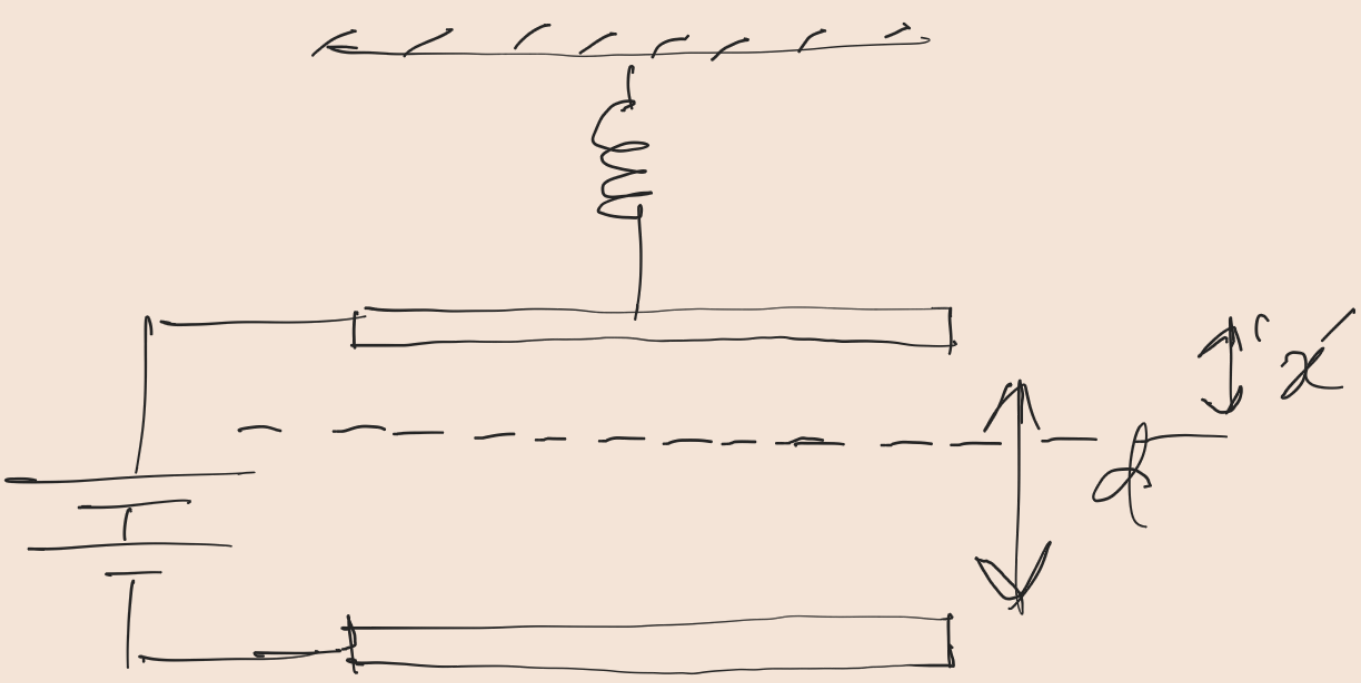
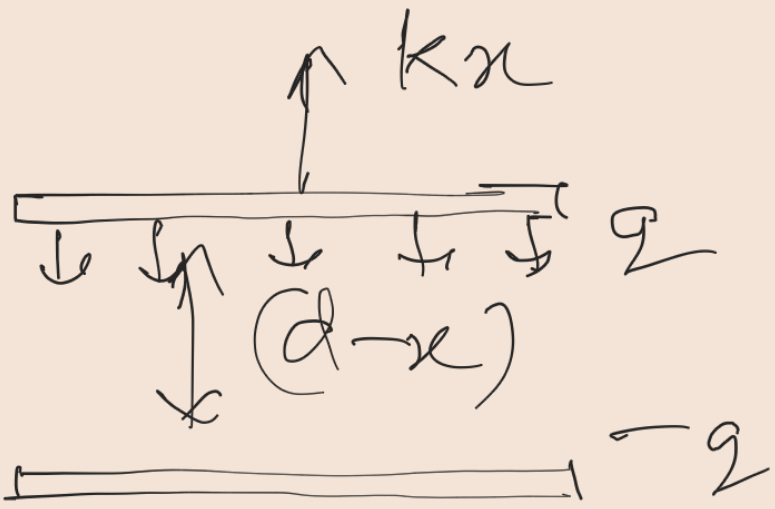


When the switch will be closed, the plate will extend to a max elongation and then again spring back & forth. However, this will be possible only if the nature of equilibrium of the plate is stable. For unstable

cases, once the plate crosses the equilibrium barrier, it will continue moving down & collide with bottom plate. Now,



At Equilibrium,

$$\frac{q^2}{2A\epsilon_0} = kx.$$ Also,

$$q = \left[\frac{A\epsilon_0}{(d-x)}\right] V.$$ So,

$$kx = \frac{A\epsilon_0 V^2}{2(d-x)^2}.$$ So,

$$x(d-x)^2 = \frac{A\epsilon_0 V^2}{2k}.$$

Now, let analyse LHS.

$$\frac{d(LHS)}{dx} = (d-x)(d-3x).$$

We see that max value of LHS is when $x = \frac{d}{3}$.

So, we have to ensure that the 'V' obtained for equilibrium at

$x = \frac{d}{3}$ is stable. For stable equilibrium, the increment of spring force must dominate increment of electrostatic force.

Hence,

$$k(dx) > \frac{\epsilon A V^2}{x(d-x)^3}(-dx)\,dx$$

$$V < \sqrt{\frac{k(d-x)^3}{A\epsilon_0}}, \quad \text{for } x \geq \frac{d}{3}$$

We already obtained

that to maximise V, the equilibrium at $x = \frac{d}{3}$ has to be stable. So,

$$V < \frac{2}{3}\sqrt{\frac{2kd^3}{3AG_0}}$$