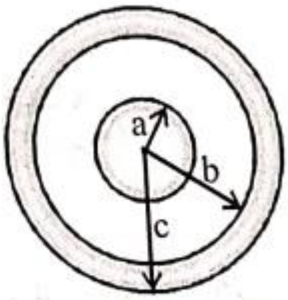
SRIGAYATRI EDUCATIONAL INSTITUTIONS

INDIA

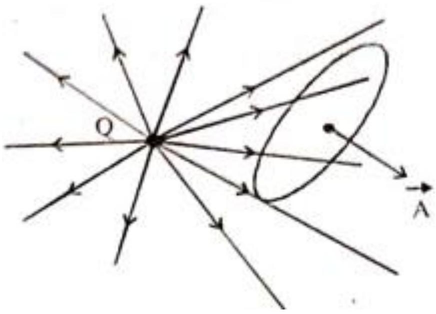
ELECTRIC CHARGES AND FIELDS UT-3

1. **A solid conducting sphere of radius a has a net positive charge 2Q. A conducting spherical shell of inner radius hand 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 respectively**



a) $-\dfrac{2Q}{4\pi b^2}, \dfrac{Q}{4\pi c^2}$ b) $-\dfrac{Q}{4\pi b^2}, \dfrac{Q}{4\pi c^2}$ c) $0, \dfrac{Q}{4\pi c^2}$ d) $\dfrac{Q}{4\pi c^2}, 0$

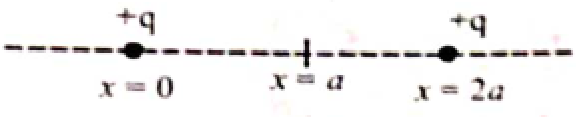
2. **In the figure, the net electric flux In the figure, the net electric flux through the area A is $\phi = \vec{E}.\vec{A}$ when the system is in air. On immersing the system in water the net electric flux through the area**

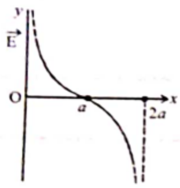
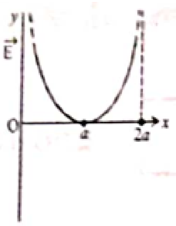
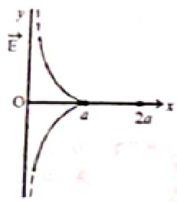
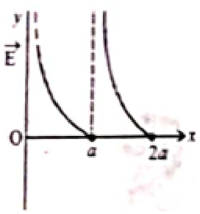


(a) becomes zero (b) remains same (c) increases (d) decreases

3. **An electric dipole is placed in a uniform electric field. The dipole will experience**
   (a) a force that will displace it in the direction of the field
   (b) a force that will displace it in a direction opposite to the field.
   (e) a torque which will rotate it without displacement
   (d) a torque which will rotate it and a force that will displace it

4. **Figure shows two charges of equal magnitude separated by a distance 2a. As we move away from the charge situated at x=0 to the charge situated at x=2a, which of the following graphs shows the correct behaviour of electric field?**



a)  b)  c)  d) 

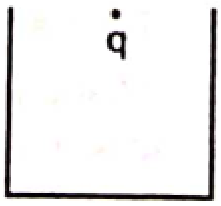
5. **An electric dipole is placed along the x -axis at the origin O. A point P is at a distance of 20 cm from this origin such that OP makes an angle π/ 3 with the x -axis. If the electric field at P makes an angle θ with the x -axis, the value of θ would be**

a) $\frac{\pi}{3}$ b) $\frac{\pi}{3}+\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$ c) $\frac{2\pi}{3}$ d) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

6. **A spherically symmetric charge distribution is characterized by a charge density having the following variations: $\rho(r)=\rho_0\left(1-\frac{r}{R}\right)$ $for\ r<R$ $\rho(r)=0$ $for\ r\ge R$ Where r is the distance from the centre of the charge distribution ρ_0 is a constant. The electric field at an internal point (r<R) is:**

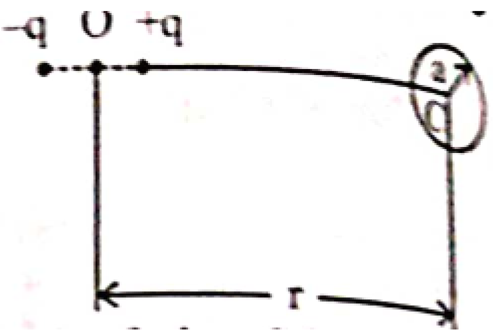
a) $\frac{\rho_0}{4\epsilon_0}\left(\frac{r}{3}-\frac{r^2}{4R}\right)$ b) $\frac{\rho_0}{\epsilon_0}\left(\frac{r}{3}-\frac{r^2}{4R}\right)$ c) $\frac{\rho_0}{3\epsilon_0}\left(\frac{r}{3}-\frac{r^2}{4R}\right)$ d) $\frac{\rho_0}{12\epsilon_0}\left(\frac{r}{3}-\frac{r^2}{4R}\right)$

7. **A charge q is placed at the centre of the open end of a cylindrical vessel. The flux of the electric field through the surface of the vessel is**



a) Zero b) q/ϵ_0 c) $q/2\epsilon_0$ d) $2q/\epsilon_0$

8. **A short electric dipole to dipole moment $\vec{p}$ is placed at a distance r from the centre of solid metallic centre of radius a (<<r) as shown in the figure. The electric field intensity at the centre of sphere C due to indored charge on the sphere is**

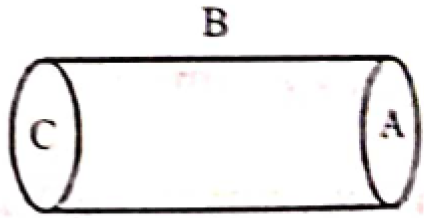


a) Zero b) $\frac{1}{4\pi\epsilon_0}\frac{2p}{r^3}$ $along\ CO$ c) $\frac{1}{4\pi\epsilon_0}\frac{2p}{r^3}$ $along\ OC$ d) $\frac{1}{4\pi\epsilon_0}\frac{p}{r^3}$ $along\ CO$

9. **A semi-circular arc of radius ' a ' is charged uniformly and the charge per unit length is λ The electric field at the centre of this arc is**

a) $\frac{\lambda}{2\pi\epsilon_0 a}$ b) $\frac{\lambda}{2\pi\epsilon_0 a^2}$ c) $\frac{\lambda}{4\pi^2\epsilon_0 a}$ d) $\frac{\lambda^2}{2\pi\epsilon_0 a}$

10. **A hollow cylinder has a charge q coulomb within it. If ϕ is the electric flux in units of voltmeter associated with the curved surface B, the flux linked with the plane surface A is units of voltmeter will be**

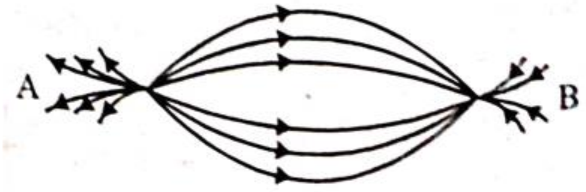


a) $\frac{q}{2\epsilon_0}$ b) $\frac{\phi}{3}$ c) $\frac{2}{\epsilon_0}-\phi$ d) $\frac{1}{2}\left(\frac{q}{\epsilon_0}-\phi\right)$

11. **A point Q lies on the perpendicular bisector of an electrical dipole of dipole moment p. If the distance of Q from the dipole is r (much larger than the size of the dipole), then the electric field at Q is proportional to**

(a) p^{-1} and r^{-2} (b) p and r^{-2} (c) p^2 and r^{-3} (d) p and r^{-3}

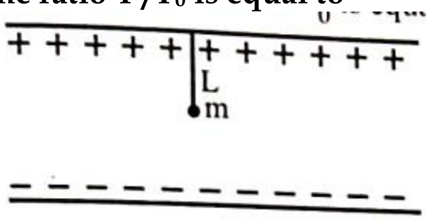
12. The spatial distribution of electric field due to charges (A, B) shown in figure. Which one of the following statements correct?



(a) A is +ve and B – ve , $|A|>|B|$ (b) A is -ve and B +Ve, $|A|=|B|$

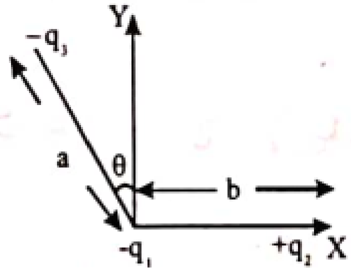
(c) Both are +Ve but A>B (d) Both are - Ve but A>B

13. A small sphere carrying a charge 'q' is hanging in between two parallel plates by a string of length L. Time between pendulum is T_0. When parallel plates are charged. the time period changes to T. The ratio T/T_0 is equal to



a) $\left(\dfrac{g+\dfrac{qE}{m}}{g}\right)^{1/2}$ b) $\left(\dfrac{g}{g+\dfrac{qE}{m}}\right)^{3/2}$ c) $\left(\dfrac{g}{g+\dfrac{qE}{m}}\right)^{1/2}$ d) None of these

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



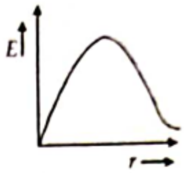
a) $\frac{q_2}{b^2}-\frac{q_3}{a^2}\cos\theta$ b) $\frac{q_2}{b^2}+\frac{q_3}{a^2}\sin\theta$ c) $\frac{q_2}{b^2}+\frac{q_3}{a^2}\cos\theta$ d) $\frac{q_2}{b^2}-\frac{q_3}{a^2}\sin\theta$

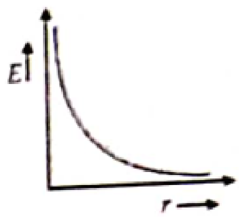
15. An oil drop of radius r and density ρ is held stationary in a uniform vertically upwards electric field 'E'. If $\rho_0(<\rho)$ is the density of air and e is quanta of charge, then the drop has-

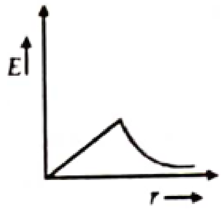
a) $\frac{4\pi r^3(\rho-\rho_0)g}{3eE}$ *excess electrons* b) $\frac{4\pi r^2(\rho-\rho_0)g}{eE}$ *excess electrons*

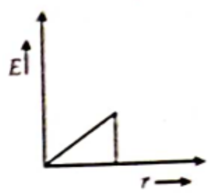
c) *deficiency of* $\frac{4\pi r^3(\rho-\rho_0)g}{3eE}$ *electrons* d) *deficiency of* $\frac{4\pi r^2(\rho-\rho_0)g}{eE}$ *electrons*

16. In a uniformly charged sphere of total charge Q and radius R, the electric field E is plotted as function of distance from the centre. The graph which would correspond to the above will be:

a) 

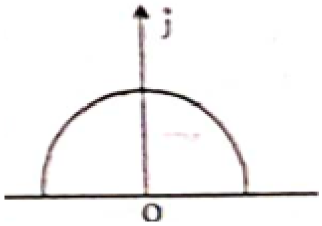
b) 

c) 

d) 

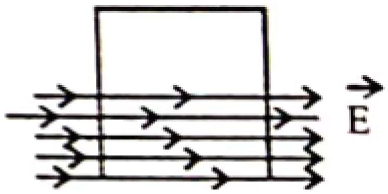
17. **Which of the following is a wrong statement?**
(a) The charge of an isolated system is conserved
(b) It is not possible to create or destroy charged particles
(c) It is possible to create or destroy charged particles
(d) It is not possible to create or destroy net charge

18. **A thin semi-circular ring of radius r has a positive charge q distributed uniformly over it. The net electric field $\vec{E}$ at the centre O is**



a) $\frac{q}{4\pi^2 \epsilon_0 r^2} j$ b) $-\frac{q}{4\pi^2 \epsilon_0 r^2} j$ c) $-\frac{q}{2\pi^2 \epsilon_0 r^2} j$ d) $\frac{q}{2p^2 e_0 r^2} j$

19. **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 in SI units associated with the surface is**



a) $EL^2/2$ b) Zero c) EL^2 d) $EL^2/(2\epsilon_0)$

20 **Two positive ions, each carrying a charge q, are separated by a distance d . If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge of an electron)**

a) $\frac{4\pi \epsilon_0 Fd^2}{e^2}$ b) $\sqrt{\frac{4\pi \epsilon_0 Fe^2}{d^2}}$ c) $\sqrt{\frac{4\pi \epsilon_0 Fd^2}{e^2}} 1$ d) $\frac{4\pi \epsilon_0 Fd^2}{q^2}$

PART-II (NUMERICAL/INTEGER TYPE QUESTIONS)

21. **A solid sphere of radius R has a charge O distributed in its volume with a charge density $\rho = kr^a$ where k and a are constants and r is the distance from its centre. If the electric field at $r = \frac{R}{2} is \frac{1}{8}$ times that at r=R, find the value of a**

22. **An uniform electric field E exists along positive x-axis. The work done in moving charge 0.5 C through a distance 2m along a direction making an angle 60^0 with x –axis is 10 J. Then what is the magnitude of electric field (in Vm^{-1})?**

23. **Two small similar metal spheres A and B having charges 4q and -4q, when placed at a certain distance apart , exert electric force F on each other. When another identical uncharged sphere C, first touched with then with B and then removed to infinity, the force of interaction between A and B for the same separation will be F/x, then find the value of x ?**

24. **A surface has the area vector $\vec{A}=\left(2\hat{i}+3\hat{j}\right)m^2$. Then what is the flux (in V-m) of an electric field through it if the field is $\vec{E}=4\hat{i}\frac{V}{m}$?**

25. **The surface charge density of a thin charged disc R is σ. The value of the electric field at the centre of the disc is $\frac{\sigma}{2\in_0}$. With respect to the field at the centre, the electric field along the axis at a distance reduces (in percent) by**

KEY SHEET

1) **a**	2) **d**	3) **c**	4) **a**	5) **b**	6) **b**	7) **a**	8) **b**	9) **a**	10) **d**
11) **d**	12) **a**	13) **c**	14) **b**	15) **c**	16) **c**	17) **b**	18) **c**	19) **b**	20) **c**
21) **2**	22) **20**	23) **8**	24) **8**	25) **71.43**					