UNIVERSIDADE da MADEIRA

Electromagnetismo

Série de exercícios 3

1. Calculate the capacity C of two parallel plates of area $A = 100\,\text{cm}^2$ separated by a distance $d = 1\,\text{cm}.= 1\,\text{cm}$.

2. Find the area of a parallel plate capacitor with 1 cm plate separation and 1 F capacity.

3. Find the expression for the capacity of a cylindrical capacitor consisting of two conductors both of length L. One cylinder has radius r_1 and the other is a hollow cylinder (i.e. a cylindrical surface) of coaxial interior radius r_2 with $r_1 < r_2 \ll L$.

4. A capacitor with 14 cm square side plates separated by 2.0 mm is connected to a battery and charged up to 12 V.

   (a) What is the charge on the capacitor?

   (b) How much energy is stored in the capacitor?

   (c) The battery is disconnected from the capacitor and the plate separation is increased to 3.5 mm. What is the capacitor energy variation?

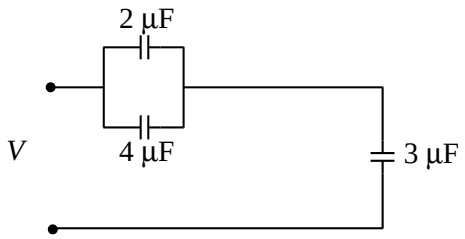
5. Two capacitors have capacities $20\,\mu$F and $30\,\mu$F. Find equivalent capacity if capacitors are connected in

   (a) parallel.

   (b) series.

6. A $2\,\mu$F and a $4\,\mu$F capacitor are connected in series to an 18 V battery. Find the charge and potential difference for each of the capacitors.

7. Consider the circuit made up of the three capacitors in the figure.



   (a) Find the equivalent capacity.

   (b) Find the charge and voltage drop on each capacitor when the system is connected to a 6 V battery.

8. A parallel plate capacitor has 10 cm square side plates and a $d = 4\,\text{mm}$ separation. A slab with dielectric constant $\varepsilon_r = 2$ has the same area as the plates.

   (a) What is the capacity without the dielectric?

   (b) What is the capacity if the dielectric slab fills the space between the plates?

   (c) What is the capacity if a 3 mm thick dielectric slab is inserted into the 4 mm opening?

9. Two parallel plate capacitors, each having a capacity $C_1 = C_2 = 2\,\mu$F, are connected in parallel to a 12 V battery. Find:

   (a) The charge on each capacitor;

   (b) The total energy stored in the capacitors.

   The capacitors are then disconnected from the battery and a constant dielectric $\varepsilon_r = 2.5$ is inserted between the capacitor plates C_2. After the dielectric is inserted, find:

   (c) the potential difference for each capacitor;

   (d) the charge on each capacitor;

   (e) the total energy stored in the capacitors.

Solutions:
1) $C = 8,85\,\mathrm{pF}$; 2) $A = 0,11 \times 10^{10}\,\mathrm{m}^2$; 3) $C = \frac{2\pi\varepsilon_0 L}{\ln\left(\frac{r_2}{r_1}\right)}$; 4a) $1,04\,n\mathrm{C}$; 4b) $U = 6,24\,\mathrm{nJ}$; 4c) $\Delta U = 4,68\,\mathrm{nJ}$; 5a) $C_{eq} = 50\,\mu\mathrm{F}$; 5b) $C_{eq} = 12\,\mu\mathrm{F}$; 6) $Q_1 = Q_2 = 24\,\mu\mathrm{C}$; $V_1 = 12\,\mathrm{V}$; $V_2 = 6\,\mathrm{V}$; 7a) $C_{eq} = 2\,\mu\mathrm{F}$; 7b) $Q_1 = 4\,\mu\mathrm{C}$; $Q_2 = 8\,\mu\mathrm{C}$; $V_{12} = 2\,\mathrm{V}$; $V_3 = 4\,\mathrm{V}$; 8a) $C_0 = 22,1\,\mathrm{pF}$; 8b) $C = 44,2\,\mathrm{pF}$; 8c) $C = 35,4\,\mathrm{pF}$; 9a) $Q = 24\,\mu\mathrm{C}$; 9b) $U = 288\,\mu\mathrm{J}$; 9c) $V = 6,86\,\mathrm{V}$; 9d) $Q_1 = 13,7\,\mu\mathrm{C}$; $Q_2 = 34,3\,\mu\mathrm{C}$; 9e) $U = 165\,\mu\mathrm{J}$.