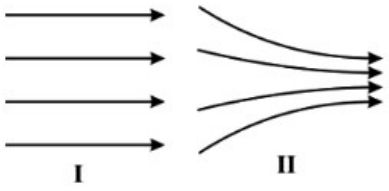
1. The image below shows two examples of electric field lines.



Which of the following statements is true?

(a) The electric fields in both I and II arise due to a single positive point charge located somewhere on the left.

(b) The electric fields in both I and II can be created by negative charges located somewhere on the left and positive charges somewhere on the right.

(c) The electric field in I is the same everywhere but the electric field in II becomes stronger as we move from left to right.

(d) As you move from left to right, the electric fields in both I and II become stronger.

2. For a Gaussian surface across which there is no net flux.

(P) The Gaussian surface contains no charges
(Q) There is no net charge inside the surface
(R) On the surface, there is no electric field at all
(S) The quantity of field lines entering and leaving the surface is the same
Which of the following claims is/are ABSOLUTELY true?

(a) Only the statement (Q)

(b) Both statements (P) and (S)

(c) Both statements (Q) and (R)

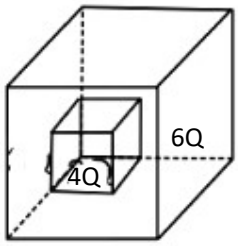
(d) Both statements (Q) and (S)

3. Two charges, each equal to q, are kept at x=−a and x= a on the x−axis. A particle of mass m and charge $q_0=\frac{q}{2}$ is placed at the origin. If charge q_0 is given a small displacement (y << a) along the y-axis, the net force acting on the particle is proportional to:

(a) y (b) –y

(c) $\frac{1}{y}$ (d) $\frac{-1}{y}$

4. C_1 and C_2 are two hollow cubes with a same vertex enclosing charge 4Q and 6Q respectively as shown in figure. The ratio of electric flux passing through $C_1$and C_2 is



(a) $\frac{1}{5}$ (b) $\frac{4}{5}$
(c) $\frac{2}{5}$ (d) $\frac{1}{2}$

ASSERTION AND REASON

For question number 5 and 6, Two statements are given below, one labelled as Assertion (A) and the other as Reason (R). select the correct answer to these questions from the codes (a),(b),(c) and (d) as given below:

(a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) If Assertion is true but Reason is false.

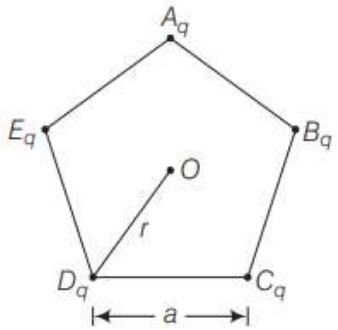
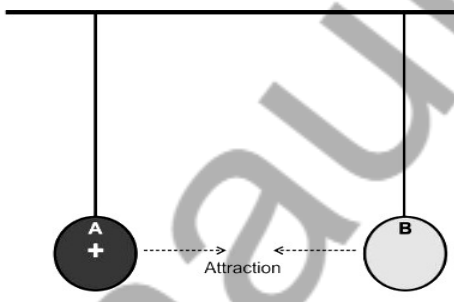
(d) If both Assertion and Reason are false.

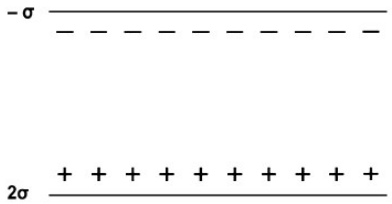
5. **Assertion (A):** On going away from a point charge or a small electric dipole, electric field decreases at the same rate in both the cases
Reason (R): Electric field is inversely proportional to square of distance from the charge or an electric dipole.

6. **Assertion (A):** A charge q is placed on a distance $\frac{a}{2}$ directly above the centre of square of side a. The magnitude of electric field associated with the square is independent of side length of the square.
Reason (R): Gauss 's law is independent of size of the Gaussian surface

Short Answer Type Qs (2 & 3 Marks)

7. Five charges, each with charge q, are placed at the corners of a regular pentagon of side

	a.  **(a)**(i) What will be the electric field at O, if the centre of the pentagon? (ii) What will be the electric field at O if the charge from one of the corners (say A) is removed? (iii) What will be the electric field at O if the charge q at A is replaced by -q? **(b)** How would your answer to (a) be affected if pentagon is replaced by n-sided regular polygon with charge q at each of its corners?
8.	A positively charged ball A hangs from a string. A non-conducting ball B is brought near ball A. Ball A is seen to be attracted to ball B.  (a) Give reason why it is NOT possible to determine whether ball B is negatively charged or neutral for sure from the above experiment alone. (b) Suggest any ONE additional experiment with ball B required to determine whether ball B is negatively charged or neutral for sure.
9.	A charge Q located at a point r is in equilibrium under the combined electric field of three charges q_1, q_2, q_3. If the charges q_1, q_2 q_3 are located at points $\overrightarrow{r_1}$, $\overrightarrow{r_2}$ and $\overrightarrow{r_3}$respectively, find the direction of the force on Q, due to q_3 in terms q_1, q_2, $\overrightarrow{r_1}$, $\overrightarrow{r_2}$,$\vec{r}$.

10.	Two charged sheets having charge density 2σ and -σ are placed parallel and close to each other in a vertical plane as shown in the figure. A particle having positive charge q and mass m is placed between these sheets and released from rest under gravity. What is the acceleration of this particle? 
	Long Answer Type Qs (5 Marks)
11.	A solid sphere of radius R carries a positive charge. The volume charge density is given as $\rho=\rho_0\left[1-\frac{r}{R}\right]$ where *r* is the distance of observation point from centre and ρ_0 is a constant. Let *ε* be the permittivity of the ball. Then find: (a) The electric field inside the sphere at a distance 'r' from centre. (b) The electric field intensity (E_m).
12.	A small conducting, sphere of radius 'r' carrying a charge +q is surrounded by a large concentric conducting shell of radius R on which a charge +Q is placed. Using Gauss's law derive the expressions for the electric field at a point 'x': (a) Between the sphere and the shell (r<x <R). (b) Outside the spherical shell.

HINTS AND ANSWER

1. (c)

2. (d)

3. (a)

4. (c)

5. (d)

6. (a)

7. (a) (i) electric field at O is zero

(ii) E = $\frac{q}{4\pi\varepsilon_0 r^2}$ along OA

(iii) E = $\frac{2q}{4\pi\varepsilon_0 r^2}$ along OA

(b) It does not depend on the number of sides or the number of charges.

8. (a) The attraction between A and B could be due to the following reasons: B is negatively charged and hence A and B attract each other. B is neutral. The two balls attract each other due to the polarization of molecules in neutral ball B. It is not possible to determine for sure that ball B is negative or neutral from this experiment alone.

(b) Possible additional experiments: A known neutral ball can be brought near ball B (without ball A nearby). If the neutral ball is attracted to ball B, then ball B is negatively charged for sure. If there is no interaction between the two balls, then ball B is neutral for sure. A known negatively charged ball is brought near ball B (without ball A nearby). If ball B repels the negatively charged ball, ball B is negatively charged for sure. On the other hand, if ball B is attracted to the negatively charged ball, then ball B is neutral for sure.

9. **Expression type Question**

$$\frac{1}{q_3}\left[\frac{q_1(\vec{r}_1-\vec{r})}{|\vec{r}-\vec{r}_1|^3}+\frac{q_2(\vec{r}_2-\vec{r})}{|\vec{r}-\vec{r}_2|^3}\right]$$

10. **Expression type Question**

$$\text{acceleration } a = \frac{F_{net}}{m} = \frac{3q\sigma}{2m\varepsilon_0} - g$$

11.	**Expression type Question** (a) $E = \frac{\rho_0}{\varepsilon}\left(\frac{r}{3} - \frac{r^2}{4R}\right)$ (b) $E_m = \frac{\rho_0}{\varepsilon}\frac{R}{9}$
12.	**Derivation**

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