SHORT QUESTIONS

12.1 The potential is constant throughout a given region of space. Is the electrical field zero or non-zero in this region? Explain.

Ans. When the potential is constant through a given region of space then electric field in this region will be zero.

Reason: We know the relation between electric intensity and potential difference is

$$E = -\frac{\Delta V}{\Delta r} \qquad \ldots\ldots (i)$$

As potential is constant.

$$\therefore \qquad \Delta V = 0$$

Put in (i) eq. we get

$$E = 0$$

So electric field will be zero.

12.2 Suppose that you follow an electric field line due to a positive point charge. Do electric field and the potential increases or decreases?

Ans. If we follow an electric field line due to a positive point charge then electric field and potential both will decrease.

Reason: The formula for electric intensity and electric potential are

$$E = \frac{1}{4\pi\epsilon_o}\frac{q}{r^2} \quad \text{and} \quad V = \frac{1}{4\pi\epsilon_o}\frac{q}{r}$$

From these formulae we see that electric intensity is inversely proportional to square of distance and electric potential is inversely proportional to the distance therefore both will decrease.

12.3 How can you identify that which plate of a capacitor is positively charged?

Ans. There are different methods by which we can identify that which plate of a capacitor is positively charged.

(i) The plate of a capacitor connected with the positive terminal of battery will be positively charged.

(ii) A device called gold leaf electroscope can also be used for this purpose. We will bring a positively charged electroscope close to the plate of a capacitor, if the leaves will diverge then that plate will be positively charged.

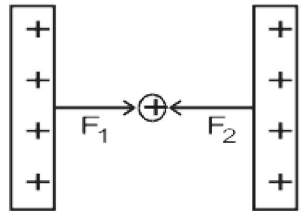
(iii) If a positive test charge is brought near the plate and if test charge will repel then that plate will be positively charged.

12.4 Describe the force or forces on a positive point charge when placed between parallel plates.

(a) With similar and equal charges.

(b) With opposite and equal charges.

Ans. (a) When a positive point charge is placed between parallel plates with similar and equal charge plates then net force will be zero.



Reason: We know that the expression of electric force is

$$F = qE$$

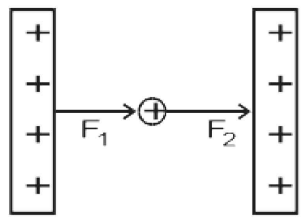
Here, $|F_1| = |F_2| = F$

i.e., magnitude of force is equal but in opposite direction.

Net force $= F_1 + (F_2)$

Net force $= 0$

(b) When a positive point charge is placed between two parallel plates with opposite and equal charges then force will be double i.e., 2F.



As $|F_1| = |F_2| = F$

Net force $= F_1 + F_2$

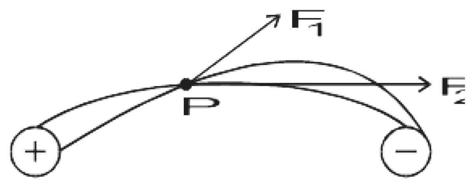
Net force $= 2F$

In this case both forces are equal in magnitude and are in same direction.

12.5 Electric lines of force never cross. Why?

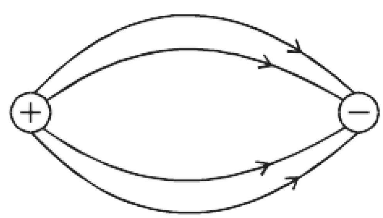
Ans. Electric lines of forces can never cross each other.

Reason: As electric intensity is a vector quantity and if two electric lines of forces cross each other at a single point then electric intensity will have two different direction at a single point which is not possible because electric intensity is a vector quantity and vector has only one direction.



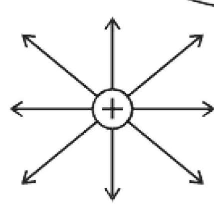
12.6 If a point charge q of mass m is released in a non-uniform electric field with field lines in the same direction pointing, will it make a rectilinear motion?

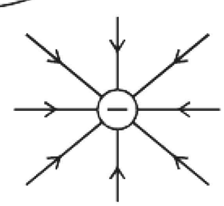
Ans. If a point charge q of mass m is released in a non-uniform electric field then there are two possibilities:



(i) If a point charge is released in a non-uniform field produced by positive and negative charges then it will move in curved path.

(ii) If a point charge is placed in non-uniform field produced by a positive or negative charge then it will make a rectilinear motion.

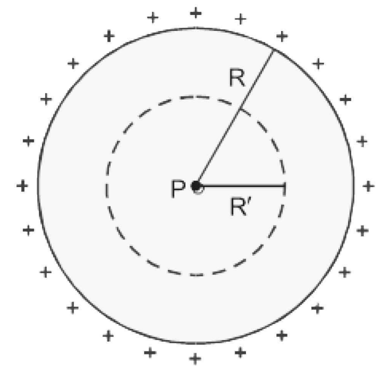




12.7 Is E necessarily zero inside a charged rubber balloon if balloon is spherical? Assume that charge is distributed uniformly over the surface.

Ans. Electric intensity inside a charged rubber balloon will be zero.

Reason: Consider a Gaussian surface inside the charged rubber balloon. As there is no charge at the centre therefore q = 0.



According to Gauss's law

$$\phi_e = \frac{1}{\epsilon_o}\text{(Charge)}$$

$$\phi_e = \frac{1}{\epsilon_o}(q)$$

$$\phi_e = \frac{1}{\epsilon_o}\ 0$$

$$\therefore \quad \phi_e = 0 \qquad \text{...... (i)}$$

But according to definition of electric flux.

$$\phi_e = \vec{E}\,.\,\vec{A} \qquad \text{...... (ii)}$$

Comparing equations (i) and (ii) we get:

$$\vec{E}\,.\,\vec{A} = 0$$

As $\vec{A} \neq 0$

$$\therefore \quad \vec{E} = 0$$

So the electric intensity inside a charged rubber balloon is zero.

12.8 Is it true that Gauss's law states that the total number of lines of forces crossing any closed surface in the outward direction is proportional to the net positive charge enclosed within surface?

Ans. We know that according to Gauss's law, total flux passing through any closed surface is equal to $\frac{1}{\epsilon_o}$ times the total charge enclosed within the surface.

i.e., $$\phi = \frac{1}{\epsilon_o}\ \text{(total charge)}$$

Here, $$\frac{1}{\epsilon_o} = \text{Constant}$$

So, $$\phi \propto \text{Total charge}$$

Here ϕ = flux which is total number of lines passing through a certain area and we see that it is directly proportional to charge enclosed within the surface therefore given statement is true that the total number of lines of forces crossing any closed surface in the outward direction is proportional to net positive charge enclosed within the surface.

12.9 Do electrons tend to go to region of high potential or of low potential?

Ans. As electrons are negatively charged particle therefore when they enter the electric field they will tend to go the region of high potential (positive terminal) from the region of low potential (negative terminal).