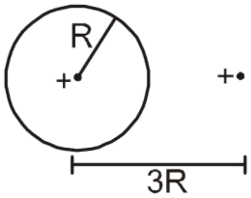
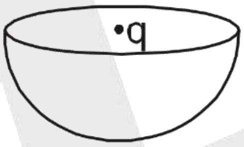
DPP- 05

Gauss's law

Q1. Find the flux of the electric field through a spherical surface of radius R due to a charge of 8.85×10^{-8}C at the centre and another equal charge at a point 3R away from the centre
(Given : $\varepsilon_0 = 8.85 \times 10^{-12}$ units)



Q.2 A charge q is placed at the centre of an imaginary hemispherical surface. Using symmetry arguments and the Gauss's law, find the electric flux due to this charge through the given surface.



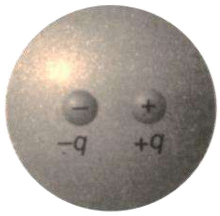
Q.3 An electric dipole is placed at the centre of a sphere. Mark the correct options.

(A) The electric field is zero at every point of the sphere.

(B) The flux of the electric field through the sphere is non-zero.

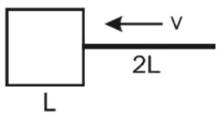
(C) The electric field is zero on a circle on the sphere.

(D) The electic field is not zero anywhere on the sphere.

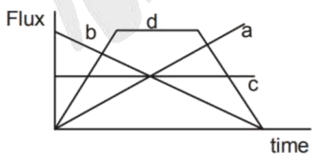


Q.4 Figure (i) shows an imaginary cube of edge length L. A uniformly charged rod of length 2 L moves towards left at a small but constant speed v. At t = 0, the left end of the rod just touches the centre of the face of the cube opposite to it. Which of the graphs shown in fig.(ii) represents the flux of the electric field through the cube as the rod goes through it ?

(i)

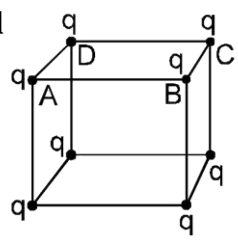


(ii)



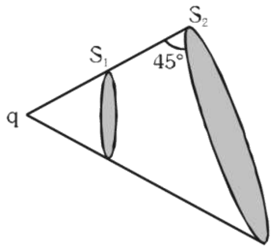
(A) a (B) b (C) c (D) d

Q.5 Eight point charges (can be assumed as uniformly charged small spheres and their centres at the corner of the cube) having value q each are fixed at vertices of a cube. The electric flux through square surface ABCD of the cube is



(A) $\frac{q}{24\epsilon_0}$ (B) $\frac{q}{12\epsilon_0}$ (C) $\frac{q}{6\epsilon_0}$ (D) $\frac{q}{8\epsilon_0}$

Q.6 In the given figure flux through surface S_1 is ϕ_1 & through S_2 is ϕ_2. Which is correct?

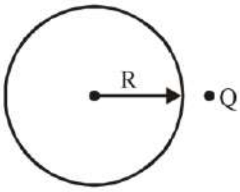


(A) $\phi_1 = \phi_2$ (B) $\phi_1 > \phi_2$

(C) $\phi_1 < \phi_2$ (D) None of these

Q.7 Statement 1: A charge is outside the Gaussian sphere of radius R. Then electric field on the surface of sphere is zero. And

Statement 2 : As $\oint \vec{E} \cdot d\vec{s} = \frac{q_{in}}{\varepsilon_0}$, for the sphere q_{in} is zero, so $\oint \vec{E} \cdot d\vec{s} = 0$.



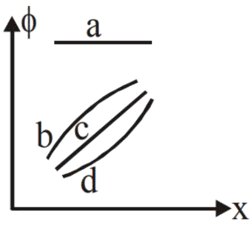
(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(C) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement- 2 is true.

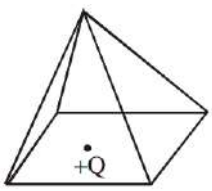
Q.8 A line of charge extends along a X-axis whose linear charge density varies directly as x. Imagine a spherical volume with its centre located on X-axis and is moving gradually along it. Which of the graphs shown in figure correspond to the flux ϕ with the x coordinate of the centre of the volume?



(A) a (B) b

(C) c (D) d

Q.9 A point charge +Q is positioned at the center of the base of a square pyramid as shown. The flux through one of the four identical upper faces of the pyramid is :-



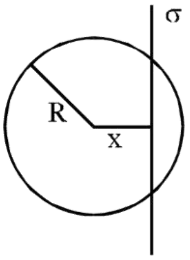
(A) $\frac{Q}{16\varepsilon_0}$

(B) $\frac{Q}{4\varepsilon_0}$

(C) $\frac{Q}{8\varepsilon_0}$

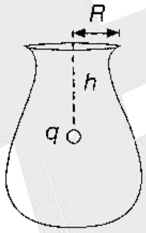
(D) None of these

Q.10 An infinite, uniformly charged sheet with surface charge density σ cuts through a spherical Gaussian surface of radius R at a distance x from its center, as shown in the figure. The electric flux Φ through the Gaussian surface is :-

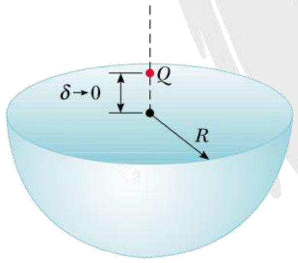


(A) $\frac{\pi R^2 \sigma}{\varepsilon_0}$ (B) $\frac{2\pi(R^2-x^2)\sigma}{\varepsilon_0}$ (C) $\frac{\pi(R-x)^2\sigma}{\varepsilon_0}$ (D) $\frac{\pi(R^2-x^2)\sigma}{\varepsilon_0}$

Q.11 Consider the situation shown in figure. A point charge q is placed at a depth $h = \sqrt{3}R$ exactly below the centre of mouth of a vessel whose open end is circular having a radius R. Calculate the electric flux through the lateral surface of this vessel.



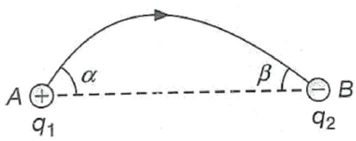
Q.12 A point charge Q is located just above the center of the flat face of a hemisphere of radius R as shown in figure. What is the electric flux through



(a) the curved surface and

(b) the flat face?

Q.13 Two charges $+q_1$ and $-q_2$ are placed at A and B respectively. A line of force emanates from q_1 at angle α with the line AB. At what angle will it terminate at $-q_2$?



ANSWER KEY

1. 0
2. $10^4 \frac{N-m^2}{C}, 0$
3. (D)
4. (D)
5. (C)
6. (A)
7. (D)
8. (C)
9. (C)
10. (D)
11. $\phi = \left(1 + \frac{\sqrt{3}}{2}\right)\frac{q}{2\varepsilon_0}$
12. **(a)** $\phi_{curved} = \frac{Q}{2\varepsilon_0}$ **(b)** $\phi_{flat} = -\frac{Q}{2\varepsilon_0}$
13. $\beta = 2\sin^{-1}\left[\sqrt{\frac{q_1}{q_2}}\sin\left(\frac{\alpha}{2}\right)\right]$