## Q1)

PIEZOELECTRIC SPARK GENERATOR The piezoelectric spark generator, as used in various applications such as lighters and car ignitions, operates by stressing a piezoelectric crystal to generate a high voltage which is discharged through a spark gap in air as schematically shown in Figure 7.44a. Consider a piezoelectric sample in the form of a cylinder as in Figure 7.44a. Suppose that the piezoelectric coefficient $d = 250 \times 10^{-12}$ m V^{-1} and $\varepsilon_r = 1000$. The piezoelectric cylinder has a length of 10 mm and a diameter of 3 mm. The spark gap is in air and has a breakdown voltage of about 3.5 kV. What is the force required to spark the gap? Is this a realistic force?

(a)   (b)
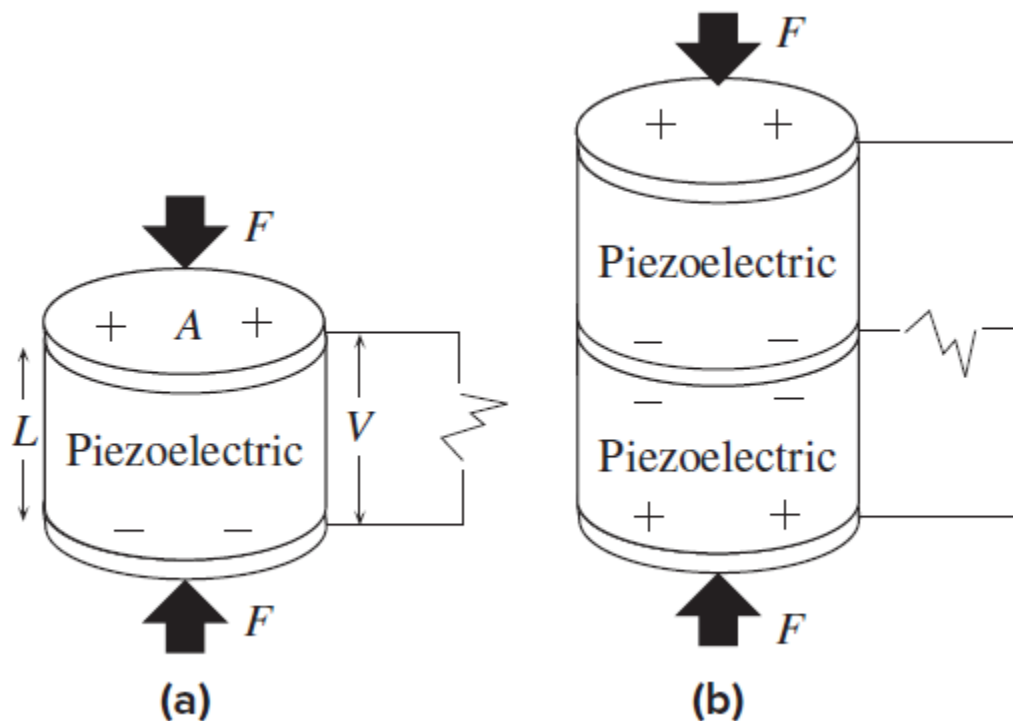
Q2)

A parallel-plate capacitor is constructed by filling the space between two square plates with blocks of three dielectric materials, as in the figure below. You may assume that $\ell \gg d$. Find an expression for the capacitance of the device in terms of the plate area A and d, κ_1, κ_2, and κ_3.
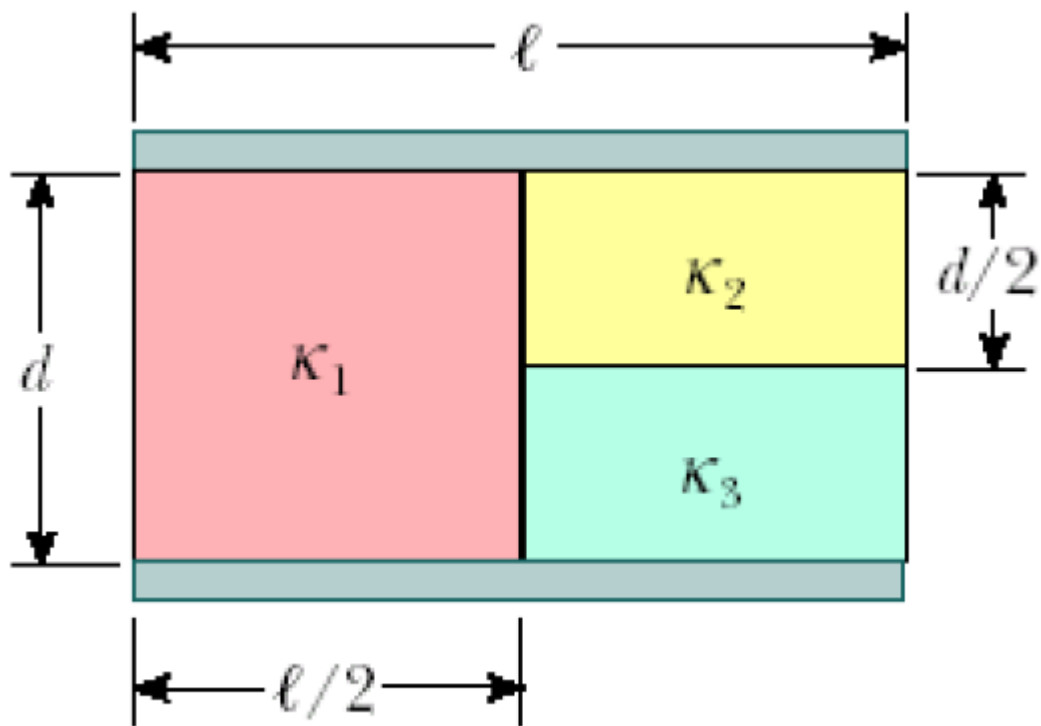
Q3)

Given a parallel-plate capacitor, dielectric filled, with area A = 100 cm2, charge Q = 890 nC, and electric field E = 1.4 kV/mm.

(a) Find dielectric constant of the material.
(b) Find the induced charge.

Q4)

A parallel plate capacitor has capacitance C. It is connected to a battery of EMF ε until fully charged, and then disconnected. The plates are then pulled apart an extra distance d, during which the measured potential difference between them changed by a factor of 4. Below are a series of questions about how other quantities changed. Although they are related you do not need to rely on the answers to early questions in order to correctly answer the later ones.

a) Did the potential difference increase or decrease by a factor of 4?

INCREASE   DECREASE

b) By what factor did the electric field change due to this increase in distance? Make sure that you indicate whether the field increased or decreased.

c) By what factor did the energy stored in the electric field change? Make sure that you indicate whether the energy increased or decreased.

d) A dielectric of dielectric constant κ is now inserted to completely fill the volume between the plates. Now by what factor does the energy stored in the electric field change? Does it increase or decrease?