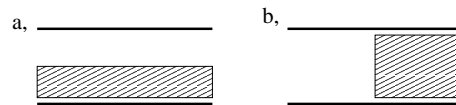


## One-sentence-problems

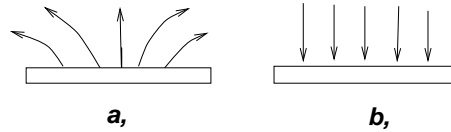
3 points for each questions

Give a *short* explanation of your answers!

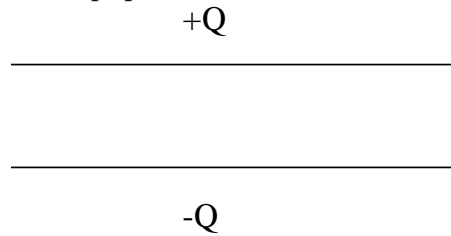
1. There are two positive point charges close to each other. Can the electric potential be zero in the vicinity of the charges?
2. The space between two metal plates is partially filled according to the figure. Which system has larger capacity?



3. On the figure electric lines of force on the surface of a piece of metal and on a surface of a piece of glass are depicted. Identify the metal surface!



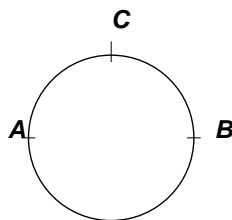
4. There are two charged parallel metal plates as it is given by the figure. Denote some of the equipotential surfaces on the figure!



0-15	1	34-42	4
16-24	2	43-50	5
25-33	3		

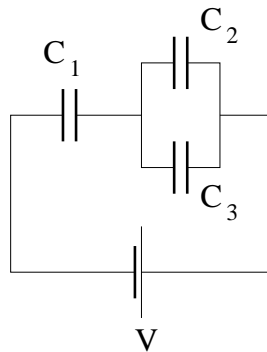
# Problems

- Two parallel metal plates with the area of  $0.01 \text{ m}^2$  are separated  $0.01\text{m}$  from each other. The space between the plates is filled by an insulator with  $\epsilon_r = 10$ .
  - Give the capacitance of the system! 3 points
  - We put  $Q = 10^{-4}C$  charge on the plate. How large is the potential difference between the plates? 3 points
  - How does the potential difference change if the insulator is removed? 3 points
  - How much work do we have to do in order to remove the insulator? 5 points
- There is a metal ring shown by fig. 1. made of a wire with the diameter of  $0.5 \text{ mm}$ . The radius of the ring is  $0.5 \text{ m}$  and its specific resistivity is  $10^{-4} \Omega\text{m}$ .
  - Give the resistivity of the system between the  $A$  and  $B$  points! 6 points
  - How large is the resistivity between the  $A$  and  $C$  points? 6 points



- A system of capacitors given by the figure is connected to a battery.

$$\begin{aligned}C_1 &= 20\mu F \\C_2 &= 10\mu F \\C_3 &= 20\mu F\end{aligned}$$



- How much charge is stored in the different capacitors if the voltage of the battery is  $10 \text{ V}$ ? 4 points
- Give the potential difference on each capacitors! 4 points
- How much energy is stored in the system ? 4 points

Name:  
Number of points:

Group:

## Questions:

2 points for each question

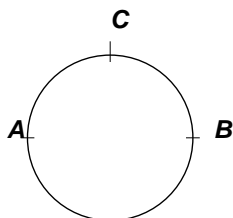
1. What does the capacity of a capacitor depend on?
2. What is the unit of the capacitance?
3. What does the energy stored in a capacitor depend on?
4. How large can a potential difference be on the surface of an ideal metal?
5. State the Ohm's law!
6. How does the resistivity of a metal wire depend on the area of the cross-section ?
7. Give the unit of the resistivity!
8. Give the unit of the specific resistivity!
9. How large is the capacity of a metal sphere with the radius of  $R$ !
10. Define the capacitance of a system!

## Problems

1. Two parallel metals plate with the area of  $0.01 \text{ m}^2$  are separated  $0.01\text{m}$  from each other. The space between the plates is filled by an insulator with  $\epsilon_r = 10$ .
  - a.) Give the capacitance of the system!
  - b.) We put  $Q = 10^{-4}C$  charge on the plate. How large is the potential difference between the plates?
  - c.) How does the potential difference change if the insulator is removed?
  - d.) How much work do we have to do in order to remove the insulator?
  
2. We have a voltage meter which can measure the voltage in the range of  $0 - 3\text{V}$ . However, we have to measure the voltage in the power line in the range of  $0 - 300\text{V}$ . The resistivity of the voltage meter is very large and we can neglect its effect. The resistivity of the new system must be  $1\text{M}\Omega$ .
  - a.) Give the arrangement of the resistors we have to apply before the voltage meter!
  - b.) Give the resistivity of the resistors!
  - c.) How much current will flow through the resistors when we measure the  $220 \text{ V}$  power line?

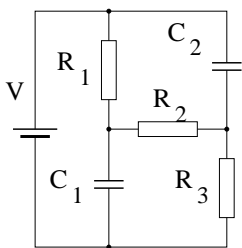
3. There is a metal ring shown by fig. 1. made of a wire with the diameter of 0.5 mm. The radius of the ring is 0.5 m and its specific resistivity is  $10^{-4}$  Ohmm.

- a.) Give the resistivity of the system between the *A* and *B* points!
- b.) How large is the resistivity between the *A* and *C* points?



4. There is a net of resistors and capacitors given by the figure.

- a.) Give the voltage drops on each resistors!
- b.) Give the currents in each resistors!
- c.) How large is the resistivity of the hole system?
- d.) How much charge is stored in the capacitors?



$$R_1 = 100\text{Ohm} \quad C_1 = 100 \mu\text{ F}$$

$$R_2 = 200\text{Ohm} \quad C_2 = 100 \mu\text{ F}$$

$$R_3 = 300\text{Ohm}$$

$$V = 9\text{V}$$

Have a good luck!

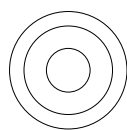
Name:  
Number of points:

Group:

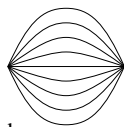
## Questions:

2 points for each question

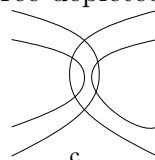
1. What does the capacity of a capacitor depend on?
2. What is the unit of the capacitance?
3. Which figure are electrostatic lines of force depicted on?



a



b



c

4. What does the energy stored in a capacitor depend on?
5. How large can a potential difference be on the surface of an ideal metal?
6. Is the electric field of a point charge proportional to the distance ?
7. How large is the capacity of a metal sphere with the radius of  $R$ !
8. Define the capacitance of a system!
9. There are two positive point charge in the space. Can the electric potential be zero in the vicinity of the charges?
10. What does the force between two point charges depend on?

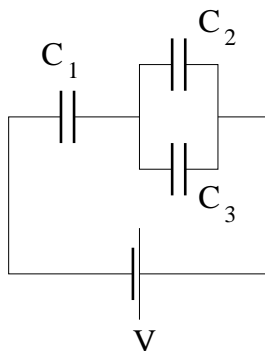
## Problems

- Two parallel metal circular plates with the radius of  $0.1\text{ m}$  are separated  $0.01\text{m}$  from each other. The space between the plates is filled by an insulator with  $\epsilon_r = 5$ .
  - Give the capacitance of the system! 5 points
  - We put  $Q = 10^{-4}\text{C}$  charge on the plate. How large is the potential difference between the plates? 5 points
  - How does the potential difference change if the insulator is removed? 5 points
  - How much work do we have to do in order to remove the insulator? 5 points
  
- A system of capacitors given by the figure is connected to a battery.

$$C_1 = 20\mu\text{F}$$

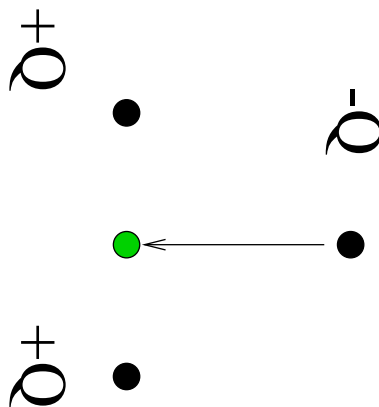
$$C_2 = 10\mu\text{F}$$

$$C_3 = 20\mu\text{F}$$



- How much charge is stored in the different capacitors if the voltage of the battery is  $10\text{ V}$ ? 5 points
- Give the potential difference on each capacitors! 5 points
- How much energy is stored in the system ? 5 points

3. There are three charges at the edges of an equal-sided triangle. The sides of the triangle is  $a = 0.1m$ ,  $Q = 10^{-3}C$  The negative charge is moved to the base of the triangle, as it is shown by the figure.
- How much work has to be done during the process? 5 points
  - Give the electric potential at the place of the negative charge at the beginning and at the end! 5 points
  - How large is the potential energy of the system at the beginning? 5 points



Have a good luck!

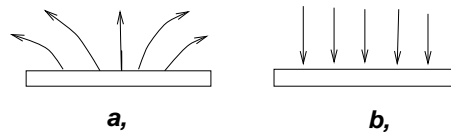


## One-sentence-problems

3 points for each questions

Give a *short* explanation of your answers!

1. Give the definition of the equipotential surface!
2. The capacity of two parallel metal plates is 2 nF ( $2 \times 10^{-9}$  F). How large will the capacity of the system be if the distance between them is doubled?
3. On the figure electric lines of force on the surface of a piece of metal and on a surface of a piece of glass are depicted on. Identify the metal surface!



4. What does the capacity of a capacitor depend on?
5. How large can a potential difference be between two points on a surface of a metal ?

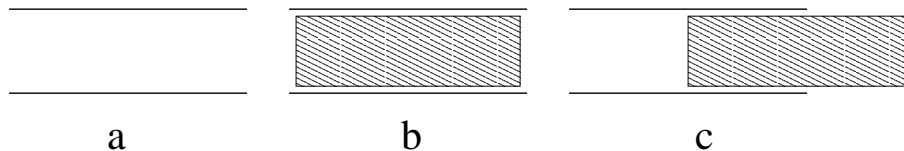
## Problems

1. The amount of charge stored in the system shown by Fig. **a** is  $Q = 2 \times 10^{-6}$  C and the voltage difference between the plates is  $V_a = 2000$  V.

**a** How large is the capacity of the system? 5 points

**b** If the space between the plates is filled by an insulator the voltage will drop to  $V_b = 1000$  V (Fig **b**). How large is the dielectric constant of the insulator? 5 points

**c** How large will the voltage on the system if only the half of the space is filled by the insulator (Fig **c**)? (Hint: The half filled system can be considered as two parallel connected capacitor. One of them is filled and the other one is empty.) 5 points



2. There is a network of capacitors as it is given by the figure below.

a Find the voltages and the charges on the capacitors! 10 points

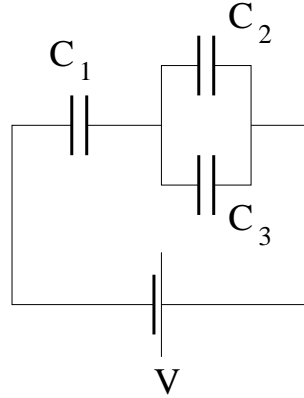
b How much energy is stored in the system? 5 points

$$C_1 = 20\mu F$$

$$C_2 = 10\mu F$$

$$C_3 = 30\mu F$$

$$V = 12V$$



3. There are three charges at the vertices of an equilateral triangle as it is shown by Fig. a.

a Give the electric potential at the point denoted by  $P$  on the figure! 7 points

b How much work has to be done in order to move  $Q_2$  from its original position to the midpoint between  $Q_1$  and  $Q_3$ . See Fig. b. 8 points

$$Q_1 = 2 \times 10^{-5} C$$

$$Q_2 = 3 \times 10^{-5} C$$

$$Q_3 = -10^{-5} C$$

$$a = 0.3 m$$

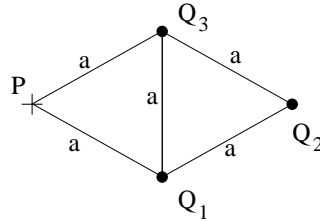


Figure a

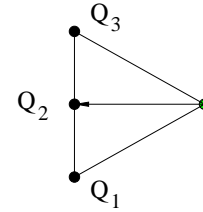


Figure b

0-20	1	41-50	4
21-30	2	51-60	5
31-40	3		

Name:  
Number of points:

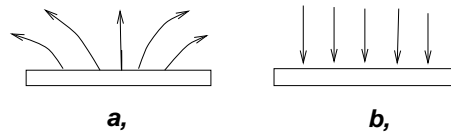
Group:

## One-sentence-problems

3 points for each questions

Give a *short* explanation of your answers!

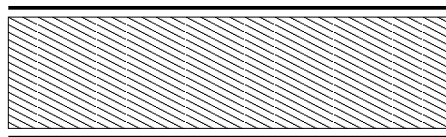
1. The energy stored in a system which consist of two charged parallel metal plates is 10 J. How much work has to be done in order to double the distance between the plates?
2. The capacity of two parallel metal plates is 2 nF ( $2 \times 10^{-9}$  F). How large will the capacity of the system be if the distance between them is doubled?
3. On the figure electric lines of force on the surface of a piece of metal and on a surface of a piece of glass are depicted on. Identify the metal surface!



4. There are two positive point charge in the space. Can the electric potential be zero in the vicinity of the charges?
5. How large can a potential difference be between two points on a surface of a metal ?

## Problems

1. The amount of charge stored in the system shown by Fig. is  $Q = 2 \times 10^{-4}$  C and the voltage difference between the plates is  $V_a = 2000$  V.
  - a How large is the capacity of the system? 3 points
  - b If the insulator from the plates is removed the voltage will raise to 6000 V. How large is the dielectric constant of the insulator? 6 points
  - c How much work has to be done in order to remove the insulator? 6 points



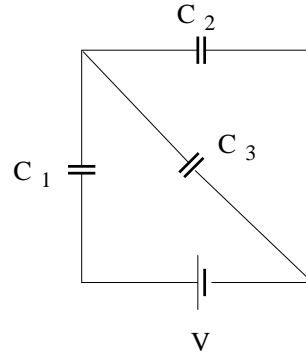
2. There is a network of capacitors as it is given by the figure below.
- a Find the voltages and the charges on the capacitors! 10 points
- b How much energy is stored in the system? 5 points

$$C_1 = 30\mu F$$

$$C_2 = 20\mu F$$

$$C_3 = 40\mu F$$

$$V = 12V$$



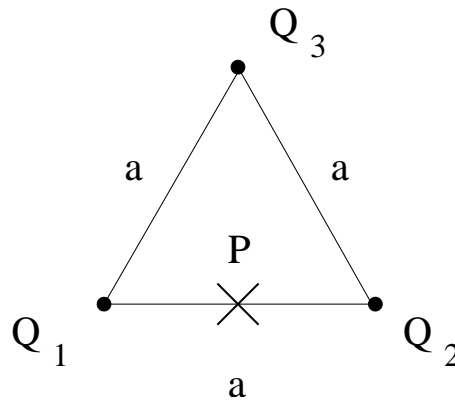
3. There are three charges at the vertices of an equilateral triangle as it is shown by Figure.
- a Give the electric potential at the point denoted by  $P$  on the figure! 7 points
- b How much work has to be done in order to move  $Q_3$  from its original position to the point  $P$ . 8 points

$$Q_1 = 2 \times 10^{-5} C$$

$$Q_2 = 3 \times 10^{-5} C$$

$$Q_3 = -10^{-5} C$$

$$a = 0.3 m$$




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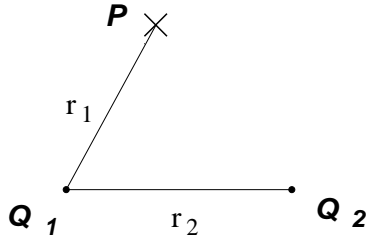
0-20	1	41-50	4
21-30	2	51-60	5
31-40	3		

Name:  
 Number of points:

Group:

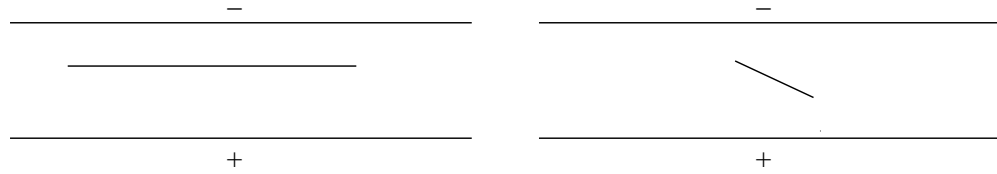
## Problems

1. There are two charges,  $Q_1 = 2 \times 10^{-6} C$  and  $Q_2 = 10^{-6} C$ , separated by a distance of  $r_2 = 1 m$ . At a distance of  $r_1 = 1 m$  from  $Q_1$ , at the point  $P$ , the electric potential is  $V = 2.7 \times 10^4 V$ .

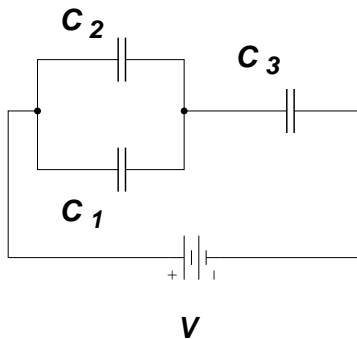


Give the coordinates the point  $P$  if  $Q_1$  is at the origin!  
 12 points

2. There are two parallel, oppositely charged metal plates as it is shown by the figure. A small metal plate is put between the charged plates. Draw the schematic pictures of the electric lines of force in the two cases given by the figure. 8 points



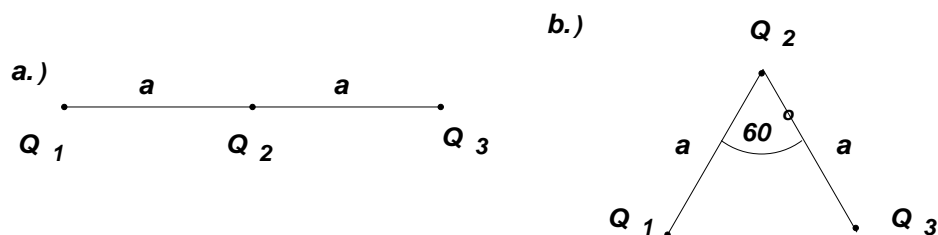
3. A network of capacitors is depicted on the following figure.



$$\begin{aligned} C_1 &= 10 \mu F \\ C_2 &= 20 \mu F \\ C_3 &= 15 \mu F \\ V &= 9 V \end{aligned}$$

- a.) Give the voltages on each capacitors! 5 points  
 b.) Give the charges stored in each capacitors! 5 points  
 c.) How much energy is stored in the system? 5 points

4. The amount of charge stored in the system shown by Fig. **a** is  $Q = 2 \times 10^{-6} \text{ C}$  and the voltage difference between the plates is  $V_a = 2000 \text{ V}$ .
- a.) How large is the capacity of the system? 3 points
- b.) If the space between the plates is filled by an insulator the voltage will drop to  $V_b = 1000 \text{ V}$ . How large is the dielectric constant of the insulator? 4 points
- c.) How much work has to be done in order to remove the insulator? 5 points
5. There are three charges on a line (Fig **a.**). The distance between the first and the second charges and second and the third charges are  $a = 1 \text{ m}$ . The system is distorted according to Fig. **b.**. How much energy must be done in order to bend the system? 13 points

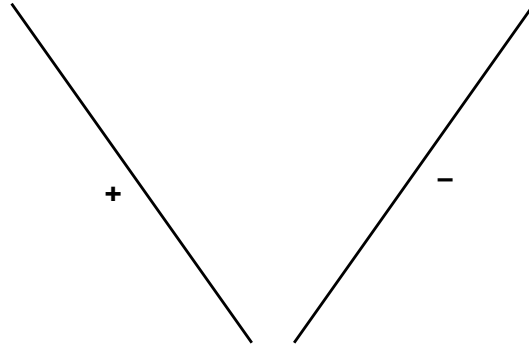


$$Q_1 = 10^{-5} \text{ C} \quad Q_2 = -2 \times 10^{-5} \text{ C} \quad Q_3 = 10^{-5} \text{ C}$$

0 - 16	1
17 - 27	2
28 - 38	3
39 - 49	4
50 - 60	5

## Problems

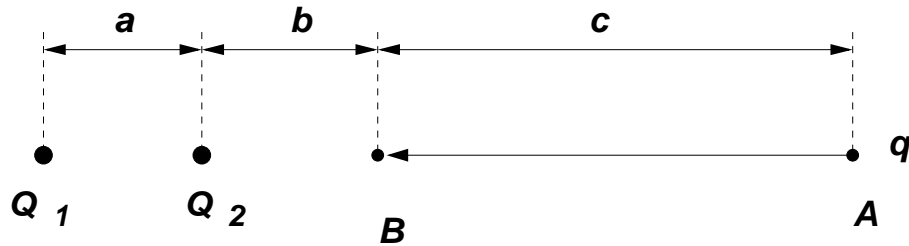
1. There are two oppositely charged metal plates as it is shown by the figure. Draw a schematic picture of the electric lines of force! 5 points



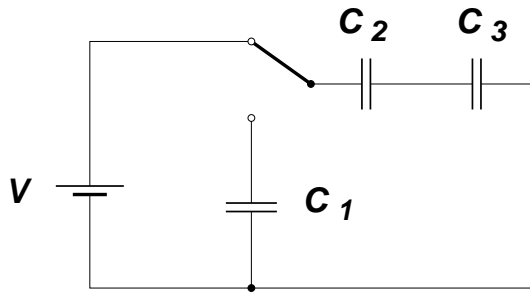
2. The voltage on a planar capacitor filled by an insulator is  $V_1 = 30 \text{ V}$ . If the insulator is removed the voltage will be increased to  $V_2 = 120 \text{ V}$ . How large is the dielectric constant of the insulator? 10 points
3. A small charge of  $q = 10^{-5} \text{ C}$  is moved from point **A** to point **B** in the presence of the electric field of the point charges  $Q_1$  and  $Q_2$ . How much work had to be done? 10 points

$$Q_1 = 10^{-4} \text{ C} \quad a = 0.3 \text{ m} \quad b = 0.3 \text{ m}$$

$$Q_2 = -2 \times 10^{-4} \text{ C} \quad c = 0.6 \text{ m}$$



4. A network of capacitors is shown by the figure. In the first case  $C_2$  and  $C_3$  are charged by the battery. Give the voltages and the charges on each capacitors after turning the switch. 15 points



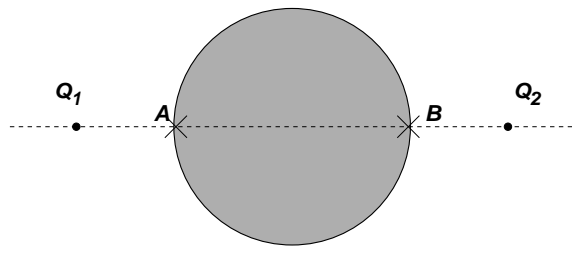
$$C_1 = 10 \mu F$$

$$C_2 = 30 \mu F$$

$$C_3 = 60 \mu F$$

$$V = 12 V$$

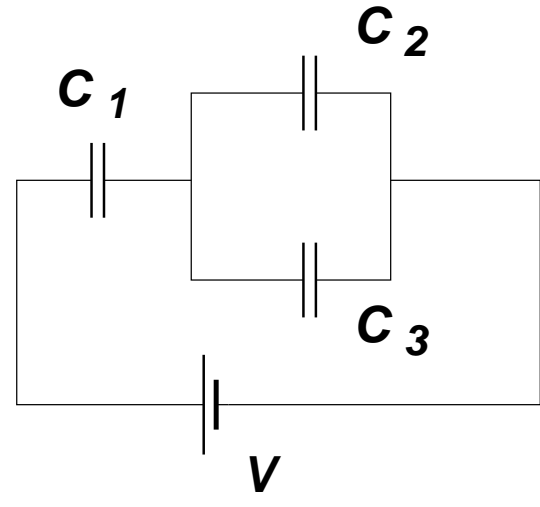
5. A system of two point charges and a metal sphere is shown by the figure. Give the potential difference between points **A** and **B**! 5 pints



$$Q_1 = 10^{-4} C$$

$$Q_2 = 2 \times 10^{-4} C$$

6. Give the voltages and the charges stored in the capacitors for the following system! 15 points



$$C_1 = 30 \mu F$$

$$C_2 = 20 \mu F$$

$$C_3 = 40 \mu F$$

$$V = 12 V$$

---

0 - 20	21 - 28	29 - 36	37 - 43	44 - 50
1	2	3	4	5