	a	127)	a	128)	d
25)	d	26)	a	27)	d	28)	a	129)	a	130)	b	131)	d	132)	c
29)	c	30)	c	31)	c	32)	b	133)	a	134)	b	135)	a	136)	a
33)	d	34)	d	35)	b	36)	d	137)	b	138)	a	139)	c	140)	c
37)	b	38)	a	39)	b	40)	a	141)	c	142)	d	143)	b	144)	a
41)	b	42)	d	43)	c	44)	d	145)	a	146)	a	147)	c	148)	b
45)	a	46)	c	47)	a	48)	a	149)	d	150)	c	151)	a	152)	b
49)	d	50)	b	51)	c	52)	c	153)	c	154)	b	155)	a	156)	a
53)	d	54)	a	55)	d	56)	d	157)	d	158)	c	159)	b	160)	b
57)	b	58)	d	59)	c	60)	a	161)	b	162)	c	163)	b	164)	c
61)	d	62)	b	63)	b	64)	c	165)	a	166)	a	167)	c	168)	a
65)	d	66)	b	67)	c	68)	c	169)	b	170)	a	171)	a	172)	a
69)	a	70)	a	71)	b	72)	a	173)	b	174)	b	175)	a	176)	d
73)	c	74)	c	75)	c	76)	c	177)	a	178)	c	179)	a	180)	c
77)	a	78)	c	79)	b	80)	a	181)	d	182)	b	183)	d	184)	b
81)	a	82)	b	83)	c	84)	a	185)	a	186)	a	187)	b	188)	d
85)	c	86)	a	87)	c	88)	a	189)	c	190)	c	191)	b	192)	a
89)	c	90)	a	91)	b	92)	d	193)	c	194)	b	195)	c	196)	b
93)	a	94)	c	95)	b	96)	a	197)	a	198)	c	199)	a	200)	a
97)	b	98)	d	99)	b	100)	a								
101)	a	102)	d	103)	a	104)	d								

N.B.Navale

Date : 28.03.2025 **TEST ID: 54**
Time : 03:00:00 **PHYSICS**
Marks : 200

3.ELECTROSTATICS,8.ELECTROSTATICS

: HINTS AND SOLUTIONS :

Single Correct Answer Type

11 **(b)**

Relation for electric field is given by,

$E = \dfrac{\lambda}{2\pi\varepsilon_0 r}$

$\therefore \lambda = 2\pi\varepsilon_0 rE = \dfrac{2 \times 2\pi\varepsilon_0 rE}{2}$

$= \dfrac{1 \times 2 \times 10^{-2} \times 7.182 \times 10^{8}}{2 \times 9 \times 10^{9}} = 7.98 \times 10^{-4}\text{C/m}$

12 **(c)**

3 plate – forms (3–1) = 2 condenser

4 plate – forms (4–1) = 3 condenser

5 plate – forms (n–1) = (n–1) condenser

14 **(b)**

$E = \dfrac{Q}{4\pi\varepsilon_0 R^2}$

$\therefore E_{max} = \dfrac{Q_{max}}{4\pi\varepsilon_0 R^2}$

$\therefore Q_{max} = 4\pi\varepsilon_0 R^2 \times E_{max}$

$= \dfrac{1}{9 \times 10^{9}} \times (10 \times 10^{-2})^2 \times 2 \times 10^{6}$

$= \dfrac{2}{9} \times 10^{-5}\text{C}$

15 **(b)**

$U_1 + U_2 = \dfrac{1}{2}C_1V_1^2 + \dfrac{1}{2}C_2V_2^2$

$= \dfrac{1}{2}[4 \times 10^{-6} \times 50 \times 50 + 2 \times 10^{-6} \times 100 \times 100]$

$= \dfrac{1}{2}[10^{-2} + 2 \times 10^{-2}] = \dfrac{3}{2} \times 10^{-2}\text{ J}$

16 **(a)**

$E = \dfrac{\lambda}{2\pi\varepsilon_0 r}$

$\therefore \lambda = 2\pi\, \varepsilon_0 r\, E = \dfrac{4\pi\varepsilon_0 rE}{2}$

$= \dfrac{1}{2 \times 9 \times 10^{9}} \times 4 \times 10^{-2} \times 9 \times 10^{4}$

$= 2 \times 0^{-7}\text{C m}^{-1}$

17 **(d)**

There are two loops, each having two capacitors of 20 μF each in parallel

$C_{eff.} = 20 + 20 = 40\ \mu\text{F}$ for each loop

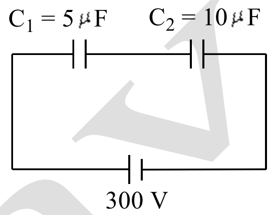
Now, these two capacitors of 40 μF each are in series

$C_{eff.} = \dfrac{40 \times 40}{40 + 40} = \dfrac{1600}{80} = 20\ \mu\text{F}$

19 **(c)**

Electric field near the surface of the conductor is given by, $\frac{\sigma}{\varepsilon_0}$ and it is perpendicular to surface

21 **(c)**



$C_{eq} = \left[\dfrac{1}{C_1} + \dfrac{1}{C_2}\right]^{-1} = \dfrac{C_1C_2}{C_1 + C_2}$

$= \dfrac{5 \times 10}{15} = \dfrac{10}{3}\mu\text{F}$

$= \dfrac{10}{3} \times 10^{-6}\text{F}$

$U = \dfrac{1}{2}C_{eq}V^2 = \dfrac{1}{2} \times \dfrac{10}{3} \times 10^{-6} \times 300^2 = 0.15\text{ J}$

22 **(d)**

For the soap bubble,

$P_m - P_{out} = P_{excess} = P_{ST} - P_{electro}$

$= \dfrac{4R}{r} - \dfrac{q^2}{2A^2\varepsilon_0}$

$= \dfrac{4T}{r} - \dfrac{q^2}{2(4\pi r^2)^2\varepsilon_0}$

$= \dfrac{4T}{r} - \dfrac{q^2}{32\pi^2 r^4\varepsilon_0}$

For equilibrium,

$P_m = P_{out}$

$\therefore \dfrac{4T}{r} = \dfrac{q^2}{32\pi^2 r^4 \varepsilon_0}$

$\therefore q = \sqrt{\dfrac{128\pi^2 r^4\varepsilon_0 T}{r}} = \sqrt{\dfrac{16 \times 8\pi^2\, r^4\varepsilon_0 T}{r}}$

$\therefore q = 4\pi r^2\sqrt{\dfrac{8\varepsilon_0 T}{r}}$

23 **(a)**

T.N.E.I. does not depend upon shape or the size of

Gaussian surface but depends only upon charge enclosed within the surface

24 **(a)**

Work done in compression

= Energy stored in condenser

⇒ Ratio of energies = 1

25 **(d)**

The electric field is always perpendicular to the surface of a conductor. On the surface of a metallic solid sphere, the electrical field is oriented normally (*i.e.* directed towards the centre of the sphere)

26 **(a)**

$$f=\frac{\sigma^2}{2\varepsilon_0 k}=\frac{q^2}{2\varepsilon_0 k ds^2}$$

$$=\frac{q^2}{32\varepsilon_0 k\pi^2R^4}\quad \ldots(\because ds=4\pi R^2)$$

$$=\frac{(12\times10^{-6})^2}{32\times8.85\times10^{-12}\times1\times9.87\times(10^{-1})^4}$$

$$\approx 5.15\times10^2 N/m^2$$

27 **(d)**

$U=\frac{1}{2}QV=$ Area of triangle OAB

29 **(c)**

$$E=\frac{1}{4\pi\varepsilon_0}\frac{ne}{r^2}$$

$$\therefore n=\frac{Er^2}{e}4\pi\varepsilon_0$$

$$\therefore n=\frac{0.036\times0.1\times0.1}{9\times10^9\times1.6\times10^{-19}}$$

$$=\frac{360}{144}\times10^5$$

$$=2.5\times10^5$$

30 **(c)**

For a charged conductor of any shape (assuming air medium),

$$E_1=\frac{\sigma}{\varepsilon_0}\quad\ldots(1)$$

For a infinite thin plane sheet (assuming air medium),

$$E_2=\frac{\sigma}{2\varepsilon_0}\quad\ldots(2)$$

Comparing (1) and (2)

$E_1=2E_2$

33 **(d)**

$\phi=\frac{\Sigma q}{\varepsilon_0}=0\Rightarrow[\because$ charge on dipole is zero]

34 **(d)**

Electric diploe consist of equal and opposite charges the resultant of them is zero. So flux will be zero.

36 **(d)**

The effective capacitance is C_2 when three capacitors are connected is series

$$\therefore\frac{1}{C_1}=\frac{1}{4}+\frac{1}{5}+\frac{1}{6}=\frac{37}{60}$$

$$\therefore C_1=60/37\ \mu F\qquad\ldots(i)$$

When three capacitors are connected in parallel mode, the effective capacitance is C_2

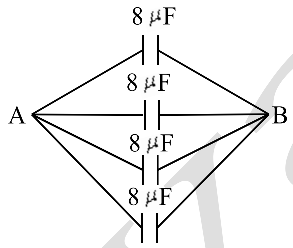
$$\therefore C_2=4+5+6=15\ \mu F\quad\ldots(ii)$$

From (i) and (ii),

$$\frac{C_2}{C_1}=\frac{15}{60/37}=\frac{37}{4}$$

38 **(a)**

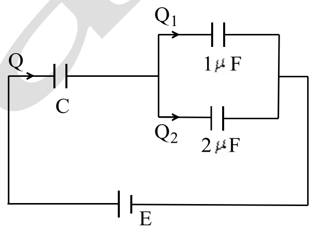
Given circuit can be drawn as,



∴ Equivalent capacitance between A and B

$=C_p=4\times8=32\ \mu F$

41 **(b)**



$$Q_2=\frac{2}{2+1}Q=\frac{2Q}{3}\qquad\ldots(i)$$

$Q=C_RV$

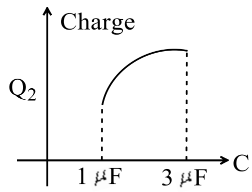
$C_R=(1\ \mu F||2\ \mu F)$ series with C

$$C_R=\frac{3C}{C+3}$$

$$Q=E\left(\frac{C\times3}{C+3}\right)$$

$$\Rightarrow Q_2=\frac{2}{3}\left(\frac{3CE}{C+3}\right)=\frac{2CE}{C+3}\quad\ldots\text{using (i)}$$

This shows as C increases Q increases but not linearly. Also the given relation does not correspond to exponential graph. Hence correct choice is (B)



42 **(d)**

There will be zero charge inside closed surface

43 **(c)**

$$C_{eff} = C + \frac{C}{2} = \frac{3C}{2}$$

$\therefore$ Work done $= \frac{1}{2}\left(\frac{3C}{2}\right)V^2 = \frac{3CV^2}{4}$

44 **(d)**

The cube has six surfaces and as the charge is at its centre. Hence, it will produce equal number of lines of forces through each surface. The charge of Q will produce in all $\frac{Q}{\varepsilon_0}$ lines of force

$\therefore$ Each surface will allow $\left(\frac{Q}{6\varepsilon_0}\right)$

45 **(a)**

Electric flux, $\phi_E = \int \vec{E}.\,d\vec{S}$

$= \int EdS\cos\theta$

$= \int EdS\cos 90° = 0$

The lines are parallel to the surface

46 **(c)**

$$U = \frac{1}{2}CV^2 = \frac{1}{2} \times 6 \times 10^{-6}(100)^2 = 0.03\text{ J}$$

48 **(a)**

$\overline{AB} = (\vec{B} - \vec{A}) = a(-4\hat{j} + 3\hat{k})$

$\therefore$ Work done $= \overline{F}.\overline{AB} = q\left(\frac{\sigma}{2\varepsilon_0}\right)\hat{k}.\,a(-4\hat{j} + 3\hat{k})$

$$= \frac{3q\sigma a}{2\varepsilon_0}$$

54 **(a)**

$C = \frac{A\varepsilon}{d} \Rightarrow C_1 = \frac{A_1\varepsilon}{d_1}$ and $C_2 = \frac{A_2\varepsilon}{d_2}$

$$\therefore \frac{C_2}{C_1} = \frac{A_2\varepsilon}{d_2} \times \frac{d_1}{A_1\varepsilon} = \frac{A_2}{A_1} \times \frac{d_1}{d_2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

$$\therefore C_2 = \frac{C_1}{4} = \frac{1}{4} \times 12 = 3\ \mu F$$

55 **(d)**

n plates will form $(n-1)$ number of parallel capacitors

$\therefore$ Total capacity will be $(n-1)C$

57 **(b)**

Volume $= 1$ litre $= 1 \times 10^{-3}\text{ m}^3$

$$u = \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2} \times 8.85 \times 10^{-12} \times (10^3)^2$$

$= 4.425 \times 10^{-6}$

Energy stored in 10^{-3} m^3 of air

$= 4.425 \times 10^{-6} \times 10^{-3} = 4.425 \times 10^{-9}$ J

59 **(c)**

Energy density $= \frac{\text{Energy}}{\text{Volume}}$. So its dimensions are

$$\frac{[M^1L^2T^{-2}]}{[L^3]} = [M^1L^{-1}T^{-2}]$$

61 **(d)**

The capacitors of capacitance 2 μF and 2 μF are connected in parallel

$\therefore$ Equivalent capacitance $(C') = 2 + 2 = 4\ \mu F$

Now 4 μF, 4μF and C' are connected in series

$\therefore$ Relation for the capacitance between P and Q,

$$\frac{1}{C''} = \frac{1}{4} + \frac{1}{4} + \frac{1}{4} = \frac{3}{4} \text{ or } C'' = \frac{4}{3}\ \mu F$$

64 **(c)**

$$E = \frac{1}{4\pi\varepsilon_0}.\frac{q}{r^2}$$

$$\therefore E = \frac{9 \times 10^9 \times 3 \times 10^{-9}}{(3 \times 10^{-2})^2} = 3 \times 10^4\text{ V/m}$$

65 **(d)**

$V = \frac{Q}{C}$ But $Q = C_{eff}V$ ...(i)

$C_p = 3 + 6 + 3 = 12\ \mu F$

$$\therefore C_s = C_{eff} = \frac{12 \times 2}{12 + 2} = \frac{24}{14} = \frac{12}{7}\mu F$$

$\therefore Q = \frac{12}{7} \times 70 = 120\ \mu C$ ...[From (i)]

$$\therefore V = \frac{120}{2} = 60\text{ V}$$

73 **(c)**

$$\frac{1}{C_{eq}} = \frac{1}{3} + \frac{1}{10} + \frac{1}{15}$$

$\therefore C_{eq} = 2\ \mu F$

$\therefore$ Charge on each capacitor,

$Q = C_{eq} \times V = 2 \times 100 = 200\ \mu C$

75 **(c)**

$Q = VC \Rightarrow V = Q/C$

As V is constant,

$\therefore \frac{Q_g}{C_g} = \frac{Q_o}{C_o} \Rightarrow \frac{Q_g}{Q_o} = \frac{C_g}{C_o}$ where C_g is the new capacitance and Q_g is new charge

$\because C_g > C_o \Rightarrow Q_g > Q_o$

76 **(c)**

$$V = \frac{1}{2}\frac{Q^2}{C}$$

$\therefore$ Increase in energy $= \frac{1}{2C}[Q_2^2 - Q_1^2]$

$$= \frac{1}{2 \times 48 \times 10^{-6}}[0.5^2 - 0.1^2]$$

$$= \frac{10^6}{96}[24 \times 10^{-2}]$$

$= 0.25 \times 10^4 = 2500$ J

77 **(a)**

$$U = \frac{1}{2}CV^2 = \frac{1}{2} \times 12 \times 10^{-12} \times (50)^2$$

$= 1.5 \times 10^{-8}$ J

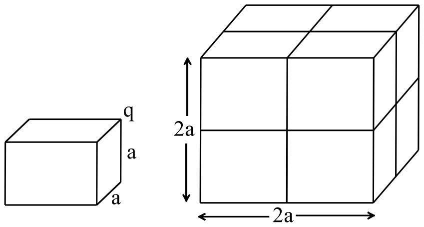
80 **(a)**

As density of line is more at A than B, $E_A > E_B$

82 **(b)**

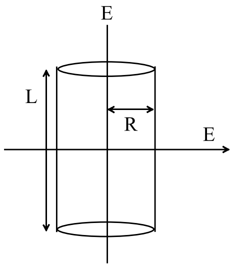
Eight identical cubes are required to arrange so that this charge is at centre of the cube formed

$$\therefore \phi = \frac{q}{8\varepsilon_0}$$



85 **(c)**

Total flux ϕ



$= \vec{E}.\Delta\vec{A} = E\,\Delta A\cos\theta$

(where θ is an angle between E and ΔA)

For top and bottom faces of the cylinder, $\theta = 90°$

$\therefore \phi = E\Delta A\cos 90°$ ... ($\because \cos 90° = 0$)

$\therefore\ \phi = 0$

87 **(c)**

For spherical conductor, $C = 4\pi\varepsilon_0 R$

Now, for a sphere,

$V = \frac{4}{3}\pi R^3$ and $A = 4\pi R^2$

Also, $R = \frac{3V}{A}$

$\therefore C = 12\pi\varepsilon_0\dfrac{V}{A}$

89 **(c)**

If σ is the surface density, then charge on the surface S, $q = \sigma.S$

Electric intensity E due to remaining charges on the surface, $E = \frac{\sigma}{2k\varepsilon_0}$

Force experienced due to other charges on surface S,

$$F = E \times q = \frac{\sigma}{2k\varepsilon_0}\sigma\,S = \frac{\sigma^2}{2\,k\varepsilon_0}S$$

90 **(a)**

The two condensers filled with k and with air are in parallel

With air: $C_1 = \frac{\varepsilon_0}{d}\left(\frac{3A}{d}\right) = \frac{3\varepsilon_0 A}{4d}$

With medium: $C_2 = \frac{\varepsilon_0 K}{d}\left(\frac{A}{4}\right) = \frac{\varepsilon_0 Ak}{4d}$

$\therefore C_{eq} = C_1 + C_2$

$$\therefore C_{eq} = \frac{3\varepsilon_0 A}{4d} + \frac{\varepsilon_0 Ak}{4d}$$

$$= \frac{\varepsilon_0 A}{4d}\left[\frac{3}{4} + \frac{k}{4}\right] = \frac{C}{4}(k+3)$$

$$\therefore C_{eq} = \frac{C}{4}(k+3)$$

91 **(b)**

The charge flowing through C_4 is

$q_4 = C_4 \times V = 4\,CV$ ...(i)

For the series combination of C_1, C_2 and C_3,

$$\frac{1}{C_{eq}} = \frac{1}{C} + \frac{1}{2C} + \frac{1}{3C}$$

$$\therefore \frac{1}{C_{eq}} = \frac{6+3+2}{6C} = \frac{11}{6C}$$

$$\Rightarrow C_{eq} = \frac{6C}{11}$$

Now, C_{eq} and C_4 form parallel combination giving,

$$C' = C_{eq} + C_4 = \frac{6C}{11} + 4C = \frac{50C}{11}$$

$\therefore$ Net charge, $q = C'V = \frac{50}{11}CV$

Total charge flowing through C_1, C_2, C_3 will be

$$q' = q - q_4 = \frac{50}{11}CV - 4CV = \frac{6CV}{11}\ \text{... (ii)}$$

As C_1, C_2, C_3 are in series combination, the charge flowing through them will be same

$\therefore$ From equations (i) and (ii),

the required ratio $= \frac{6CV/11}{4CV} = \frac{3}{22}$

92 **(d)**

As $\sigma_1 = \sigma_2$,

$$\therefore \frac{Q_1}{4\pi r_1^2} = \frac{Q_2}{4\pi {r_2}^2}$$

$$\therefore \frac{Q_1}{4\pi\varepsilon_0 r_1^2} = \frac{Q_2}{4\pi\varepsilon_0 {r_2}^2}$$

$\therefore E_1 = E_2 \Rightarrow \dfrac{E_1}{E_2} = \dfrac{1}{1}$ or $E_1 : E_2 = 1 : 1$

94 **(c)**

$$E = \frac{\sigma R^2}{k\varepsilon_0 r^2}$$

Just outside the conductor, $R \le r \Rightarrow \frac{R^2}{r^2} \approx 1$

$$\therefore E = \frac{\sigma}{k\varepsilon_0} = \frac{\sigma 4\pi}{4\pi\varepsilon_0 k}$$

$$= \frac{12 \times 10^{-12} \times 4 \times 3.14 \times 9 \times 10^9}{3.14}$$

$= 43.2 \times 10^{-2} = 0.43$ V/m

97 **(b)**

For a spherical capacitor,

$$C = 4\pi\varepsilon_0 k\left(\frac{ab}{b-a}\right) \Rightarrow C \propto k$$

98 **(d)**

$\phi_E = \frac{Q_{enclosed}}{\varepsilon_0} : Q_{enclosed}$ remains unchanged

101 **(a)**

As there is no charge residing inside the cube, the net flux is zero

102 **(d)**

$$C = \frac{\varepsilon_0 A}{d}$$

Hence as d increases, C decreases

Q is constant ⇒ V increases

103 **(a)**

Given six capacitors are in parallel

$\therefore C_{eq} = 6C = 6 \times 2\ \mu F = 12\ \mu F$

107 **(c)**

Aluminium being a metal, the field inside it will be zero. Hence it would not affect the field in between the two plates. Hence capacity $= \frac{q}{V} = \frac{q}{Ed}$ remains unchanged

109 **(c)**

$$\lambda = \frac{q}{2\pi r l} = \frac{10 \times 10^{-3}}{2 \times 3.14 \times 1 \times 10^{-3} \times 10^{3}} = 1.59 \times 10^{-3} C/m^2$$

110 **(d)**

$Q = CV \Rightarrow V = \frac{Q}{C} \Rightarrow V \propto \frac{1}{C}$

Now, $\frac{1}{C_{eff}} = \frac{1}{3} + \frac{1}{6} + \frac{1}{6} = \frac{4}{6}$

$\therefore C_{eff} = \frac{6}{4} \mu F$

$\therefore C_1 V_1 = C_2 V_2$

$\Rightarrow V_2 = \frac{C_1}{C_2} \times V_1 = \frac{6}{4 \times 3} \times 120 = 60\ V$

112 **(b)**

$\frac{dF}{ds} = \frac{\sigma^2}{2k\varepsilon_0}$

$= \frac{0.885 \times 0.885 \times 10^{-12}}{2 \times 8.85 \times 10^{-12}}$

$= 4.425 \times 10^{-2} N/m^2$

114 **(d)**

$u = \frac{1}{2}\varepsilon_0 E^2$

$\therefore E = \sqrt{\frac{2u}{\varepsilon_0}} = \sqrt{\frac{2 \times 44.25 \times 10^{-8}}{8.85 \times 10^{-12}}} = 316.2\ N/C$

116 **(b)**

For series combination, $V_1 = \frac{Q}{C_1}$ and $V_2 = \frac{Q}{C_2}$

$\therefore \frac{V_2}{V_2} = \frac{C_1}{C_2} = 4 : 1$

121 **(c)**

$C = \frac{\varepsilon_0 A}{d} = 8$ pF and

$C' = \frac{\varepsilon_0 k A'}{d'}$

But $A' = A, d' = d/2$

$C' = \frac{\varepsilon_0 k \times A}{d/2} = \frac{2 \times 5 \times \varepsilon_0 A}{d}$

$C' = 10 \times 8\ pF = 80\ pF$

122 **(b)**

Flux linked with the given sphere $\phi = \frac{Q}{\varepsilon_0}$; where

Q = Charge enclosed by the sphere

Hence $Q = \phi\varepsilon_0 = (EA)\varepsilon_0$

$\therefore Q = 4\pi(\gamma_0)^2 \times A\gamma_0\varepsilon_0 = 4\pi\varepsilon_0 A{\gamma_0}^3$

125 **(a)**

Electric field is zero at any interior point as there is no line of force

126 **(a)**

Let r be radius of each small drop and R be radius of bigger drop

The volume remains constant

$\therefore \frac{4}{3}\pi R^3 = n \times \frac{4}{3}\pi r^3$

$\therefore R = n^{1/3} r$

For the small drop,

Capacitance, $C_0 = 4\pi\varepsilon_0 r$ and

Charge $q_0 = C_0 V = 4\pi\varepsilon_0 r V$

For the bigger drop,

Capacitance, $C = 4\pi\varepsilon_0 R$ and

Charge $Q = nq_0$

$\therefore$ Potential of bigger drop $\frac{Q}{C} = \frac{nq_0}{4\pi\varepsilon_0 R}$

$= \frac{n(4\pi\varepsilon_0 rV)}{4\pi\varepsilon_0 R} = nV\left(\frac{r}{R}\right) = n\left(\frac{1}{n^{1/3}}\right)V$

$= n^{2/3}\ V$

137 **(b)**

$Q = CV = 6 \times 10^{-6} \times 18 = 108\ \mu C$

139 **(c)**

Heat produced = Energy of charged capacitor

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

$= \frac{1}{2} \times (2 \times 10^{-6}) \times (100)^2$

$= 0.01$ J

140 **(c)**

Electric intensity at a distance r from the centre of a charged spherical conductor of radius R,

$E = \frac{q}{4\pi k\varepsilon_0 r^2} \quad \ldots (i)$

Since charge is uniformly distributed on A, the surface density of charge on A will be

$\sigma = \frac{q}{4\pi R^2} \Rightarrow q = 4\pi R^2 \sigma$

Substituting in eq. (i), we get

$E = \frac{4\pi R^2 \sigma}{4\pi k\varepsilon_0 r^2} = \frac{\sigma R^2}{k\varepsilon_0 r^2}$

141 **(c)**

Volume of 8 small drops = Volume of big drop

$\therefore 8 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3 \Rightarrow R = 2r$

$\because$ Capacity $\propto$ r ⇒ capacity becomes 2 times

142 **(d)**

If charge acquired by the smaller sphere is Q, then it's potential, $V = \frac{kQ}{r}$

$\therefore 120 = \frac{kQ}{2} \Rightarrow kQ = 240$ ... (i)

Whole charge resides on the outer sphere,

$\therefore$ Potential of the outer sphere,

$V' = \frac{kQ}{6}$

$\therefore V' = \frac{240}{6}$ ...[From (i)]

$\therefore V' = 40$ V

143 **(b)**

Charge density: Here it is surface charge density

$\therefore \frac{\text{Charge}}{\text{Area}} = \frac{\text{Coulomb}}{m^2}$

147 **(c)**

Increase in energy $= \frac{1}{2}C_1V_1^2 - \frac{1}{2}C_0{V_0}^2$

$= \frac{1}{2}C({V_1}^2 - {V_0}^2)$ ... $(\because C_1 = C_0 = C)$

$= \frac{1}{2} \times 10 \times 10^{-6}(121 - 100)$

$= \frac{1}{2} \times 10 \times 21 \times 10^{-6} = 105 \times 10^{-6}\text{J} = 105\ \mu\text{J}$

148 **(b)**

Capacity of capacitor = C

$Q = CV = \frac{\varepsilon_0 AV}{d}$ ... (i)

After inserting a slab, capacitance becomes C_1 and charge remains same, $Q = C_1V_1$

By increasing the distance, we get same potential difference as in first case

$Q = C_2V$ ...(ii)

$\frac{1}{C_2} = \frac{d - 3 + 2.4}{\varepsilon_0 A} + \frac{3}{k\varepsilon_0 A} = \frac{d - 0.6}{\varepsilon_0 A} + \frac{3}{k\varepsilon_0 A}$

From equations (i) and (ii),

$C = C_2$

$\therefore \frac{1}{C} = \frac{1}{C_2}$

$\therefore \frac{d}{\varepsilon_0 A} = \frac{d - 0.6}{\varepsilon_0 A} + \frac{3}{k\varepsilon_0 A}$

$\therefore d = d - 0.6 + \frac{3}{k}$

$\therefore k = \frac{3}{0.6} = 5$

151 **(a)**

TNEI does not depend upon shape or the size of Gaussian surface, it depends only upon charge enclosed within the surface

152 **(b)**

By inserting the dielectric slab, capacitance (*i.e.* ability to hold the charge) increases. In the presence of battery more charge is supplied from battery

153 **(c)**

As conductivity increase dielectric constant increase.

154 **(b)**

Common potential $= \frac{C_1V_1 + C_2V_2}{C_{eff.}}$

$= \frac{20 \times 10^{-6} \times 500 + 10 \times 10^{-6} \times 200}{20 \times 10^{-6} + 10 \times 10^{-6}}$

$= \frac{12000}{30} = 400$ V

156 **(a)**

The $\pm$q charges appearing on the inner surfaces of A, are bound charges. B is uncharged initially and as it is isolated, the charges on A will not be affected on closing the switch S. No charge will flow in to B

159 **(b)**

Charge enclosed by cylindrical surface is, $Q_{enc} = 100$ Q. By applying Gauss' law,

$\phi = \frac{1}{\varepsilon_0}(Q_{enc.}) = \frac{1}{\varepsilon_0}(100Q)$

163 **(b)**

Heat produced = Energy stored in capacitor

$= \frac{1}{2}CV^2 = \frac{1}{2} \times 4 \times 10^{-6} \times (400)^2$

$= 2 \times 10^{-6} \times 16 \times 10^4$

$= 0.32$ J

164 **(c)**

$\because$ Charge 8q is placed at one corner of the cube, we can imagine it to be placed at the centre of a large cube which can be formed using an arrangement of 8 similar cubes. Charge 8q is at centre of the 8 cubes arranged to form a closed box

$\therefore$ By using gauss's law,

total flux through the bigger cube

$= \frac{8q}{\varepsilon_0}$

$\therefore$ Flux through one small cube $= \frac{1}{8} \times \frac{8q}{\varepsilon_0} = \frac{q}{\varepsilon_0}$

171 **(a)**

$E_s = \frac{q}{4\pi \in_0 r^2} = \frac{q}{2\pi \in_0 r} \times \frac{\ell}{2r\ell} = \frac{q}{2\pi \in_0 r\ell} \times \frac{\ell}{2r}$

$E_s = Ec\ \frac{\ell}{2r}$ $\left(\because\ E_C = \frac{q}{2\pi \in_0 r\ell}\right)$

180 **(c)**

$E = \frac{\sigma R}{k\varepsilon_0 r} = \frac{1}{4\pi\varepsilon_0} \times \frac{\sigma R \times 4\pi}{kr}$

$= \frac{9 \times 10^9 \times 2 \times 10^{-6} \times 5 \times 10^{-3} \times 4 \times 3.14}{6.28 \times 2}$

$= 90$ V/m

182 **(b)**

Presence of proton will not affect field between the plates (since proton charge is quite small compared to the charges on the plate)

$E = \frac{V}{d} = \frac{200}{2 \times 10^{-2}} = \frac{20000}{2} = 10000 \text{ V/m}$

183 **(d)**

$\frac{1}{C_{eff}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

$= \frac{1}{6} + \frac{1}{6} + \frac{1}{6} = \frac{3}{6}$

$\therefore C_{eff} = 2 \text{ pF} = 2 \times 10^{-12} \text{ F}$

186 **(a)**

Capacitance of first capacitor (C_1)

$= 30\ \mu F = 30 \times 10^{-6} F$ and its voltage $(V_1) =$ 500 V

Capacitance of the second capacitor (C_2)

$= 15\ \mu F = 15 \times 10^{-6} F$ and its voltage $(V_2) =$ 300 V

$\therefore$ Common potential $(V) = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$

$= \frac{(30 \times 10^{-6} \times 500) + (15 \times 10^{-6} \times 300)}{(30 \times 10^{-6}) + (15 \times 10^{-6})}$

≈ 433 V

187 **(b)**

Let C be capacitance of each capacitor connected in parallel

$\therefore C_{eff.} = 3C$

Now, 3C and C are in series

$\therefore \frac{1}{C'_{eff}} = \frac{1}{3C} + \frac{1}{C} = \frac{4}{3C}$

$\therefore C'_{eff} = \frac{3C}{4} = 3.75$

$\therefore C = \frac{3.75 \times 4}{3} = 1.25 \times 4 = 5\ \mu F$

190 **(c)**

Initial charge on the capacitor $Q = 10 \times 12$

$= 120\ \mu C$

Final charge on the capacitor $Q' = (5 \times 10) \times 12$

$= 600\ \mu C$

$\therefore$ Charge supplied by the battery later $= Q' - Q$

$= 480\ \mu C$

193 **(c)**

T.N.E.I $= \sum q_{enclosed}$

$\therefore$ T.N.E.I. for A = zero

T.N.E.I for B $= (2q - q) = q \Rightarrow (0, q)$

195 **(c)**

Electric field in vacuum $E_v = \frac{\sigma}{\varepsilon_0}$ and in medium,

$E = \frac{\sigma}{\varepsilon_0 k}$

If $k > 1$, then $E < E_0$

196 **(b)**

$\phi = \frac{1}{\varepsilon_0} \times Q_{enc} = \frac{1}{\varepsilon_0}(2q)$

200 **(a)**

Electric flux coming out through a closed surface is q/ε_0