

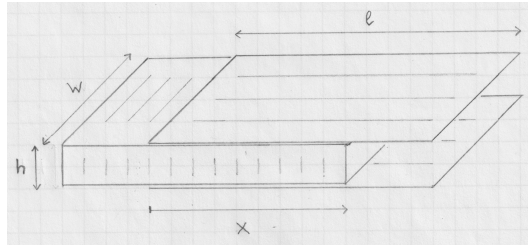
[lex31] Lateral force on dielectric slab between parallel plates

A dielectric slab of height  $h$  is free to slide between oppositely charged, rectangular, conducting plates of width  $w$  and length  $l$ . A generic position of the slab has the dielectric covering a volume  $whx$  between the plates and leaving a volume  $wh(l-x)$  without dielectric. The dielectric constant is  $\kappa > 1$ . We assume that  $x/l$  is neither close to 0 nor close to 1, by which we justify that the effects of fringe fields are negligible.

Determine direction (in/out) and magnitude of the lateral force  $F(x)$  acting on the dielectric slab for two distinct scenarios:

- (a) The capacitor carries charge  $Q_0 = \text{const}$  and is disconnected from a power source.
- (b) The capacitor is connected to a power source that provides a voltage  $V_0 = \text{const}$ .

Hint: Start with the potential energy  $U(x)$ , and derive the force  $F(x)$  via  $F = -dU/dx$ . Note that when the power source is connected, its energy must be included.



**Solution:**