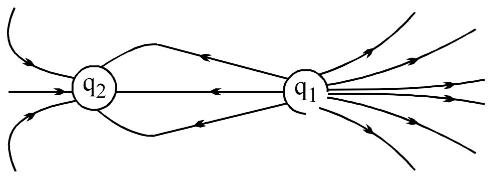
[SINGLE CORRECT CHOICE TYPE]

Q.1 For the figure shown, what is the ratio of the charges q_2/q_1, where the figure shown has a representation of the field lines in the space near the charges **[3]**



(A) –3/2 (B*) –2/3 (C) 2/3 (D) 3/2

Q.2 Potential within a hypothetical charged sphere varies with the distance of a point from centre as $V = -\vec{a}.\vec{r}$ where $\vec{a}$ is a vector of constant magnitude parallel to $\vec{r}$ and $\vec{r}$ is position vector of point under consideration taking centre of sphere as origin. Then the total charge stored within a sphere of radius R is. **[3]**

(A) $\pi R^2\varepsilon_0 a$ (B) $2\pi R^2\varepsilon_0 a$ (C) $3\pi R^2\varepsilon_0 a$ (D*) $4\pi R^2\varepsilon_0 a$

Q.3 The linear charge density on a dielectric ring of radius r is varying with θ as $\lambda = \lambda_0 \cos\frac{\theta}{2}$, where λ_0 is constant. Find the potential at the centre O of ring. [in volt] **[3]**

(A) $\frac{\lambda_0}{2\pi \in_0}$ (B) $\frac{2\lambda_0}{\pi^2 \in_0}$ (C*) zero (D) $\frac{\lambda_0}{\pi^2 \in_0}$

Q.4 A point electric dipole is at the origin of coordinates with its dipole moment along the positive Z-axis. Consider a circular disc of radius R with its centre at z = L and its plane perpendicular to the Z-axis. The modulus of the electric flux due to the dipole through the disc is maximum when R is equal to **[3]**

(A) infinity (B*) $\sqrt{2}\ L$ (C) L (D) $L/\sqrt{2}$

Q.5 An infinite line charge of uniform charge density λ is held fixed along the Z-axis of a cartesian coordinate system. A point electric dipole initially kept at the point A(+a, 0, 0) with the dipolemoment $\vec{p}$ along the negative X-direction is moved to the point B(+2a, 0, 0) and rotated so that its dipolemoment is along the positive X-direction. The work done by the external agent on the dipole in the entire process is **[3]**

(A) $-\frac{\lambda p}{2\pi \in_0 a}$ (B) $\frac{\lambda p}{2\pi \in_0 a}$ (C) $-\frac{\lambda p}{4\pi \in_0 a}$ (D*) $\frac{-3\lambda p}{4\pi \in_0 a}$

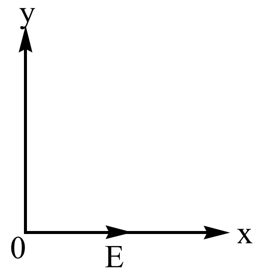
Q.6 A point charge q = 1C and mass 1 kg is projected with speed u = 10 m/s in the perpendicular direction of uniform electric field E = 100 V/m as shown. The equation of trajectory of the particle is (Neglect gravitational interaction with earth) **[3]**

(A*) $y^2 = 2x$

(B) $y = 2x^2$

(C) $y = 4x$

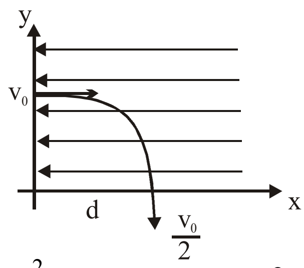
(D) $y = 4x^2$



Q.7 Electric potential at a point P, r distance away due to a point charge q at point A is V. If twice of this charge is distributed uniformly on the surface of a hollow sphere of radius 4r with centre at point A, the potential at P now is **[3]**
(A) V (B*) V/2 (C) V/4 (D) V/8

Q.8 A solid conducting sphere (radius = 5.0 cm) has a charge of 0.25 nC distributed uniformly on its surface. If point A is located at the center of the sphere and point B is 15 cm from the center, what is the magnitude of the electric potential difference between these two points? **[3]**
(A) 23 V (B*) 30 V (C) 15 V (D) 45 V

Q.9 In a certain region, free from gravity, electric field is along negative x-direction and it is constant. A particle having mass 'm' and charge q is projected along x-direction with speed v_0. A additional force $\vec{F} = \vec{C} \times \vec{v}$ is acting on the charge where $\vec{v}$ is velocity vector and $\vec{C}$ is a constant vector. The charge comes out of region with speed $\frac{v_0}{2}$. Then the magnitude of electric field will be **[3]**



(A) $\frac{3}{4}\frac{mv_0^2}{qd}$ (B) $\frac{4}{3}\frac{mv_0^2}{qd}$ (C*) $\frac{3}{8}\frac{mv_0^2}{qd}$ (D) cannot be determined.

[PARAGRAPH TYPE]

Paragraph for question nos. 10 to 11

The electric field in a certain region of space obeys

$$E_y \neq 0,\ E_x = E_z = 0 \text{ and } \partial\vec{E}/\partial x \neq 0,\ \partial\vec{E}/\partial y = \partial\vec{E}/\partial z = 0$$

Q.10 The net force on an electric dipole oriented parallel to the x axis in this field is **[3]**
(A) directed along the x axis. (B*) directed along the y axis.
(C) directed along the z axis. (D) None of the above

Q.11 The net torque on an electric dipole parallel to the x axis in this field is **[3]**
(A) directed along the x axis. (B) directed along the y axis.
(C*) directed along the z axis. (D) None of the above

[REASONING TYPE]

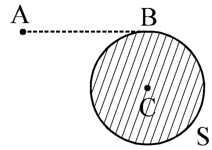
Q.12 Consider a conductor with a spherical cavity in it. A point charge q_0 is placed at the centre of cavity and a point charge Q is placed outside conductor. **[3]**
Statement-1 : Total charge induced on cavity wall is equal and opposite to the charge inside.
Statement-2 : If cavity is surrounded by a Gaussian surface, where all parts of Gaussian surface are located inside the conductor,

$$\oint \vec{E}.d\vec{A} = 0 \text{ ; hence } q_{induced} = -q_0$$

(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.

[MULTIPLE CORRECT CHOICE TYPE]

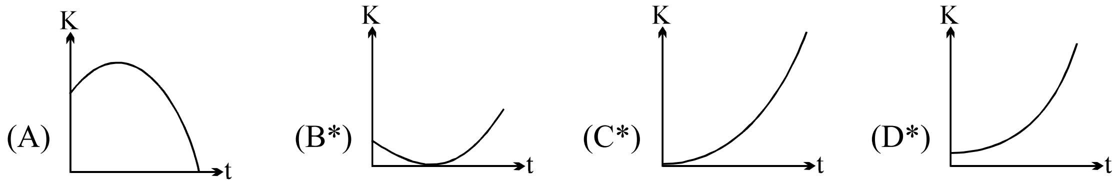
Q.13 S is a solid neutral conducting sphere. A point charge q of 1×10^{-6}C is placed at point A. C is the centre of sphere and AB is a tangent. BC = 3m and AB = 4m. **[4]**



(A*) The electric potential of the conductor is 1.8 kV
(B) The electric potential of the conductor is 2.25 kV
(C*) The electric potential at B due to induced charges on the sphere is – 0.45 kV.
(D) The electric potential at B due to induced charges on the sphere is 0.45 kV.

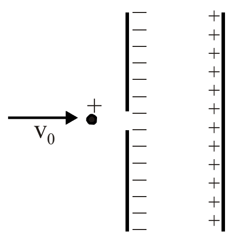
Q.14 An oil drop has a charge -9.6×10^{-19} C and has a mass 1.6×10^{-15}gm. When allowed to fall, due to air resistance it attains a constant velocity. Then if a uniform electric field is to be applied vertically to make the oil drop ascend up with the same constant speed, which of the following are correct? **[4]**
(A) the electric field is directed upward
(B*) the electric field is directed downward
(C*) the intensity of the electric field is $\frac{1}{3} \times 10^2$ N/C
(D) the intensity of the electric field is $\frac{1}{6} \times 10^5$N/C

Q.15 A proton is either released at rest or launched with a certain velocity in a uniform electric field. Which of the graphs in figure could possibly show how the kinetic energy of the proton changes during the proton's motion? **[4]**



[Ans. (e) through (h)]

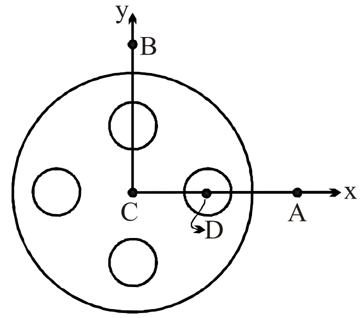
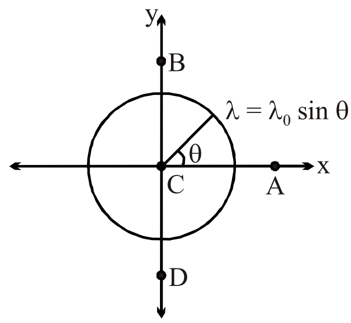
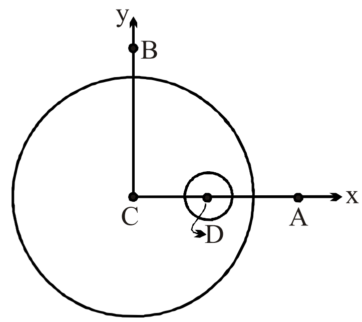
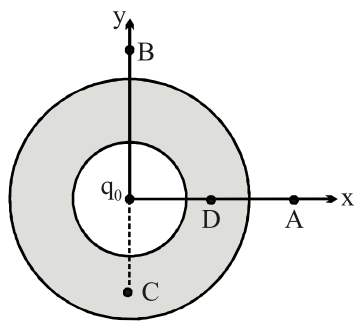
Q.16 A positively charged particle carrying 2.0×10^{-8} C enters a region between charged infinite plates through a hole in one plate, as shown. The potential difference between the plates is 1000 V, and the kinetic energy of the particle as it enters the hole is 1.0×10^{-5} J. (Only electrical effects are to be considered. Gravitational effects and air resistance are to be ignored.) **[4]**

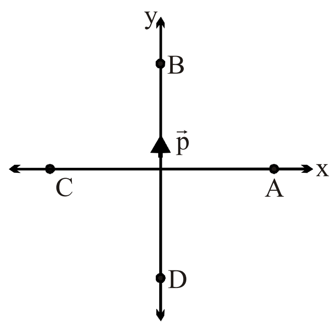


(A*) The kinetic energy of the particle decreases as it moves toward the right-hand plate.
(B*) The particle has insufficient kinetic energy to reach the right-hand plate, and it "falls back" toward the hole after going part way.
(C) The particle collides with the right-hand plate and bounces back toward the left-hand one.
(D*) As the particle moves toward the right-hand plate, the potential energy of the particle plates system increases.

[MATRIX TYPE]

Q.17 Column-II shows some charge distributions and column-I has some statement about electric field at four points A, B, C, D. Match column-I with column-II. **[6]**

Column-I		Column-II	
(A)	$\vec{E}_A$ has x component only	(P)	 Solid non conducting sphere of radius R of volumetric charge density ρ with four symmetrical cavities. All the five sphere's centre lie in same plane.
(B)	$\vec{E}_B$ has y component only	(Q)	 A very small circular filament lying in xy-plane. Points B, C and D are at large distance compared to radius of circle.
(C)	$\vec{E}_C$ has y component only	(R)	 A charged spherical conductor with a cavity in it.
(D)	$\lvert\vec{E}_D\rvert$ is zero	(S)	 A hollow thick spherical charge conductor with a concentric cavity. Charge q_0 placed inside at centre of cavity.

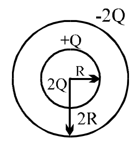
(T) 

A small electric dipole placed at origin. A,B,C and D are four points at large distance from origin.

[Ans.(A) P,R,S (B) P,Q,R,S,T (C) Q,T (D) R,S]

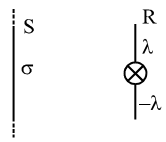
[SUBJECTIVE TYPE]

Q.18 In the figure shown a point charge 2Q is placed at the centre. The two concentric thin conducting spherical shells of radii 'R' and '2R' shown have charges +Q and –2Q respectively. Find the amount of heat generated (in J) after the shell of radius 'R' is earthed. [Take R = 1 cm, Q = 1 μC] **[5]**



[Ans.1.8]

Q.19 In the figure shown S is a large nonconducting sheet of uniform charge density σ. A rod R of length *l* and mass 'm' is parallel to the sheet and hinged at its mid point. The linear charge densities on the upper and lower half of the rod are shown in the figure. Find the angular acceleration of the rod just after it is released. **[5]**



Ans $\dfrac{3\sigma\lambda}{2m\in_0}$

Q.20 A non-conducting spherical ball of radius R contains a spherically symmetric charge with volume charge density $\rho = kr^n$, where r is the distance from the center of the ball and n is a constant. What should be n such that the electric field inside the ball is directly proportional to square of distance from the centre. **[5]**

[Ans. 0001]

Q.21 A point charge q is placed on the axis of a fixed ring of radius R so that the point charge is at a distance 3R/4 from the center of the ring. The electric flux through the ring due to the charge q is $\dfrac{nq}{\in_0}$. Fill 10 n in OMR Sheet. **[5]**

[Ans. 2]