DATE: MARKS: 180

ELECTROSTATICS

LEVEL - II

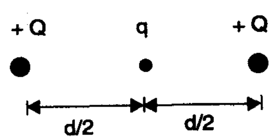
1. Two positively charged particles each having charges Q are d distance apart. A third charge is introduced in midway on the line joining the two. Find nature and magnitude of third charge, so that the system is in equilibrium:

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

b) $q = \frac{Q}{4}$

c) $q = \frac{3Q}{4}$

d) $q = -\frac{3Q}{4}$



2. Two charged spheres of radius R_1 and R_2 respectively are charged and joined by a wire. The ratio of electric field of the spheres is

a) R_1 / R_2 b) R_2 / R_1

c) R_1^2 / R_2^2 d) R_2^2 / R_1^2

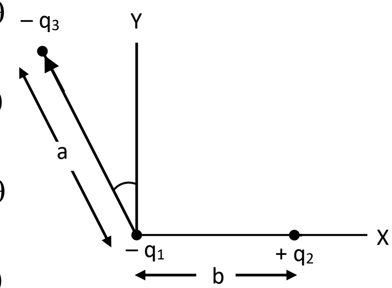
3. Three charges $-q_1$, $+q_2$ and $-q_3$ are placed as shown in figure. The x-component of the force on $-q_1$ is proportional to

a) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\cos\theta$

b) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta$

c) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\cos\theta$

d) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\sin\theta$



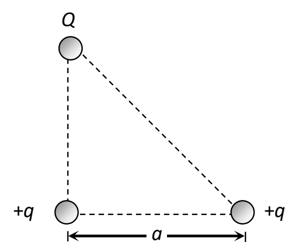
4. Three charges Q, +2q and +q are placed at the vertices of a right-angled isosceles triangle as shown. The net electrostatic energy of the configuration is zero if Q is equal to

a) $\frac{-q}{1+\sqrt{2}}$

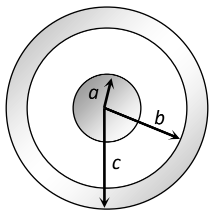
b) $\frac{-\sqrt{2}q}{1+\sqrt{2}}$

c) $-2q$

d) $+q$



5. A solid conducting sphere of radius a has a net positive charge $2Q$. A conducting spherical shell of inner radius b and outer radius c is concentric with the solid sphere and has a net charge $-Q$. The surface charge density on the inner and outer surfaces of the spherical shell will be



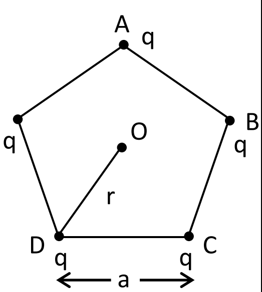
a) $-\frac{2Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$

b) $-\frac{Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$

c) $0, \frac{Q}{4\pi c^2}$

d) None of the above

6. Five charges, q each are placed at the corners of a regular pentagon of side 'a' (Fig).
The electric field at O if the charge q at A is replaced by $-q$ is



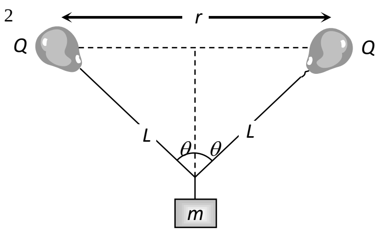
a) 0

b) $\frac{1}{4\pi\varepsilon_0}\cdot\frac{2q}{r^2}$ (along OA)

c) $\frac{1}{4\pi\varepsilon_0}\cdot\frac{q}{r^2}$ (along OA)

d) $\frac{1}{4\pi\varepsilon_0}\cdot\frac{q}{r^2}$ (away from OA)

7. Two similar balloons filled with helium gas are tied to L m long strings. A body of mass m is tied to another ends of the strings. The balloons float on air at distance r. If the amount of charge on the balloons is same then the magnitude of charge on each balloon will be



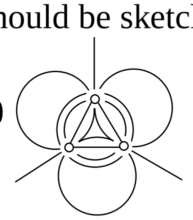
a) $\left[\frac{mgr^2}{2k}\tan\theta\right]^{1/2}$

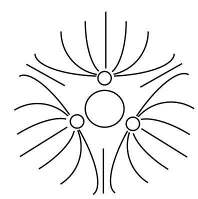
b) $\left[\frac{2k}{mgr^2}\tan\theta\right]^{1/2}$

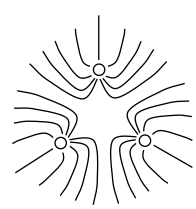
c) $\left[\frac{mgr}{2k}\cot\theta\right]^{1/2}$

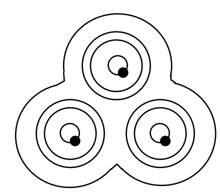
d) $\left[\frac{2k}{mgr}\tan\theta\right]^{1/2}$

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

a) 

b) 

c) 

d) 

9. Two point charges Q and $-3Q$ are placed at some distance apart. If the electric field at the location of Q is E, then at the locality of $-3Q$, it is

a) $-E$ b) $-3E$

c) $E/3$ d) $-E/3$

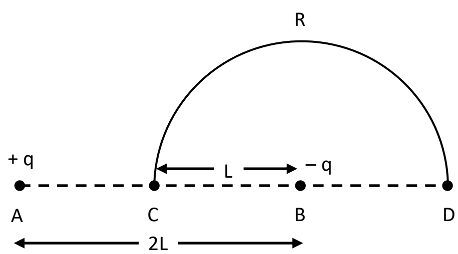
10. Charges + q and – q are placed at points A and B respectively, which are distance 2 L apart. C is the mid-point between A and B, fig. The work done in moving a charge + Q along the semicircle CRD is

a) $\frac{qQ}{2\pi \epsilon_0 L}$

b) $\frac{qQ}{6\pi \epsilon_0 L}$

c) $\frac{-qQ}{6\pi \epsilon_0 L}$

d) $\frac{qQ}{4\pi \epsilon_0 L}$



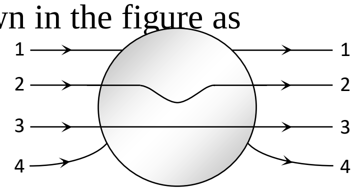
11. A metallic sphere is placed in a uniform electric field. The lines of force follow the path (s) shown in the figure as

a) 1

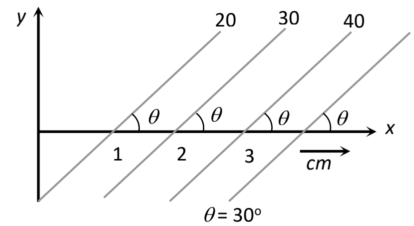
b) 2

c) 3

d) 4



12. Some equipotential surface are shown in the figure. The magnitude and direction of the electric field is



a) 100 V/m making angle 120° with the x-axis

b) 100 V/m making angle 60° with the x-axis

c) 200 V/m making angle 120° with the x-axis

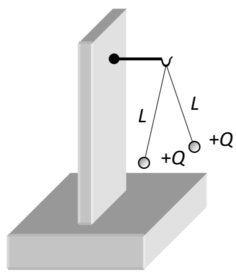
d) None of the above

13. An infinite number of charges, each of charge 1μC, are placed on the x-axis with co-ordinates x = 1, 2, 4, 8, …., ∞. If a charge of 1 C is kept at the origin, then what is the net force acting on 1C charge?

a) 9000 N b) 24000 N

c) 12000 N d) 36000 N

14. Two small balls having equal positive charge *Q* (coulomb) on each are suspended by two insulated string of equal length *L* meter, from a hook fixed to a stand. The whole set up is taken in satellite into space where there is no gravity (state of weightlessness). Then the angle between the string and tension in the string is:



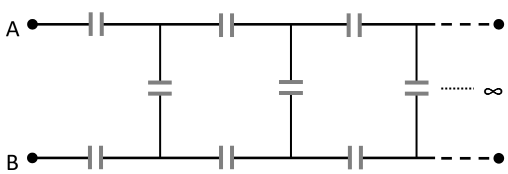
a) $180^o, \frac{1}{4\pi\varepsilon_0}.\frac{Q^2}{(2L)^2}$

b) $90^\circ, \frac{1}{4\pi\varepsilon_0}.\frac{Q^2}{L^2}$

c) $180^\circ, \frac{1}{4\pi\varepsilon_0}.\frac{Q^2}{2L^2}$

d) $180^o, \frac{1}{4\pi\varepsilon_0}.\frac{QL}{4L^2}$

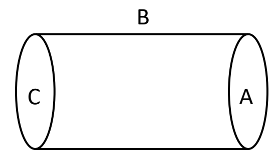
15. The equivalent capacity of the infinite network as shown if each capacitor is of 1 μF is



a) $\left(\frac{\sqrt{3}-1}{2}\right)\mu F$ b) infinity

c) $\left(\frac{\sqrt{3}+1}{2}\right)\mu F$ d) 1 μF

16. A hollow cylinder has a charge q coulomb within it. If ϕ is the electric flux in unit of volt metre associated with the curved surface B, the flux linked with the plane surface A in unit of volt metre will be



a) $\frac{1}{2}\left(\frac{q}{\varepsilon_0}-\phi\right)$

b) $\frac{q}{2\varepsilon_0}$

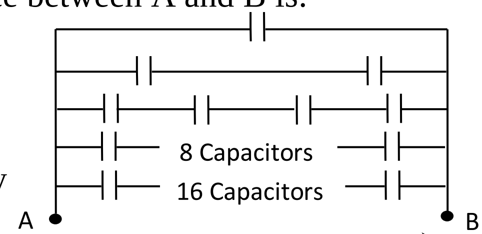
c) $\frac{\phi}{3}$

d) $\frac{q}{\varepsilon_0}-\phi$

17. The electric field intensity between the two plates of the capacitor is $\frac{1}{\sqrt{8.85}}\times 10^2$ V/m. If the dielectric constant of the medium between the two plates is 4, the energy density of the medium is:

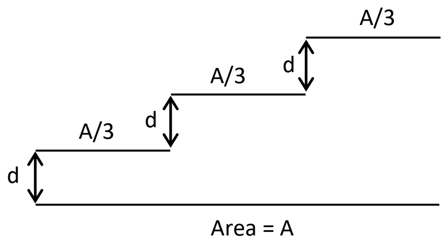
a) 40000 J/m^3 b) 80000 J/m^3
c) 60000 J/m^3 d) 2×10^{-8} J/m^3

18. An infinite number of identical capacitors each of capacitance 1 μF are connected as shown in adjoining figure. The equivalent capacitance between A and B is:



a) 1 μF
b) 2 μF
c) 1/2 μF
d) infinity

19. A capacitor is mode of plate of area A and a second plate having a stair – like structure as shown in figure. If the width of each stair is A/3 and the height is d, find the capacitance of the arrangement.



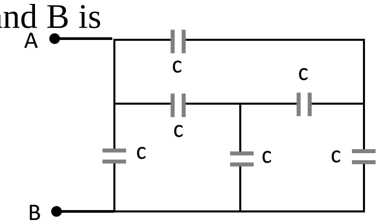
a) $\frac{1 l \varepsilon_0 A}{18d}$

b) $\frac{\varepsilon_0 A}{9d}$

c) $\frac{18\,\varepsilon_0 A}{11d}$

d) $\frac{\varepsilon_0 A}{6d}$

20. Six equal capacitors each of capacitance C are connected as shown in the figure below. Then the equivalent capacitance between A and B is



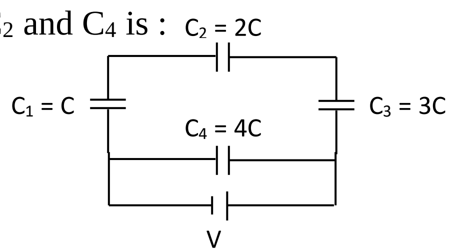
a) 6 C

b) C

c) 2 C

d) C/2

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



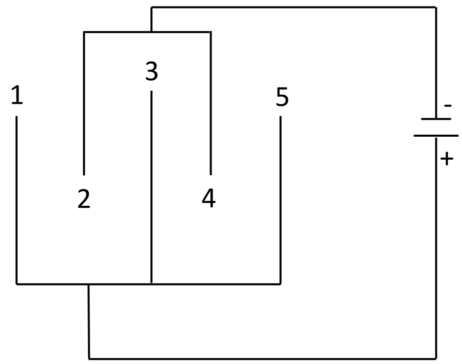
a) 22/3

b) 3/22

c) 7/4

d) 4/7

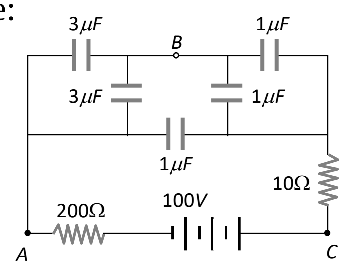
22. Five identical plates each of area A are joined as shown in the figure. He distance between the plates is d. the plates are connected to a P.D. of V volts. The charge on the plates 1 and 4 will be :



a) $\frac{\varepsilon_0 AV}{d}, \frac{2\varepsilon_0 AV}{d}$ b) $\frac{\varepsilon_0 AV}{d}, \frac{-2\varepsilon_0 AV}{d}$

c) $\frac{-\varepsilon_0 AV}{d}, \frac{2\varepsilon_0 AV}{d}$ d) $\frac{-\varepsilon_0 AV}{d}, \frac{-2\varepsilon_0 AV}{d}$

23. The potential difference between the points A and B in the following circuit in steady state will be:



a) V_{AB} = 100 volt

b) V_{AB} = 75 volt

c) V_{AB} = 25 volt

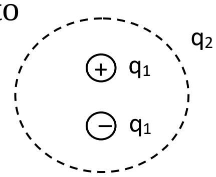
d) V_{AB} = 50 volt

24. An electrical technician requires a capacitance of 2 μF in a circuit across the

potential difference 1 kV. A large number of 1 μF capacitors are available to him each of which can withstand a potential difference of not more than 300 volt. How many minimum numbers of capacitors are required to get 2 μF capacitor?

a) 32 b) 18
c) 16 d) 2

25. Consider the charge configuration and a spherical Gaussian surface as shown in Fig. When calculating the flux of the electric field over the spherical surface, the electric field will be due to

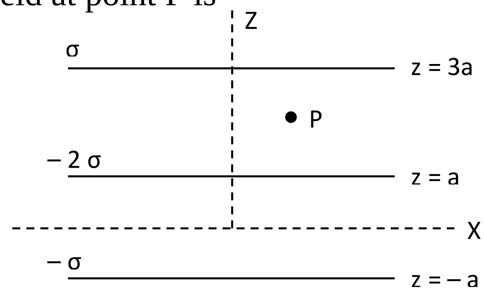


a) q_2
b) only the positive charges
c) all the charges
d) $+q_1$ and $-q_1$

26. Electric field at a distance of R from the surface of a charged sphere of radius R and surface charge density σ is E. Electric field at a distance of R from the surface of a charged sphere of radius 2R and surface charge density σ is:

a) zero b) E
c) 16E/9 d) 4E/9

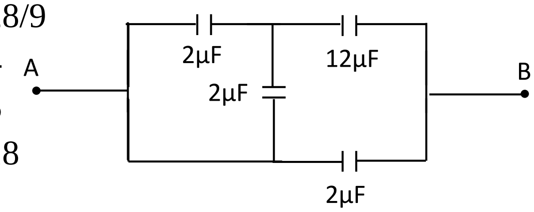
27. Three infinitely long charges sheets are placed as shown in figure. The electric field at point P is



a) $\frac{2\sigma}{\varepsilon_0}\hat{k}$ b) $-\frac{2\sigma}{\varepsilon_0}\hat{k}$

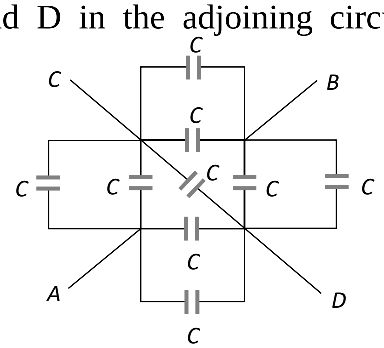
c) $\frac{4\sigma}{\varepsilon_0}\hat{k}$ d) $-\frac{4\sigma}{\varepsilon_0}\hat{k}$

28. Four condensers are connected as shown in the figure. The effective capacity in μF between the points A and B are :



a) 28/9
b) 4
c) 5
d) 18

29. The equivalent capacity between the points C and D in the adjoining circuit (Fig) will be



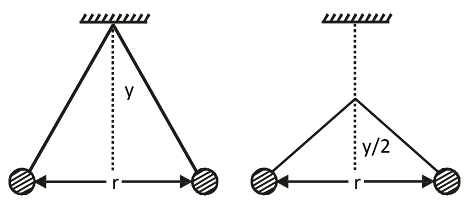
a) C
b) 2C
c) 3C
d) 4C

30. Three concentric metallic spherical shells of radii R, 2R, 3R are given charges Q_1, Q_2, Q_3 respectively. It is found that the surface charge densities on the outer surfaces of the shells are equal. Then, the ratio of the charges given to the shells, $Q_1 : Q_2 : Q_3$ is

a) 1 : 2 : 3 b) 1 : 3 : 5

c) 1 : 4 : 9 d) 1 : 8 : 18

31. Two pith balls carrying equal charges are suspended from a common point by string of equal length; the equilibrium separation between them is r. Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now become



a) $\left(\frac{1}{\sqrt{2}}\right)^2$

b) $\left(\frac{r}{\sqrt[3]{2}}\right)^2$

c) $\left(\frac{2r}{\sqrt{3}}\right)$

d) $\left(\frac{2r}{3}\right)$