A 10 $\mu$F capacitor has a $\kappa = 10$ dielectric in it. This capacitor is charged to 10 $\mu$C and then isolated. Once isolated, the slab-like dielectric is pulled out! How much work did that take?

Since the capacitor is isolated, the charge on the plates does not change. So we can write

$$U_i = \frac{1}{2}(Q^2/C_i), \quad \text{and} \quad U_f = \frac{1}{2}(Q^2/C_f).$$

Note that $C_f = C_i/\kappa$, that is, pulling out the dielectric greatly reduces the capacitance but does not change the stored charge.

By definition of potential energy, the work done is

$$W = U_f - U_i = \left(\frac{Q^2}{2C_i}\right)[\kappa - 1].$$

If we plug in the numbers we immediately find that the work done is $4.5 \times 10^{-5}$ J.

Food for thought: Suppose the capacitor were kept hooked to the battery that had charged it originally. Now, how much work would have to be done? Hint: Now $V$ would not change, but the charge would, since charge can be drawn from or sent back to the connected battery.