

QC-1 The plates of a parallel plate capacitor are charged with equal and opposite charges  $+Q$  and  $-Q$ . The plates are electrically insulated so their charges cannot change. The plates are pulled apart a little bit, so that the separation  $d$  of the plates is greater.

As the plates are pulled apart, the capacitance of the plates...

A) increased    B) decreased    C) stayed the same.



The energy stored in the capacitor...

A) increased    B) decreased    C) stayed the same.

(Hint: Did the person pulling the plates apart do positive work, negative work or no work?)

As the plates were pulled apart, the energy density (energy per volume)  $= u = (1/2)\epsilon_0 E^2$

A) increased    B) decreased    C) stayed the same.

Answers:

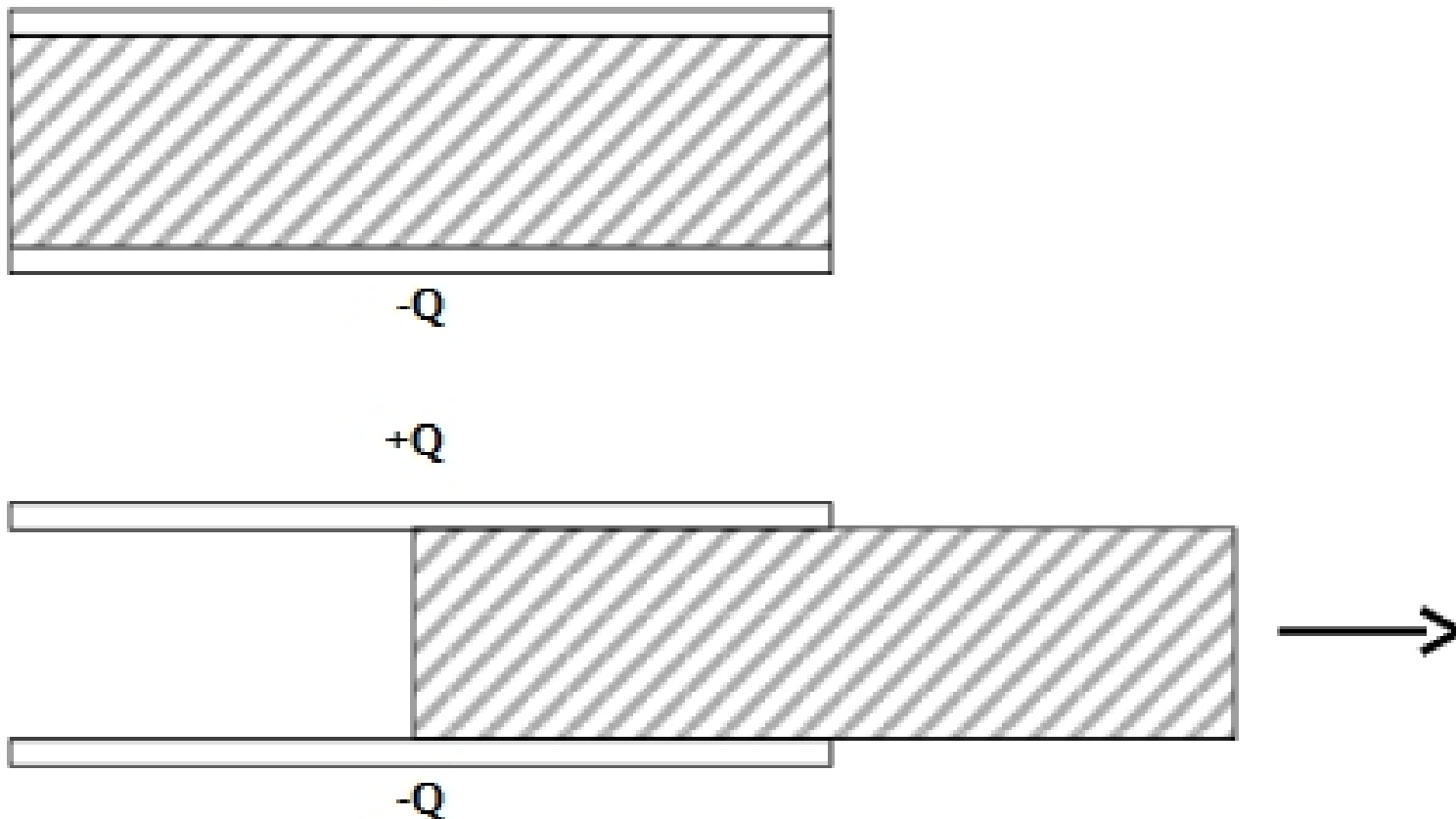
Question 1: B) Capacitance  $C$  decreases (since  $C = \epsilon_0 A / d$  so if  $d$  increases,  $C$  decreases).

Question 2: A) The energy  $U$  increased [since  $U = (1/2)Q^2/C$  and  $Q$  remains constant while  $C$  increases]. The energy density  $u$  stayed the same (since the electric field between the plates stayed the same.)

**Ch17-10.**

A parallel-plate capacitor with a dielectric between the plates is charged so that  $+Q$  resides on one plate,  $-Q$  on the other. With the plates isolated and the charge  $Q$  constant, the dielectric is pulled out from between the plates. The energy stored in the capacitor ...

- A) increased      B) decreased      C) stayed the same.



Hints: Did the electric field between the plates change? Was work done when the dielectric was removed?

Answer: The energy increased. There are three ways to get this.

Method I:  $U = (1/2)Q^2/C$ .  $Q$  remained fixed, but  $C$  decreased (since  $C = \epsilon_0 \epsilon_r A/d$ ), so  $U$  increased.

Method II: The field between the plates increased when the dielectric slab was removed, so the field energy increased.

Method III: As the slab was taken out, the fringe field at the edge of the capacitor exerted a force on the induced charges on the dielectric. This force tends to pull the dielectric back in, so the external agent had to do positive work to pull the dielectric out. The work done increased the stored electrostatic energy.

