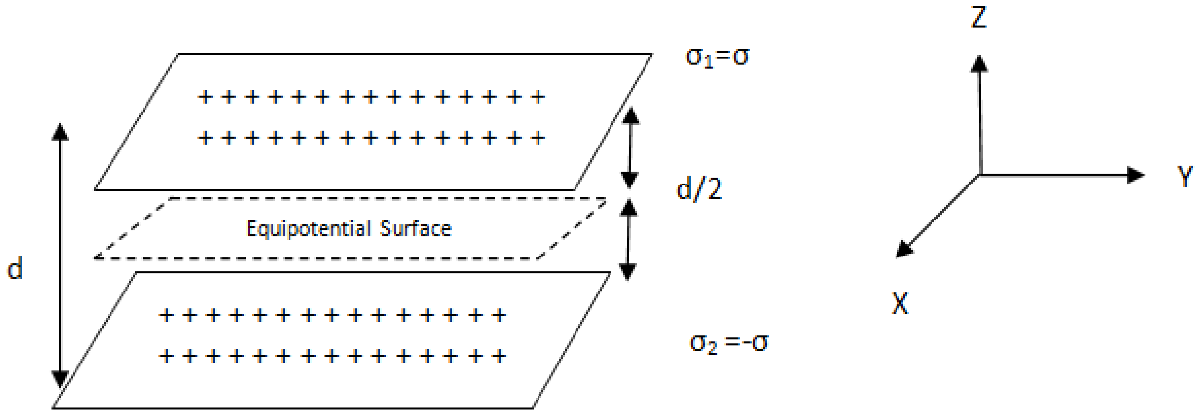
Q9. Two uniformly large parallel thin plates having charge densities $+\sigma$ and $-\sigma$ are kept in the X – Z plane at a distance'd' apart. Sketch an equipotential surface due to electric field between the plates. If a particle of mass m and charge '-q' remains stationery between the plates, what is the magnitude and direction of this field?

Answer: Equipotential surface is shown by dotted line (potential V=0).



Magnitude of the field

From the figure we find that the net electric field in the middle region where charge –q kept is:

$$E = E_1 - E_2$$

$$= \left(\frac{\sigma_1}{2\epsilon_0} - \frac{\sigma_2}{2\epsilon_0}\right) = \frac{1}{2\epsilon_0}(\sigma_1 - \sigma_2) = \frac{1}{2\epsilon_0}(\sigma + \sigma) = \frac{\sigma}{\epsilon_0}$$

The force due to mass that is gravitation is balanced by force due to electric field

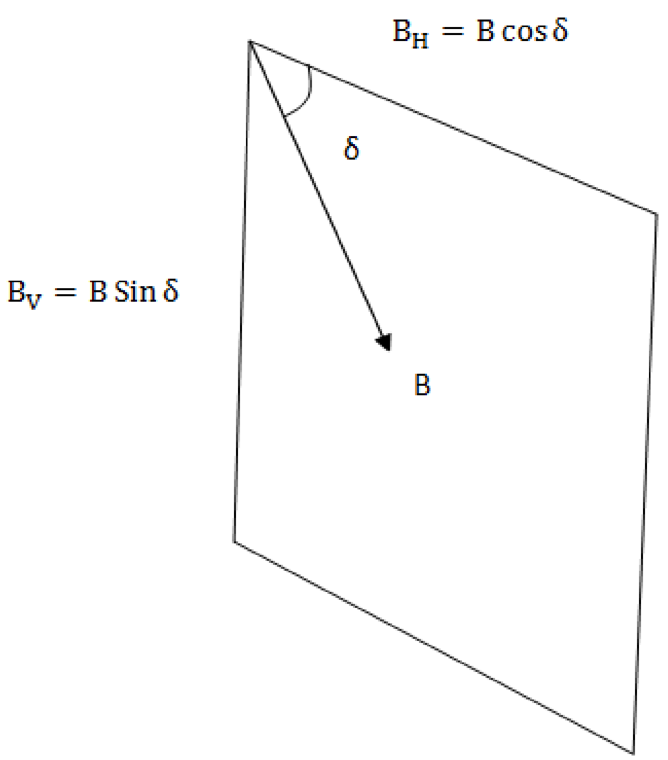
mg = qE or E= mg/q

In this case, the electric field intensity is constant between the sheets. In other words, we get a uniform electric field between the plates.

Direction: Plane of the equipotential surface lies in X-Y plane, since gravity is balance by electric force hence net force due to electric field must be upward that is along Z – axis, as per right handed system of axis shown.

Q10. A magnetic needle free to rotate in a vertical plane parallel to the magnetic meridian has its north tip down at 60^0 with the horizontal. The horizontal component of earth's magnetic field at the place is known to be 0.4 G. Determine the magnitude of the earth's magnetic field at the place.

Answer:



Earth's magnetic field B is divided into two components, horizontal B_H and vertical B_V.

Given :

$\delta = 60^\circ, B_H = 0.4\ \mathrm{G}, B = ?$

$$B_H = B\cos\delta$$

$$B = \frac{B_H}{\cos\delta} = \frac{0.4}{\cos 60^\circ}$$

$$= \frac{0.4}{1/2} = 0.4 \times 2$$

$$B = 0.8\ \mathrm{T}.$$