Image Method :-

The image method is a method which is used to calculate the magnitude, intensity, force etc. b/w the point charge and another charge (Image charge) associated with the point charge.

We know that the distribution of potential at the boundary of any medium is continuous. The image charge is the charge which is obtained by replacing the conductor due to the external potential applied on the conductor.

This replacement of conductor arises an image of conductor due to which the charge produce is known as Image charge.

The following factors are created due to the image charge of the conductor.

The magnitude and intensity of

the image charge is calculated by taking the certain boundary.

2. The force of attraction and repulsion b/w the two charges is calculated by using Coulomb's law.

3. The stability of the conductor is also given by the image method. When the displacement of the image charge and point charge remains fixed. Then the conductor is stable. and if the distance b/w the two charges does not remain fixed then the unstability arise.

4. The image method also gives the dist^n of electric field, potential across the boundary and at the surface of boundary.

5. From above it is clear that the image method is used to give the perfect dist^n of electric field or electrical potential on the surface of

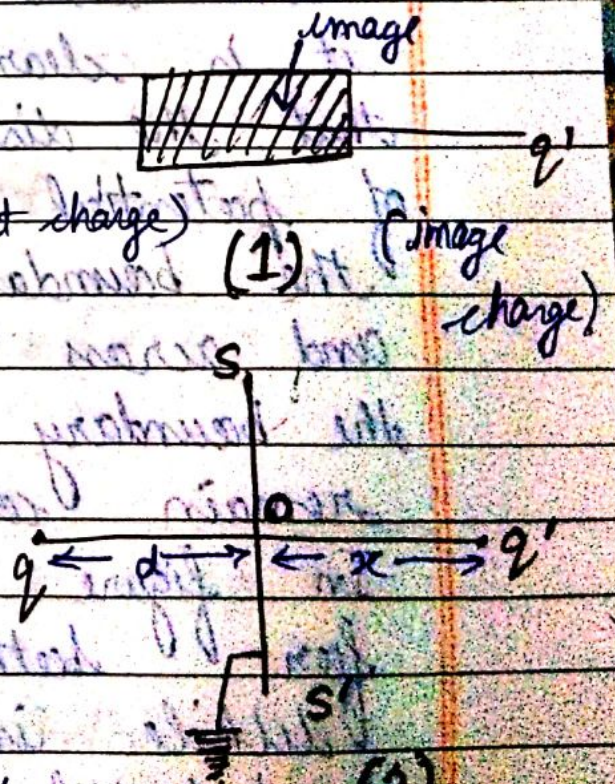
the conductor.

If an insulator or semiconductor is taken into the account then the distⁿ of electric field can not be calculated perfectly by using the image method.

(A) Point charge due to a conducting surface :-

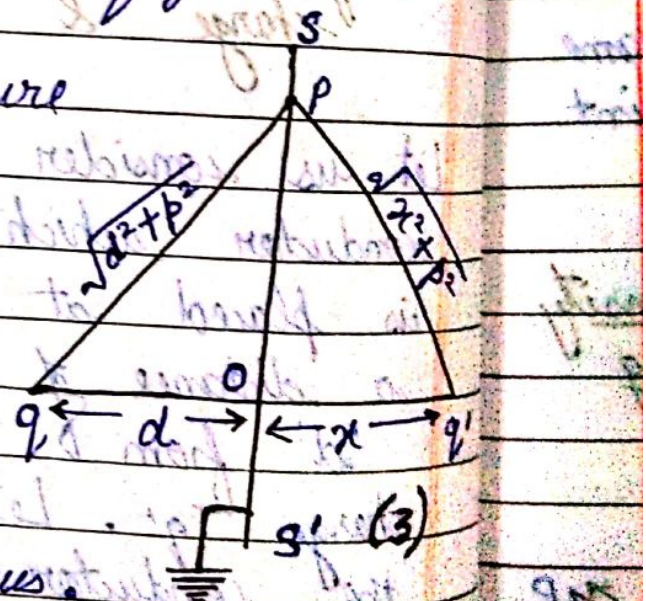
(i) Magnitude and Position of point charge & image charge :-

Let us consider a conductor which is placed at a distance of 'd' from 'q' charge. Let the conductor is perfectly removed from the medium then a image charge is obtained and due to this image a image charge is obtained at the opposite



direction of the image of as shown in the figure (3)

The image method is obtained the surface of the conductor grounded. It means that the grounded surface give the potential at the surface of conductor. Let 'x' is the distance of image charge from point of observation (O) as shown in the figure



From above figure it is clear that the dist^n of potential at the boundary and across the boundary remain continuous.

In figure 2. the dist^n of point charge is symmetrical for both charge is symmetrical while in fig. 3 the dist^n of potential across the boundary (at point S) remain continuous then the total potential can be calculated as

$$\frac{1}{4\pi\epsilon_0}\frac{q}{d} + \frac{1}{4\pi\epsilon_0}\frac{q'}{x} = 0 \quad \text{---(1)} \quad [\text{at point O}]$$

$$\frac{1}{4\pi\epsilon_0}\frac{q}{\sqrt{d^2+p^2}} + \frac{1}{4\pi\epsilon_0}\frac{q'}{\sqrt{x^2+p^2}} = 0 \quad \text{---(2)} \quad [\text{At point P}]$$

from eq^n (1)

$$\frac{1}{4\pi\epsilon_0}\frac{q'}{x} = -\frac{1}{4\pi\epsilon_0}\frac{q}{d}$$

$$q' = -\frac{qx}{d} \quad \text{---(3)}$$

put in eq^n (2)

$$\frac{1}{4\pi\epsilon_0}\frac{q}{\sqrt{d^2+p^2}} = \frac{1}{4\pi\epsilon_0}\frac{qx}{d\sqrt{x^2+p^2}}$$

$$d\sqrt{x^2+p^2} = x\sqrt{d^2+p^2}$$

on squaring

$$d^2(x^2+p^2) = x^2(d^2+p^2)$$

$$d^2x^2 + d^2p^2 = x^2d^2 + x^2p^2$$

$$d^2 = x^2$$

$$\boxed{x = d}$$

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Put in eqⁿ (3)

$$q' = -\frac{qd}{d}$$

$$\boxed{q' = -q}$$ (NET) (5)

From eqⁿ (4) and (5) it is clear that the magnitude of point charge and image charge remain always in opposite direction having same distance from the point of observation.