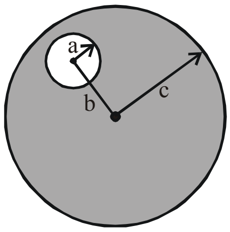
SECTION-I

Single Correct Answer Type **6 Q. [3 M (–1)]**

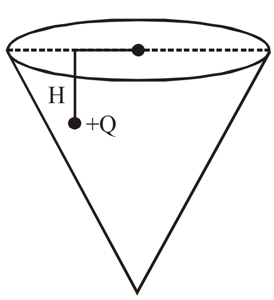
1. A spherical conductor have a cavity of radius 'a'. If radius of conductor have radius 'c' and the distance between centre of conductor and center of cavity is 'b'. Charge given to conductor is Q. Then select the correct statement :-



(A) Electric field in the cavity is non zero and uniform
(B) Electric field in the cavity is zero through out the volume
(C) Electric field intensity in the cavity depends on b
(D) Electric field intensity depends on radius of cavity 'a'

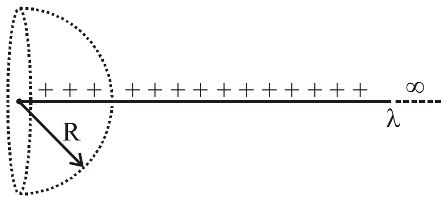
2. The potential (in volts) of a charge distribution is given by
$V(z) = 30–5z^2$ for $|z| \le 1m$
$V(z) = 35–10|z|$ for $|z| \ge 1m$.
V(z) does not depend on x and y. If this potential is generated by a uniform charge per unit volume ρ_0 (in units of $\in_0$) which is spread over a certain region, then choose the correct statement.
(A) $\rho_0=20 \in_0$ in the entire region
(B) $\rho_0=10 \in_0$ for $|z| \le 1m$ and $\rho_0=0$ elsewhere
(C) $\rho_0=40 \in_0$ in the entire region
(D) $\rho_0=20 \in_0$ for $|z| \le 1m$ and $\rho_0=0$ elsewhere

3. A charge +Q is located somewhere inside a vertical cone such that the depth of the charge from the free surface of the cone is H. It is found that the flux associated with the cone with the curved surface is $\frac{3Q}{5\varepsilon_0}$. If the charge is raised vertically through a height 2H, then the flux through the curved surface is



(A) $\frac{3Q}{5\in_0}$ (B) $\frac{2Q}{5\in_0}$ (C) $\frac{4Q}{5\in_0}$ (D) Zero

4. Consider an imaginary hemispherical surface. A semi-infinite wire of charge density λ is kept with one of its end conciding with centre of hemisphere and wire is kept along the symmetric axis of the hemisphere as shown in the figure. The electric flux passing through the spherical surface of the hemisphere is :-

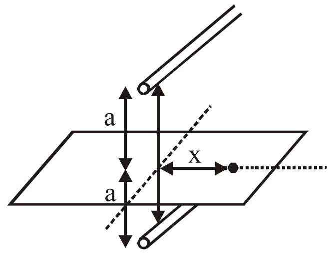


(A) $\frac{\lambda R}{3\in_0}$ (B) $\frac{\lambda R}{4\in_0}$ (C) $\frac{3}{4}\frac{\lambda R}{\in_0}$ (D) $\frac{\lambda R}{2\in_0}$

5. A sphere of radius 10 cm has a total charge Q distributed over its surface. Imagine this sphere to be resting on the open end of a cylinder of radius 8 cm and height 10cm. Find the electric flux through the curved cylindrical surface.

(A) $\frac{Q}{10\in_0}\left(2\sqrt{5}-3\right)$ (B) $\frac{Q}{5\in_0}$ (C) $\frac{Q}{2\in_0}\left(1-\frac{2}{\sqrt{5}}\right)$ (D) None of these

6. Two infinite wires are charged uniformly with same charge density and kept parallel to each other at a distance of 2a to each other. In the symmetry plane passing through the mid point of line joining both the wire; there is a point at a distance x from the central point where electric field is maximum. Find x.

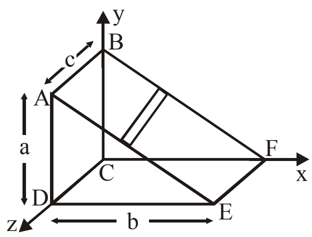


(A) x = a
(B) $x = \frac{a}{\sqrt{2}}$

(C) $x = \frac{a}{2}$
(D) $\sqrt{2}a$

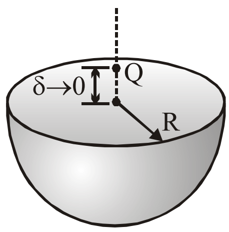
Multiple Correct Answer Type 5 Q. [4 M (–1)]

7. In the given hypothetical electric field $\vec{E} = \left[(d + x)\hat{i} - E_0\hat{j}\right] N/C$, a hypothetical closed surface is taken as shown in figure :-



(A) Net flux through plane ABCD is –acd unit.
(B) Net flux through plane CDEF is bcE_0 unit.
(C) Net flux through plane ABEF is $\left[-bcE_0 + acd + \frac{acb}{2}\right]$unit.
(D) Net charge enclosed by the closed surface is $abc\in_0$ unit.

8. A particle with charge Q is located immediately above the centre of the flat face of a hemisphere of radius R as shown in figure. Choose CORRECT statement(s) :- (Outward area is to be taken positive)



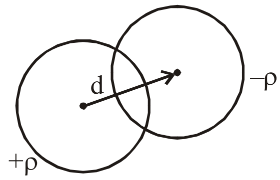
(A) Flux through the flat surface is $-\frac{Q}{2\in_0}$.

(B) Flux through the curved surface is $\frac{Q}{2\in_0}$.

(C) If charge Q is displaced up flux through flat surface is less than $\frac{Q}{2\in_0}$ in magnitude

(D) If charge Q is displaced up flux through curved surface is less than $\frac{Q}{2\in_0}$ in magnitude.

9. Figure shows two spheres, each of radius R and carrying uniform volume charge densities $+\rho$ and $-\rho$, respectively, are placed so that they partially overlap. Let the vector from the positive centre to the negative centre is $\vec{d}$. Then choose the **CORRECT** statement(s) :-



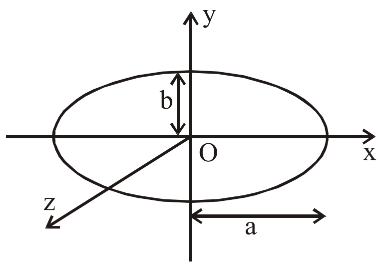
(A) Electric field inside the overlaped region will be uniform

(B) Electric field inside the overlaped region is $\frac{\rho}{3\in_0}\vec{d}$

(C) Electric field inside the overlaped region is zero

(D) Gauss's law can not be applied if only one of the spheres is taken as Gaussian surface.

10. An ellipsoidal gaussion surface with semi major axis a and minor axis b is shown in figure. An electric field $\vec{E} = \frac{C(x\hat{i}+y\hat{j}+z\hat{k})}{(x^2+y^2+z^2)^{3/2}}$ exist in space.



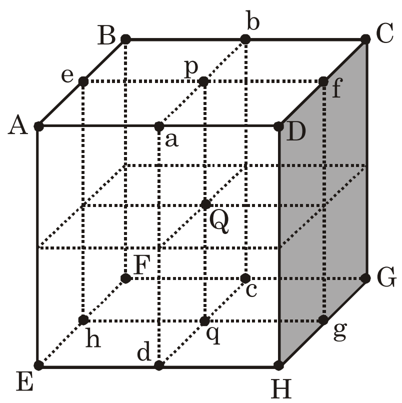
(A) Net flux through constant gaussion surface is $4\pi C$

(B) Net charge enclosed by gaussion surface is $4\pi C\varepsilon_0$

(C) If given surface is a conductor electric potential at all its inside points may be constant for given field function

(D) If given surface is a conductor electric field at all its inside points may be constant for given field function

11. The following figure shows a charge Q kept at the centre of a cube. Let ϕ represent the flux of field due to the charge Q, the correct options are :



(A) $\phi_{ABCD} = \frac{Q}{6\varepsilon_0}$ (B) $\phi_{Cbpf} = \frac{Q}{24\varepsilon_0}$ (C) $\phi_{abcd} = 0$ (D) $\phi_{abcd} = \frac{Q}{2\varepsilon_0}$

Linked Comprehension Type (1 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

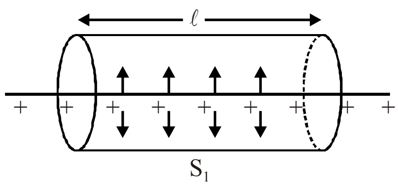
Paragraph for Question nos. 12 to 14

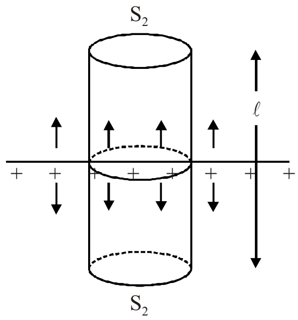
While dealing with a system of point charges, the principle of superposition is helpful in obtaining the electric field vector at any point. However, evaluating electric field at a point for continuous charge distribution in space often becomes a mathematically challenging job. The application of Gauss' law is sometimes useful in such cases. Gauss' law states that the total electric flux through a closed surface is proportional to total electric charge enclosed within the surface with $\left(\frac{1}{\epsilon_0}\right)$ as constant of proportionality.

One such application is in finding electric field for an infinite linear distribution of charge, having λ as linear charge density.

Taking S_1 as the gaussian surface, $\phi_E = \int \vec{E} \cdot d\vec{s} = E(2\pi r\ell)$, $q_{enclosed} = \lambda\ell$. Hence, $E = \frac{\lambda}{2\pi\varepsilon_0 r}$.

Mr. Becker rather decides to take an upright cylinder shown as surface S_2. He applies Gauss' law on surface S_2 as ; $\phi_E = \int \vec{E} \cdot d\vec{s} = E(2\pi r^2)$, $q_{enclosed} = (2r\lambda)$. It gives $E = \frac{\lambda}{\pi r \varepsilon_0}$. The difference in values of electric field calculated by using surfaces S_1 and S_2 is debatable.





12. Which of the following correctly points out the error in Mr. Beckers analysis ?
(A) Gaussian surface cannot cut the continuous distribution of charge
(B) The area vectors at the two ends of S_2 must be in the same direction
(C) $\oint \vec{E} \cdot d\vec{s} \neq E(2\pi r^2)$
(D) $q_{enclosed} \neq 2r\lambda$

13. To calculate the electric field due to an infinite plane sheet of uniform charge density σ, We choose two different gaussian cylinders as shown in figure (I) & figure (II). The appropriate choice is figure (I) because

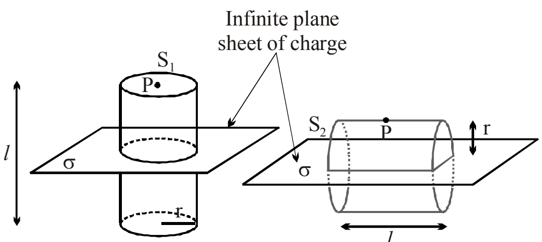
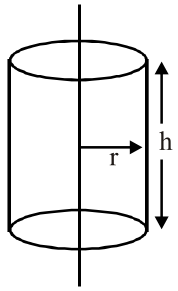


Figure (I) Figure (II)

(A) Gaussian surface cannot cut the continuous distribution of charge
(B) The area vectors at the two ends of S_2 must be in the same direction
(C) for S_2, $\oint \vec{E} \cdot d\vec{s} \neq E(2\pi r l)$
(D) $q_{enclosed} \neq 2rl\sigma$

14. Consider a finite wire having a uniform charge distribution over its length. It is symmetrically enclosed by coaxial cylindrical Gaussian surface as shown in figure. We apply Gauss's law to find electric field and for that purpose, we wish to evaluate $\oint \vec{E} \cdot \vec{ds}$. Which of the following is incorrect reason for our inability to evaluate the integeral.

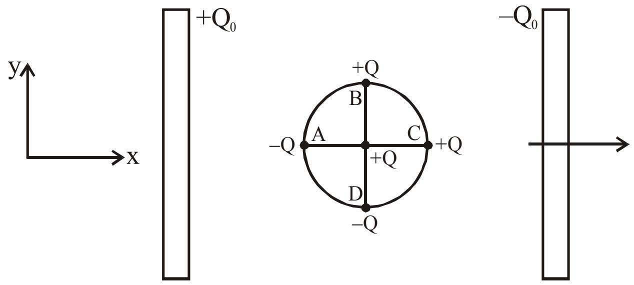


(A) The flux will be due to the components of electric field normal to the wire only.
(B) Electric field is varying in magnitude over the surface
(C) The angle between electric field and area vector is not constant at all the points on the gaussian surface
(D) The flux through the circular faces will be non zero

Linked Comprehension Type (1 Para × 2 Q.) [4 M (–1)]
(Multiple Correct Answer Type)

Paragraph for Question no 15 and 16

Figure shows a massless wheel of radius R and massless spokes with five charges each of charge Q and mass m. System is placed in a field created by two large fixed plates having charges $+Q_0$ and $-Q_0$ respectively. Entire assembly lies in a smooth horizontal plane. Wheel is placed in horizontal plane and constrained to move in horizontal plane. Initally spokes are released along x & y axis as shown in figure. (A = surface area of plate)



15. Mark the **CORRECT** statement(s) :

(A) Acceleration of centre of mass is $\dfrac{QQ_0}{5 \in_0 mA}$

(B) Acceleration of centre of mass is $\dfrac{QQ_0}{10 \in_0 mA}$

(C) Instantaneous angular acceleration of system is $\dfrac{QQ_0}{2 \in_0 AmR}$

(D) Instantaneous angular acceleration of system is $\dfrac{QQ_0}{5 \in_0 AmR}$

16. Mark the **CORRECT** statement(s) :

(A) When released from rest system executes periodic motion in the reference frame-fixed to centre of mass.

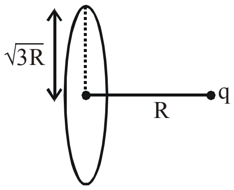
(B) When released from rest system executes simple harmonic motion in the reference frame-fixed to centre of mass.

(C) Acceleration of point A immediately after release is $\frac{QQ_0}{5\epsilon_0\, mA}\hat{i}+\frac{QQ_0}{2\epsilon_0\, Am}\hat{j}$.

(D) Acceleration of point A immediately after release is $\frac{QQ_0}{5\epsilon_0\, mA}\hat{i}-\frac{QQ_0}{5\epsilon_0\, Am}\hat{j}$.

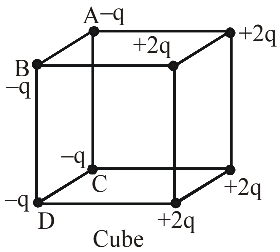
Matching List Type (4 × 4) 1 Q. [3 M (–1)]

17. List-I **List-II**

(P) 

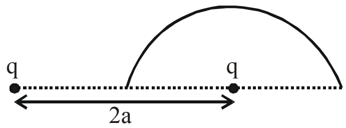
Flux through given circle

(1) O

(Q) 

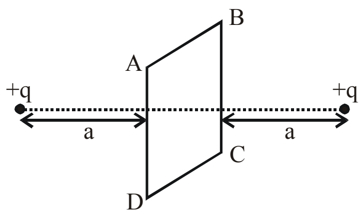
Net flux through surface ABCD

(2) $\frac{q}{2\epsilon_0}$

(R) 

Net flux through given hemispherical surface

(3) $\frac{q}{3\epsilon_0}$

(S) 

Net flux through surface ABCD

(4) $\frac{q}{4\epsilon_0}$

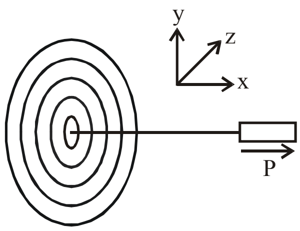
Code :-

	P	Q	R	S
(A)	4	3	2	1
(B)	3	2	1	4
(C)	2	3	4	1
(D)	1	4	2	3

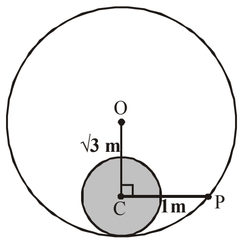
SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **3 Q. [4 M (0)]**

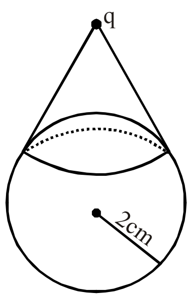
1. A long uniformly charged wire with linear charge density $\lambda = \epsilon_0$ coulomb/m is placed in the form of a spiral of outer radius R = 1m and having a total N = 160 turns as shown in figure. A dipole of dipole moment $|\vec{p}| = 0.1\ \text{Cm}$ is placed along x-axis at a = $\sqrt{3}$ m point (a, 0, 0). Find the magnitude of force (in N) experienced by dipole.



2. A uniformly charged sphere is placed inside a charged hollow sphere as shown in figure. O is the centre of hollow sphere and C is the centre of solid sphere. The magnitude of charge on both the spheres is $4\left(\sqrt{\frac{3}{7}}\right)\mu C$. The electric field at point 'P' which lie just outside the hollow sphere is given by 3α kN/C. Find the value of α.



3. A point charge q(= 4C) is placed at a distance $2\sqrt{2}$ cm from the centre of sphere having radius 2 cm as shown in figure. Flux through the surface of sphere enclosed by all the tangents to the sphere passing through the charge as shown in figure is $\frac{\sqrt{\alpha}\left(\sqrt{2}-1\right)}{\epsilon_0}$. Find the value of α.



CLASS TEST # 21	ANSWER KEY

SECTION-I

Single Correct Answer Type — **6 Q. [3 M (–1)]**

1. Ans. (B)	2. Ans. (B)	3. Ans. (B)	4. Ans. (D)
5. Ans. (A)	6. Ans. (A)		

Multiple Correct Answer Type — **5 Q. [4 M (–1)]**

7. Ans. (A, B, C)	8. Ans. (A,B,C,D)	9. Ans. (A,B)	10. Ans. (A,B)
11. Ans. (A,B,C)			

Linked Comprehension Type — **(1 Para × 3Q.) [3 M (-1)]**
(Single Correct Answer Type)

12. Ans. (C)	13. Ans. (C)	14. Ans. (A)

Linked Comprehension Type — **(1 Para × 2 Q.) [4 M (–1)]**
(Multiple Correct Answer Type)

15. Ans. (A,C)	16. Ans. (A,C)

Matching List Type (4 × 4) — **1 Q. [3 M (–1)]**

17. Ans. (A)

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) — **3 Q. [4 M (0)]**

1. Ans. 1	2. Ans. 9	3. Ans. 2