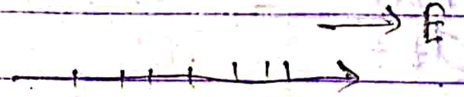
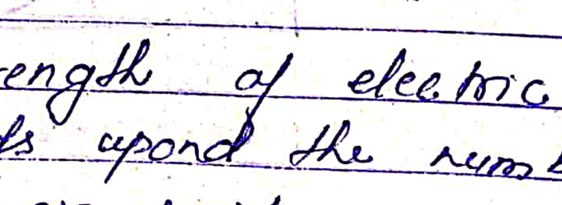
Electric field lines // Electric lines of force

It is the path followed by a unit positive charge placed in an Electric field due to a charged body. It may be a straight line or a curve. if it is a straight line the direction of Electric field is along the line, but, if it is a curve, direction of Electric field at a point is along the tangent drawn at that point.

eg:-(a) For straight line



(b) For curve line



i.e, the strength of electric field in a space depends upon the number of electric field lines per unit area

$$\left(\frac{N}{A}\right) = E$$

properties of Electric field lines

(i) Electric field lines originates from positive charge and terminate to negative charge i.e, ends at negative charges.

(ii) Electric field lines originates normally from the positive charge and terminate normally to the negative charge.

(iii) Electric field lines doesn't form any closed loop.

(iv) Electric field lines are continous curve i.e; electric field lines are not dis dotted.

(v) No two electric field lines intersect each other.

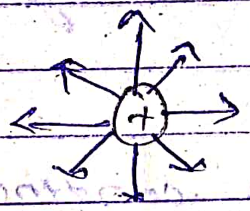
(vi) Electric field lines contract longitudinally i.e; in case of attractive force and dilate laterally i.e, in case of force of repulsion.

i.e field lines exerts pressure laterally each other.

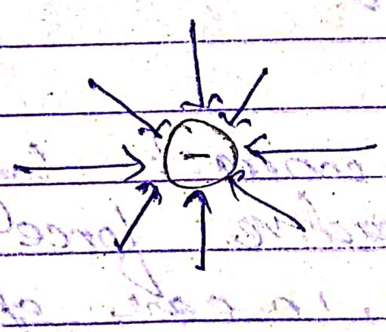
(vii) The Relative closeness determines the strength of electric ~~force~~ field.

=> Draw the electric field lines due to the following charged body

(i) Due to a +ve point charge

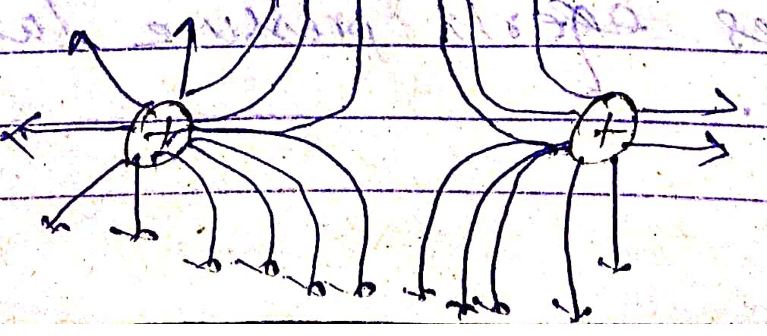


(ii) Due to a -ve point charge

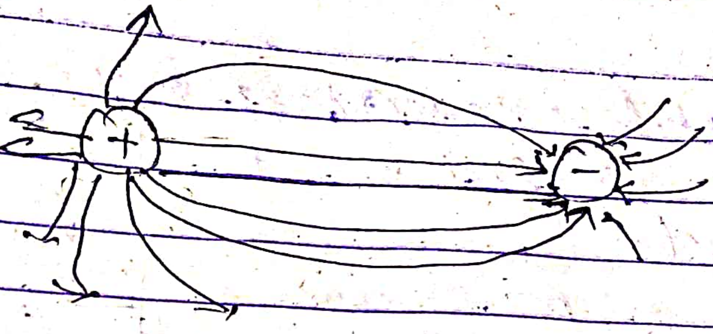


(iii) Due to a system of two point charge

(a)

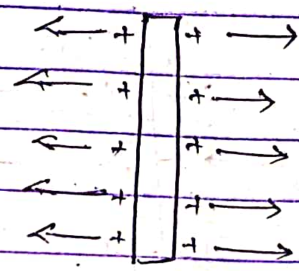


(b)

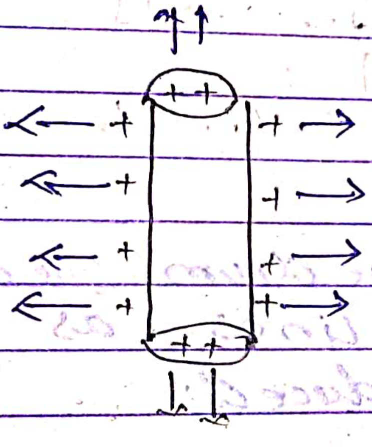


(iv) Due to a line charge

(a)

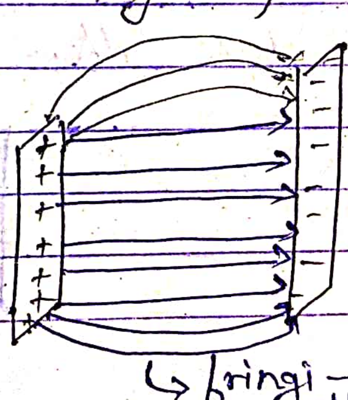


(b)



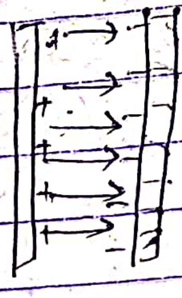
(v) Due to a system of two charged plates in case of a capacitor.

(a) When the separation of plates is longer.



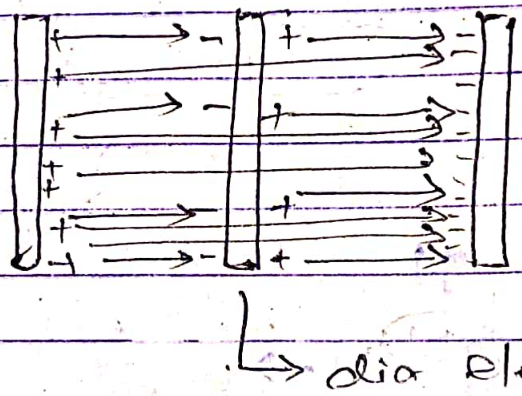
↳ fringing effect.

(b) When the plates separations is small i.e, to avoid fringing effect.



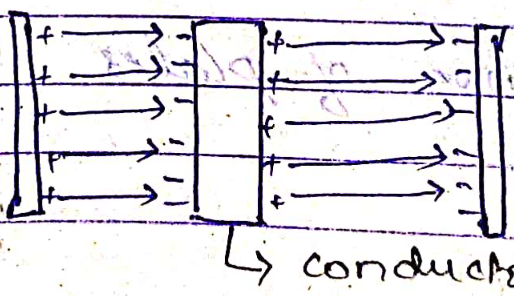
EF lines are uniform.

(C) When a diaelectric slab is placed b/w the plates.



i.e, the diaelectric medium reduces the electric field lines as few induced charge produced.

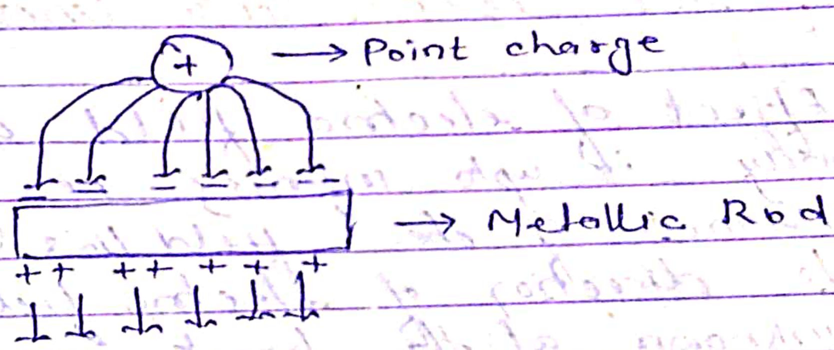
(d) When a conducting slab is placed b/w the plates.



i.e; No. electric field lines passes through the conductor and hence electric force b/w the plates A and B becomes zero i.e; i.e; dia electric constant of a conductor is infinity.

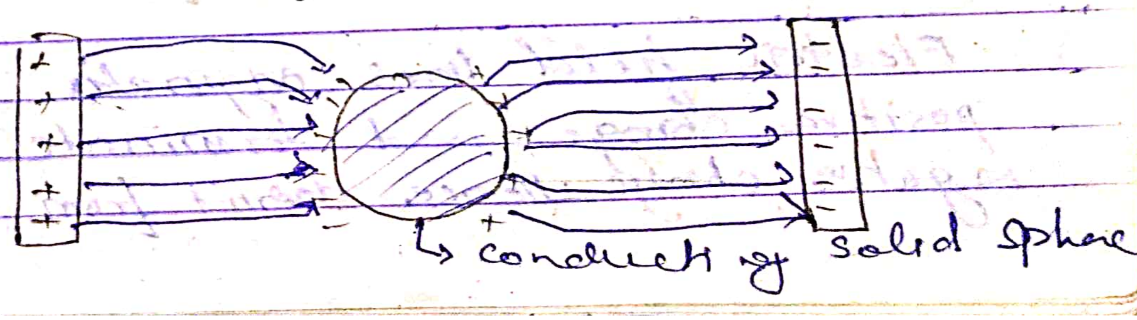
ques:- Draw the electric field lines in the following situations.

(a) A positive charge is placed near a metallic rod.



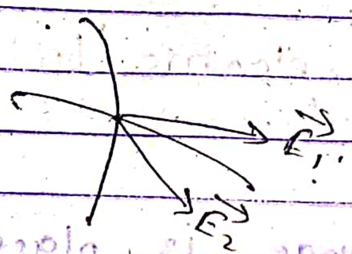
ques:- Represent the electric lines of forces when a conducting sphere is placed in a uniform electric field.

Sol:-



⇒ No two electric field lines interest each other. Why?

Ans:- This is why because at the intersection the direction of the electric field will be more than one i.e, 2.



⇒ Why the electric field lines are continous?

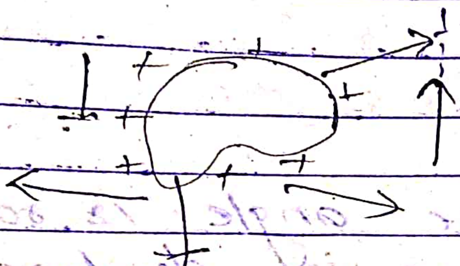
Ans:- Effect of electric field due to a charge body is upto infinity i.e, to a large distance if the field lines are not continous the direction of electric field is the unknown at the break point; hence the field lines are contionous.

⇒ Electric field line doesnot from any closed loop. Wh

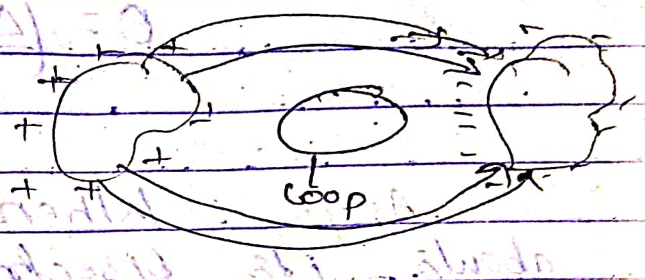
Ans:- Electric field lines originate from positive charge and terminate at the negative charge. Hence doesn't from any closed loo

Which one of the repersentation of electric field line correct?

(i)



(ii)



(iii)

(i) False, because the electric field line originate normally to the surface of changes.

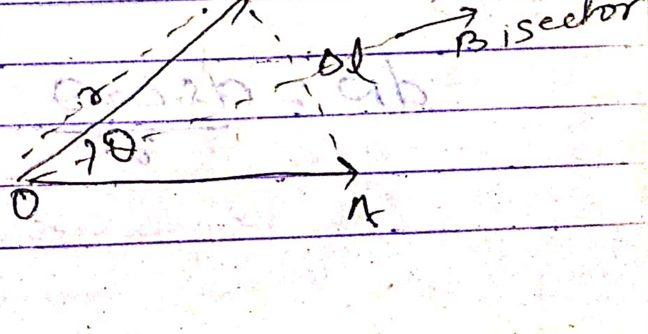
(ii) False, because Eelectric field lines doesn't form any loop

(iii) False, because Electric field lines doesn't originate from -ve change.

⟹ Plane Angle & Solid Angle

θ = Plane Angle (Radian)

Total plane angle = 2π radian or 360°.



i.e., plane angle is formed to a point by a line segment or an arc

$$\theta = \left(\frac{\Delta l}{r}\right)$$

Solid Angle :- When a plane angle is rotated about its bisector a cone is developed at the vertex called solid angle. i.e., it is a 3-D concept.

Denoted by $d\omega$ or $d\Omega$! Solid angle (Steradian)

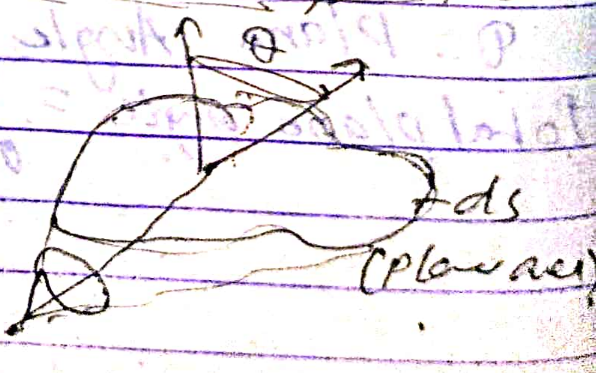
Total solid Angle = 4π Steradian

$$\oint_S d\omega = 4\pi.$$

i.e, Total solid angle at the internal point of a surface is 4π (steradian)

=) Solid angle at a point due to a plane Surface

$$d\omega = \frac{ds.\cos\theta}{r^2}$$



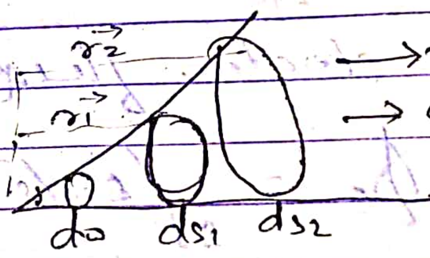
$$d\vec{\omega} = \frac{d\vec{s} \cdot \vec{r}}{(|\vec{r}|)^3}$$ where,

$d\vec{s}$ = Area vector along normal to the plane.

⇒ If the plane is of solid paper. then

$$\oint_s d\omega = \oint_s \frac{ds \cdot \cos\theta}{r^2} = 4\pi.$$

eg: Here, In this fig:



→ $\vec{r_1}$, $\vec{r_2}$

→ $\vec{ds_1}$, → $\vec{ds}$.

$$\therefore d\omega = \frac{ds_1}{r_1^2} = \frac{ds_2}{r_2^2}$$

$\therefore$ $\cos\theta = 0° = 1$.