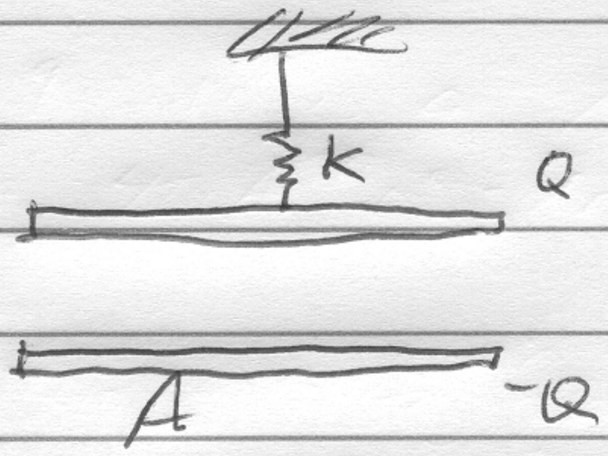
7-14



pressure $f = \frac{F}{A} = \frac{1}{2}\sigma E = \frac{1}{2}\frac{\sigma^2}{\varepsilon_0}$

so $F = A\left(\frac{1}{2}\frac{Q^2}{A^2\varepsilon_0}\right) = \frac{Q^2}{2\varepsilon_0 A}$

balanced by spring force $K\Delta x$

$$K\Delta x = \frac{Q^2}{2\varepsilon_0 A}$$

$$\underline{\Delta x = \frac{Q^2}{2K\varepsilon_0 A}}$$

Spring stretches since force is attractive

7-16 C is charged to $\Delta\phi$, then disconnected

So Q is constant.

Now $d \to \alpha d$ with $\alpha > 1$.

Since Q is constant, A is constant, σ is constant, so E is constant, and so is $u_e = \frac{1}{2}\varepsilon_0 E^2$. $U_e = u_e(\text{volume}) = u_e A d$

So $\underline{\frac{U_e'}{U_e} = \alpha}$ Energy increases!

Energy comes from work separating plates

$\Delta W_{ext} = U_{ef} - U_{ei} = F\Delta d = F(\alpha - 1)d$

As in 7-14 $F = \frac{Q^2}{2\varepsilon_0 A}$ so $\Delta W_{ext} = \frac{Q^2 d}{2\varepsilon_0 A}\alpha - \frac{Q^2 d}{2\varepsilon_0 A}$

since $C = \frac{\varepsilon_0 A}{d}$ $C_f = \frac{\varepsilon_0 A}{\alpha d}$, $C_i = \frac{\varepsilon_0 A}{d}$

$$\underline{\Delta W_{ext} = \frac{1}{2}\frac{Q^2}{C_f} - \frac{1}{2}\frac{Q^2}{C_i} = \Delta U_e}$$