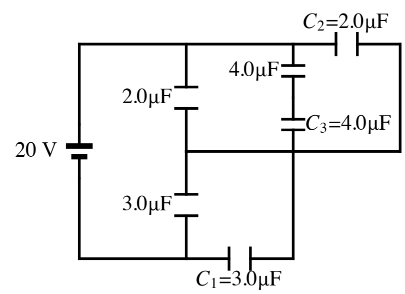
PH203H/213H
S09 Homework – due April 20, 2009

1. A parallel plate capacitor has plates of area 0.12 m^2 and separation of 1.2 cm. A battery charges the plates to a potential difference of 120 V and is then disconnected. A dielectric slab (dielectric constant 4.8) of thickness 0.4 cm and of the same area as the plates is placed symmetrically between the plates (that is, centered between the plates). (a) What is the capacitance before the dielectric is inserted? (b) What is the charge on the plates before the slab is inserted? After the slab is inserted? (c) What is the electric field in the spaces between the plates and the dielectric? (d) What is the electric field inside the dielectric? (e) What is the potential difference between the plates when the slab has been inserted? (f) What is the capacitance with the slab in place? (g) By finding the difference between the energy stored in the capacitor before and after the slab is inserted, find the external work that must be done in inserting the slab. Pay special attention to whether the external work is positive or negative.
Answers: (a) 89 pF, (d) 2.1 kV/m, (f) 120 pF

2. A parallel plate capacitor with plates of area A and separation d is charged to a potential difference ΔV. The charging battery is then disconnected. The plates are then pulled apart until their separation is $2d$. In terms of A, d, and ΔV, find (a) the new potential difference, (b) the initial and final stored energy, and (c) the external work done to separate the plates.
Answer: (c) $\varepsilon_0 A(\Delta V)^2 / 2d$

3. (a) Find the equivalent capacitance of this network. (b) Find the charge that would be stored on this equivalent capacitance by the 20-V battery. (c) Find the potential difference across and the charge stored on capacitor C_1. (d) Find the potential difference across and the charge stored on capacitor C_2. (e) Find the potential difference across and the charge stored on capacitor C_3.
Answers: (a) 3.0 μF, (c) 10 V, 30 μC



4. A 15.0-kΩ resistor and a capacitor are connected in series, and then a 12.0 volt potential difference is applied across the combination. After 1.30 μs the potential difference across the capacitor rises to 5.00 V. (a) What is the time constant of this circuit? (b) What is the capacitance of the capacitor?
Answer: (b) 161 pF

5. The figure shows a circuit for a flashing lamp, such as might be used as a warning device on highway construction. The lamp, which has negligible capacitance, is connected in parallel with the capacitor of a series RC circuit. Initially the lamp doesn't conduct as the capacitor charges. When the potential difference across the capacitor exceeds the lamp breakdown voltage V_L, the capacitor suddenly discharges completely through the lamp and then the capacitor begins charging again. It is desired to use a 95.0-volt battery, a lamp with a breakdown voltage of 75.0 volts, and a 0.150 μF capacitor to build a lamp that will flash 2 times per second. What should be the value of the resistor?
Answer: 2.XX × 10^6 Ω