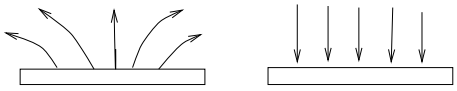
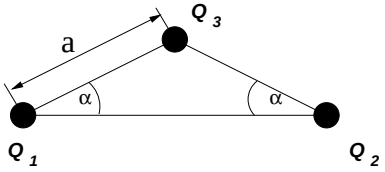
1. There are two positive point charge in the space. Can the electric potential be zero in the vicinity of the charges?
2. What does the uniform electric field mean?
3. Give the definition of the equipotential surface!
4. How can we calculate the force between a set of point charges?
5. On the figure 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!



6. What does the capacity of a capacitor depend on?
7. 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?
8. How large can a potential difference be on the surface of an ideal metal?
9. State the Ohm's low!
10. How does the resistivity of a metal wire depend on the area of the cross-section ?

1. There are three charges at the vertices of a triangle (see the figure).

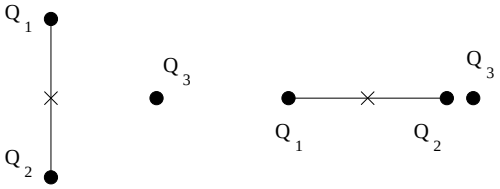


$$\begin{aligned} Q_1 &= 10^{-4}C \\ Q_2 &= -2\times 10^{-4}C \\ Q_3 &= 3\times 10^{-4}C \\ \alpha &= 30^\circ \end{aligned}$$

a. Give the force on the third charge! 5 points

b. How large is the electric field at the middle of the triangle?

2. There are three charges in the arrangement given by the figure **a**. Two of them are connected by a rod. The length of the rod is 0.6 m and the distance between the rod and the third charge is 0.4 m.



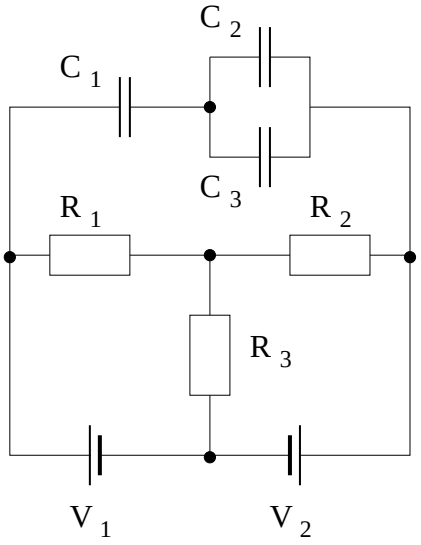
$$\begin{aligned} Q_1 &= 10^{-4}C \\ Q_2 &= -2\times 10^{-4}C \\ Q_2 &= 2\times 10^{-4}C \end{aligned}$$

a. Give the potential energy of the system!

b. Find a point on the line connecting the centre of the rod and Q_3 at which the electric potential is zero!

c. How much work has to be done if we want to rotate the rod around of its centre according to figure **b**?

3. The system of capacitors and resistors is given by the figure.



$$
\begin{aligned}
R_1 &= 100\Omega \\
R_2 &= 100\Omega \\
R_3 &= 200\Omega \\
V_1 &= 6V \\
V_2 &= 9V \\
C_1 &= 60\mu F \\
C_2 &= 10\mu F \\
C_3 &= 20\mu F
\end{aligned}
$$

a. Give the currents through the resistors! 4 points

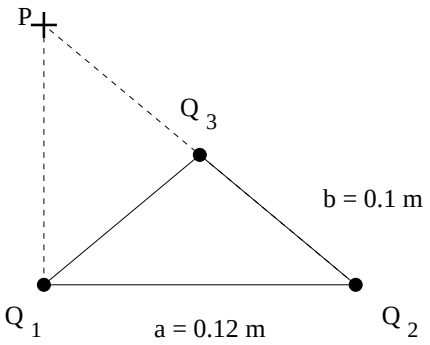
b. Give the voltage drops on the resistors! 4 points

c. Give the potential on each capacitor! 4 points

d. How much energy is stored in the hole system? 4 points

e. Give the charges stored in the capacitors! 4 points

1. There are three charges on the vertices of an isoclinic triangle as it is shown by the figure.



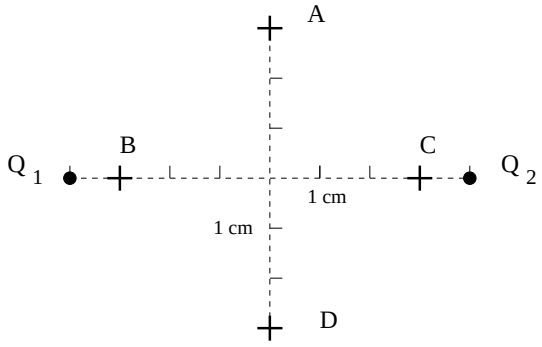
$$Q_1 = 10^{-4}C$$
$$Q_2 = -10^{-4}C$$
$$Q_3 = 2 \times 10^{-4}C$$

a) Give the force on Q_2 !

b) Give the electric field vector at the point P!

c) What will the direction of the force be on a negative charge if we put it at the point P?

2. There are two charges in the space according to the figure: $Q_1 = 10^{-5}$C, $Q_2 = -2 \times 10^{-5}$C.



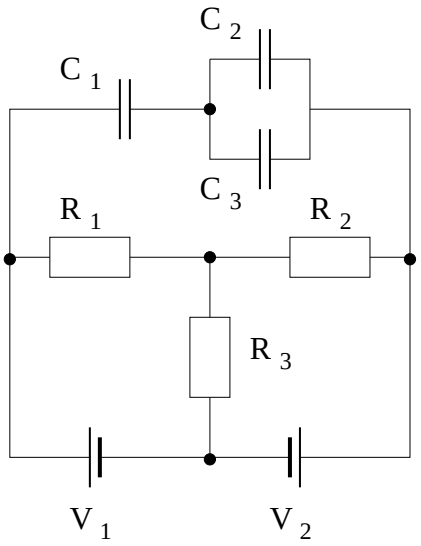
Give the work we have to do in order to move a third charge of $q = 10^{-5}$C from

a) point **A** to point **B**

b) point **B** to point **C**

c) point **A** to point **D**

3. The system of capacitors and resistors is given by the figure.



$R_1 = 100\Omega$
$R_2 = 100\Omega$
$R_3 = 200\Omega$
$V_1 = 6V$
$V_2 = 9V$
$C_1 = 60\mu F$
$C_2 = 10\mu F$
$C_3 = 20\mu F$

a. Give the currents through the resistors! 4 points

b. Give the voltage drops on the resistors! 4 points

c. Give the potential on each capacitor! 4 points

d. How much energy is stored in the hole system? 4 points

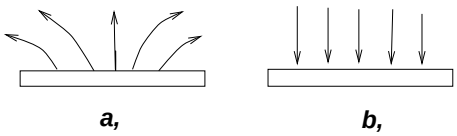
e. Give the charges stored in the capacitors! 4 points

1. There are two positive point charge in the space. Can the electric potential be zero in the vicinity of the charges?

2. What does the uniform electric field mean?

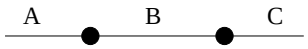
3. Give the definition of the equipotential surface!

4. 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!



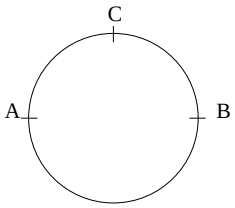
5. State the Ohm's low!

6. There are two positive charges as it is shown by the figure. Choose one from regions A, B, C where the electric filed can be zero.



7. There is a uniform electric field between two oppositely charged parallel plates. How will the electric field change if the distance between the plates is decreased?

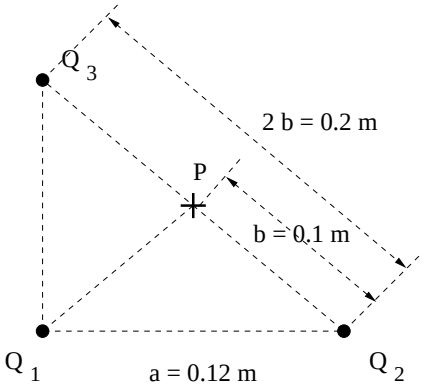
8. There is a metal ring shown by the figure. The resistance between contacts A and B is R_{AB} and the resistance between the contacts A and C is R_{AC}. Which is larger: R_{AB} or R_{AC}?



9. There is a charged metallic cube. Where is the electric potential larger: at the centre of one of its sides or at one of its vertices?

10. There are two oppositely charged large plate. Where is the electric field larger: at the middle or close to one of the plates?

1. There are three charges on the vertices of an isoclinic triangle as it is shown by the figure.



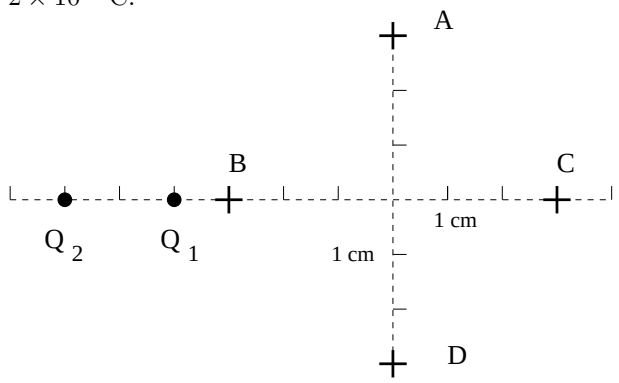
$$Q_1 = 10^{-4}C$$
$$Q_2 = -10^{-4}C$$
$$Q_3 = 2 \times 10^{-4}C$$

a) Give the force on Q_2 ! 10 points

b) Give the electric field vector at the point P! 8 points

c) What will the direction of the force be on a negative charge if we put it at the point P? 2 points

2. There are two charges in the space according to the figure: $Q_1 = 10^{-5}$C, $Q_2 = -2 \times 10^{-5}$C.



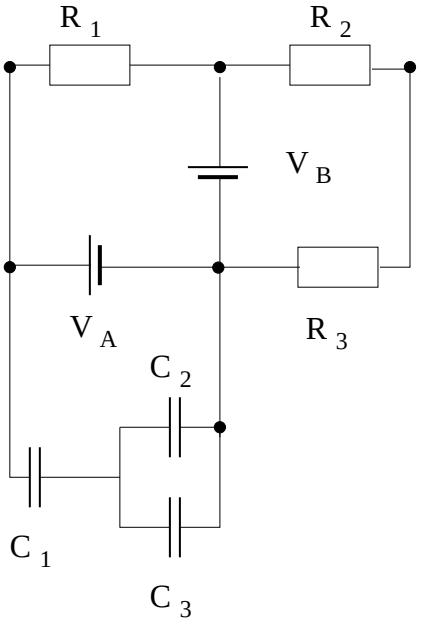
Give the work we have to do in order to move a third charge of $q = 10^{-5}$C from

a) point **A** to point **B** 8 points

b) point **B** to point **C** 7 points

c) point **A** to point **D** 5 points

3. The system of capacitors and resistors is given by the figure.



$R_1 = 100\Omega$
$R_2 = 100\Omega$
$R_3 = 200\Omega$
$V_A = 6V$
$V_B = 9V$
$C_1 = 60\mu F$
$C_2 = 10\mu F$
$C_3 = 20\mu F$

a. Give the currents through the resistors! 4 points

b. Give the voltage drops on the resistors! 4 points

c. Give the potential on each capacitor! 4 points

d. How much energy is stored in the hole system? 4 points

e. Give the charges stored in the capacitors! 4 points

1. There are two positive point charge in the space. Can the electric potential be zero in the vicinity of the charges?
2. What does the force between two point charges depend on?
3. What does the uniform electric field mean?
4. Give the definition of the equipotential surface!
5. How can we calculate the force between a set of point charges?
6. What is the unit of the electric potential?
7. What does the capacity of a capacitor depend on?
8. How large can a potential difference be on the surface of an ideal metal?
9. State the Ohm's low!
10. How does the resistivity of a metal wire depend on the area of the cross-section ?

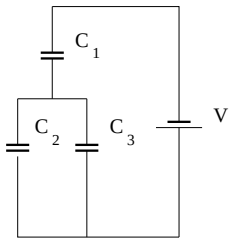
1. There is a charge of $1.69*10^{-8}$ C at the origin. At the point P the x– and y–component of the electric field is 1.2 N/C and 0.5N/C respectively.
   - **a.** Give the distance between the point P and the charge! 5 points
   - **b.** Give the position of the point P! 5 points
   - **c.** How large is the potential at P? 5 points
   - **d.** Where should a half as large charge be placed in order to get zero electric field at the point P? 5 points

2. There are two large parallel metal plates separated 1 cm from each other. The potential difference between the plates is 10000 V.
   - **a.** How large is the electric field between the plates? 6 points
   - **b.** How much work has to be done in order to move 10^{-4} coulomb from the negative plate to the positive plate? 6 points
   - **c.** A small particle with a mass of 1 g, a charge of $10^5 C$ enters the space between the plates at the positive one with a velocity of 100 m/s parallel to the plate. Give the magnitude and the direction of the velocity of the small particle when striking the negative plate! 8 points

3. A charge of $2*10^{-5}$ C is stored in the system of capacitors shown by the figure. The capacitance of the capacitors are $C_1 = 400\mu F$, $C_2 = 100\mu F$ and $C_3 = 300\mu F$ respectively.
   - **a.** How much charge stored in the different capacitors? 8 points

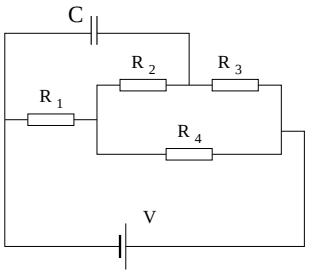
b. Give the potential on each capacitor! 5 points

c. How much energy is stored in the hole system? 7 points



4. The power dissipated on the system shown by the figure is 10 W.

$$R_1 = 100\Omega$$
$$R_2 = 200\Omega$$
$$R_3 = 400\Omega$$
$$R_4 = 300\Omega$$



a. How large is the resistivity of the system? 6 points

b. Give voltage of the battery! 6 points

c. Give the potential drops on the resistors! 8 points

1. Give the unit of the electric field!
2. Choose the vectors among the following physical quantities: electric field, force, electric potential, position, potential energy, kinetic energy.
3. How can we calculate the force between a set of point charges?
4. How large can a potential difference be on the surface of an ideal metal?
5. How does the resistivity of a metal wire depend on the area of the cross-section ?
6. Give the unit of the resistivity!
7. Give the unit of the specific resistivity!
8. What does the force between two point charges depend on?
9. What does the capacity of a capacitor depend on?
10. State the Ohm's law!

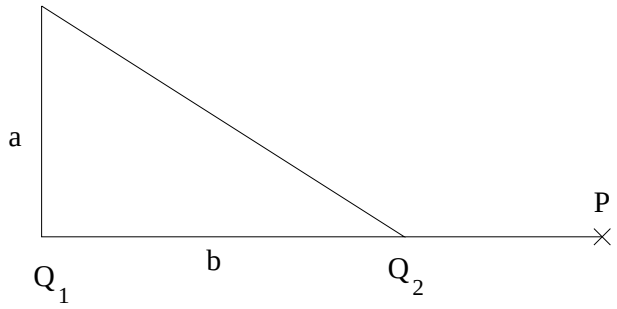
1. There are two charges on two vertices of a triangle. In which case can the electric field be zero at the third vertex of the triangle?
2. There is a neutral soap–bulb. How will the diameter of the bulb change if we put some charge on it?
3. There is a uniform electric field between two oppositely charged parallel plates. How will the electric field change if the distance between the plates is doubled?
4. There are two balls hanging on a piece of rope. One of them is conductor the other one is insulator. What happens if we touch them with a charged glass rod?
5. Do we have to do work in order to increase the distance between two oppositely charged plates?

1. There are two charges at two vertices of a rectangular triangle according to the figure. The charges Q_1 and Q_2 are $10^{-4}C$ and $-2\times10^{-4}C$ respectively. The distances are: $a = 7m$, $b = 11m$.

   a.) Give the electric potential at the third vertex of the triangle! 10 points

   b.) How large force will act on a $-10^{-4}C$ charge if we put it at the third edge of the triangle? 10 points

   c.) Find the position of the point P if the potential is zero at P. 10 points



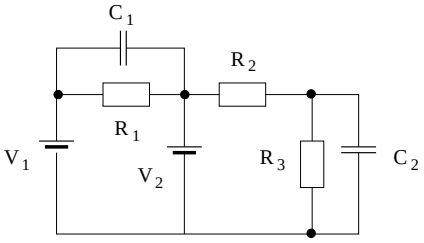
2. The system of capacitors and resistors is given by the following figure.

a.) Find the currents in each resistors! 8 points

b.) Give the charge in each capacitors! 8 points

c.) How large are the voltage drops on the resistors? 8 points

d.) How will the currents be changed if the capacitors are removed? 6 points



$$
\begin{aligned}
R_1 &= 200\Omega \\
R_2 &= 300\Omega \\
R_3 &= 200\Omega \\
C_1 &= 100\mu F \\
C_2 &= 100\mu F \\
V_1 &= 9V \\
V_2 &= 6V
\end{aligned}
$$

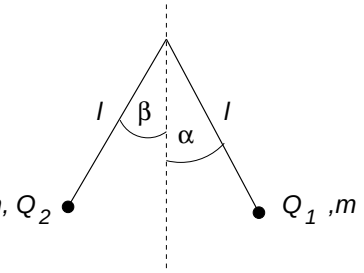
1. Two charged particles with equal masses are suspended from the same point on ropes with the length of $l = 2.5$ m as it is shown by the Figure. The charges of the particles are $Q_1 = 2 \times 10^6$ C and $Q_2 = 3 \times 10^6$ C, respectively. The angle between the rope of Q_1 and the vertical line is $\alpha = 30^o$.

   a) How large is the angle β between the rope of Q_2 and the vertical line? 2 points

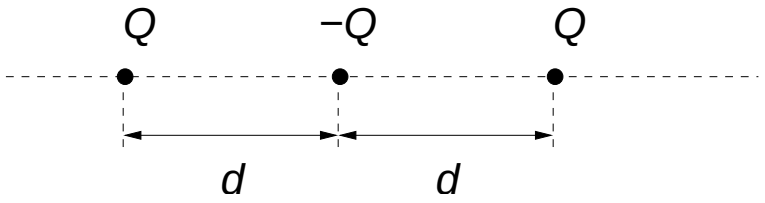
   b) How large is the mass of the particles? 5 points

   c) How large is the electric force between them? 3 points

   d) Give the electric field at the place of the particles! 5 points



2. There are three charges on a line with the separation of $d = 0.6$ m. The absolute value of the charges are the same and the sign of them is given by the figure.



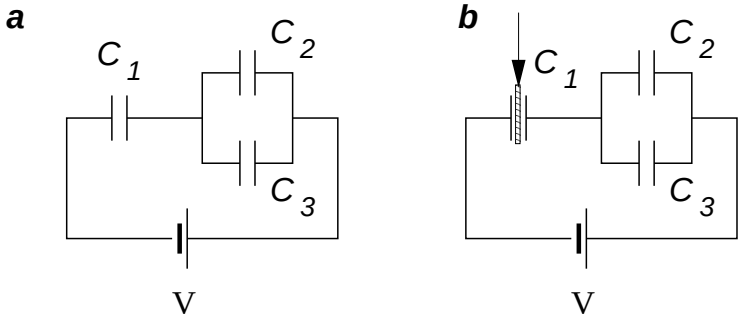
   a) Give a point where the electric potential is zero! 7 points

   b) Give the number of points where the electric potential is zero! 3 points

   c) How much work has to be done in order to move the charge in the middle with a distance of $l = 0.8$ m perpendicular to the line? 5 points

3. A network of planar capacitors is shown by the figure **a**.

$$C_1 = 1nF$$
$$C_2 = 3nF$$
$$C_3 = 6nF$$
$$V = 9V$$

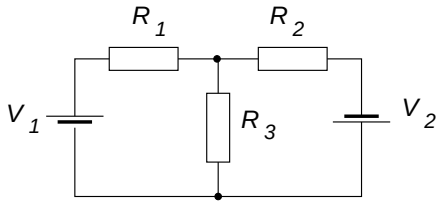


   a) Give the voltages on the capacitors and the charges stored in the capacitors! 5 points

   b) How does the amount of charge stored in the system change if an insulator with a dielectric constant of $\varepsilon = 2$ is placed between the plates of the C_1 capacitor. (see Fig. **b**) 5 points

c) Give the energy stored in the systems in both cases! 5 points

4. A network of resistors is shown by the figure.



$R_1 = 100\Omega$
$R_2 = 200\Omega$
$R_3 = 300\Omega$
$V_1 = 8V$
$V_2 = 3V$

a) Give the currents through the resistors! 5 points

b) Give the voltages on the resistors! 5 points

c) How much power is dissipated on the system? 5 points

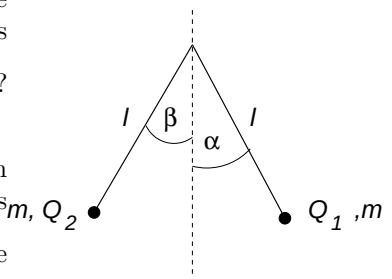
1. Two charged particles with a mass of $m_1 = m_2 = 4$ g are suspended from the same point on ropes with equal length as it is shown by the Figure. The charges of the particles are $Q_1 = 1 \times 10^6$ C and $Q_2 = 2 \times 10^6$ C, respectively. The angle between the rope of Q_1 and the vertical line is $\alpha = 30^o$.

   a) How large is the angle β between the rope of Q_2 and the vertical line? 2 points

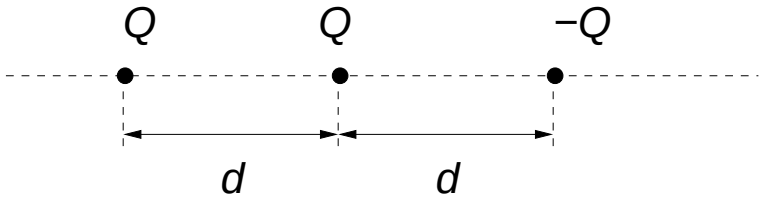
   b) How large is the length of the ropes? 5 points

   c) How large is the electric force between them? 3 points

   d) Give the electric field at the place of the particles! 5 points



2. There are three charges on a line with the separation of $d = 0.6$ m. The absolute value of the charges are the same and the sign of them is given by the figure.



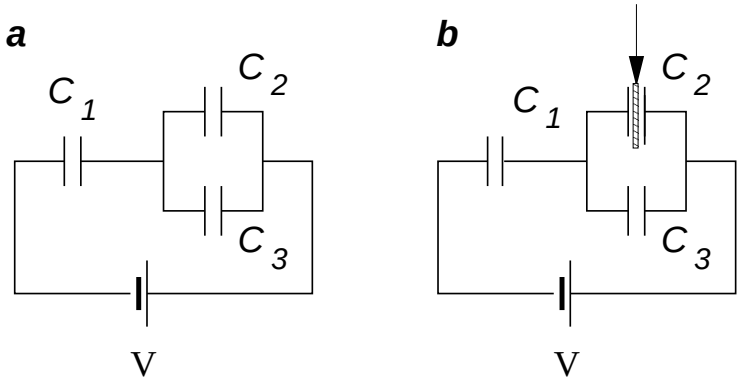
   a) Give a point where the electric potential is zero! 7 points

   b) Give the number of points where the electric potential is zero! 3 points

   c) How much work has to be done in order to move the charge in the middle with a distance of $l = 0.8$ m perpendicular to the line? 5 points

3. A network of planar capacitors is shown by the figure **a**.

$C_1 = 1nF$
$C_2 = 3nF$
$C_3 = 6nF$
$V = 9V$

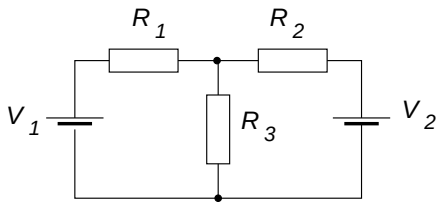


   a) Give the voltages on the capacitors and the charges stored in the capacitors! 5 points

b) How does the amount of charge stored in the system change if an insulator with a dielectric constant of $\varepsilon = 2$ is placed between the plates of the C_2 capacitor. (see Fig. **b**) 5 points

c) Give the energy stored in the systems in both cases! 5 points

4. A network of resistors is shown by the figure.



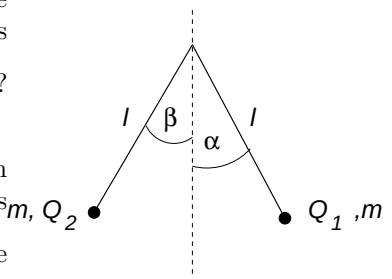
$$R_1 = 100\Omega$$
$$R_2 = 200\Omega$$
$$R_3 = 300\Omega$$
$$V_1 = 6V$$
$$V_2 = 3V$$

a) Give the currents through the resistors! 5 points

b) Give the voltages on the resistors! 5 points

c) How much power is dissipated on the system? 5 points

1. Two charged particles with equal masses are suspended from the same point on ropes with the length of $l = 2.68$ m as it is shown by the Figure. The charges of the particles are $Q_1 = 2 \times 10^6$ C and $Q_2 = 3 \times 10^6$ C, respectively. The angle between the rope of Q_1 and the vertical line is $\alpha = 45^o$.



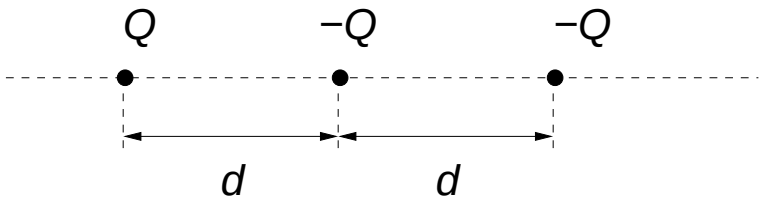
a) How large is the angle β between the rope of Q_2 and the vertical line? 2 points

b) How large is the mass of the particles? 5 points

c) How large is the electric force between them? 3 points

d) Give the electric field at the place of the particles! 5 points

2. There are three charges on a line with the separation of $d = 0.6$ m. The absolute value of the charges are the same and the sign of them is given by the figure.



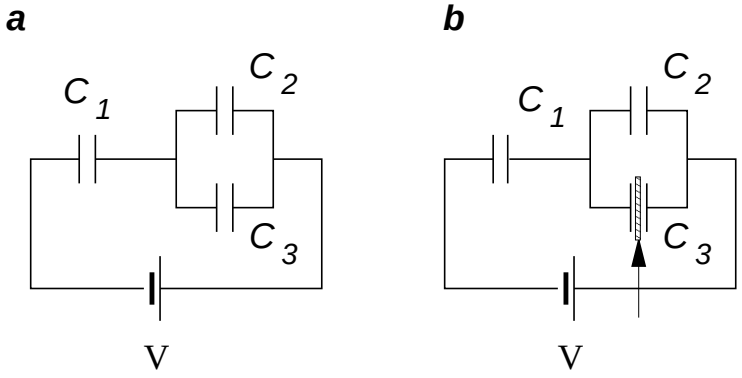
a) Give a point where the electric potential is zero! 7 points

b) Give the number of points where the electric potential is zero! 3 points

c) How much work has to be done in order to move the charge in the middle with a distance of $l = 0.8$ m perpendicular to the line? 5 points

3. A network of planar capacitors is shown by the figure **a**.

$C_1 = 1nF$
$C_2 = 3nF$
$C_3 = 6nF$
$V = 9V$

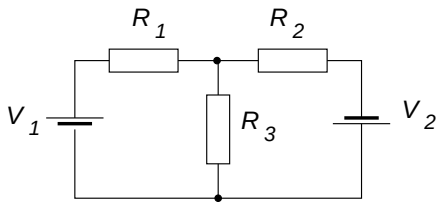


a) Give the voltages on the capacitors and the charges stored in the capacitors! 5 points

b) How does the amount of charge stored in the system change if an insulator with a dielectric constant of $\varepsilon = 2$ is placed between the plates of the C_3 capacitor. (see Fig. **b**) 5 points

c) Give the energy stored in the systems in both cases! 5 points

4. A network of resistors is shown by the figure.



$$R_1 = 100\Omega$$
$$R_2 = 200\Omega$$
$$R_3 = 300\Omega$$
$$V_1 = 16V$$
$$V_2 = 6V$$

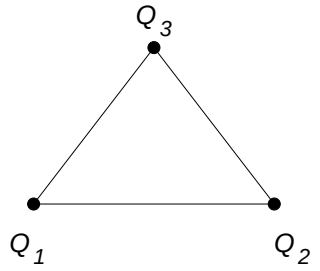
a) Give the currents through the resistors! 5 points

b) Give the voltages on the resistors! 5 points

c) How much power is dissipated on the system? 5 points

1. There are three charges as it is given by the figure. The position of the charges are given below.

$Q_1 = ?$ $\quad \vec{r}_1 = (-0.6m, 0)$
$Q_2 = -10^{-6}C$ $\quad \vec{r}_2 = (0.6m, 0)$
$Q_3 = 2 \times 10^{-6}C$ $\quad \vec{r}_3 = (0, 0.8m)$

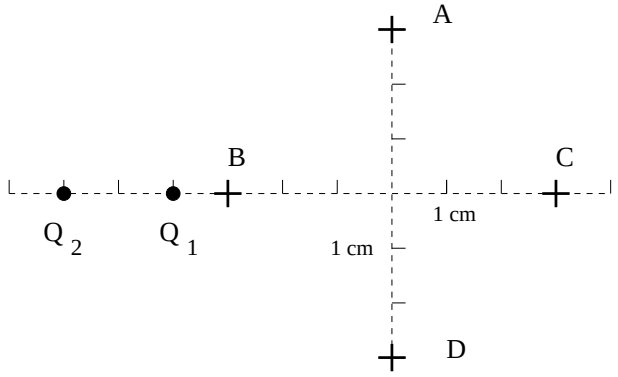


a.) The components of the electric filed at $\vec{r}_3$ are $\vec{E}_3 = (10800N/C, 0)$. Give the charge Q_1 at $\vec{r}_1$! 5 points

b.) Give the electric field at the place of Q_1 ($\vec{r}_1$)! 5 points

c.) Give the forces on the three charges! 5 points

2. There are two charges in the space according to the figure: $Q_1 = 10^{-5}$C, $Q_2 = -2 \times 10^{-5}$C.



Give the work we have to do in order to move a third charge of $q = 10^{-5}$C from

a) point **A** to point **B** 5 points

b) point **B** to point **C** 5 points

c) point **A** to point **D** 5 points

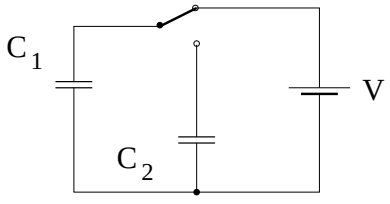
3. On the figure a network of capacitors is shown. At the first case C_1 is connected to the battery.

a.) Give the amount of charge stored in the capacitor! 5 points

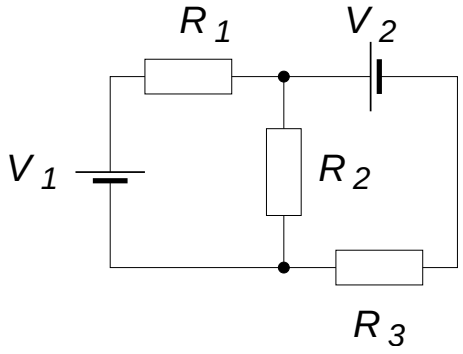
b.) In the second case the position of the switch is changed and the two capacitors C_1 and C_2 are connected. Give the voltage on the capacitors! 5 points

c.) Give the energy stored in the system in the two cases. 5 points!

$C_1 = 10\ \mu F$
$C_2 = 20\ \mu F$
$V = 12\ V$



4. The network of resistors is given by the figure below.



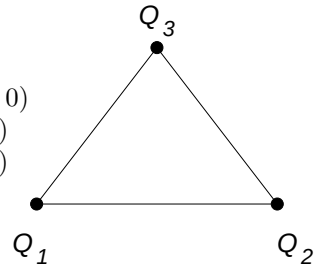
$$
\begin{aligned}
R_1 &= 30\Omega \\
R_2 &= 60\Omega \\
R_3 &= 40\Omega \\
V_1 &= 9V \\
V_2 &= 3V
\end{aligned}
$$

a.) Give the currents through the resistors and the voltages on the resistors! 9 points

b.) How much power is dissipated on the system? 6 points

1. There are three charges as it is given by the figure. The position of the charges are given below.

$Q_1 = ?$ $\quad \vec{r}_1 = (-0.5m, 0)$
$Q_2 = -2.19 \times 10^{-6} C$ $\quad \vec{r}_2 = (0.5m, 0)$
$Q_3 = 10^{-6} C$ $\quad \vec{r}_3 = (0, 1.2m)$

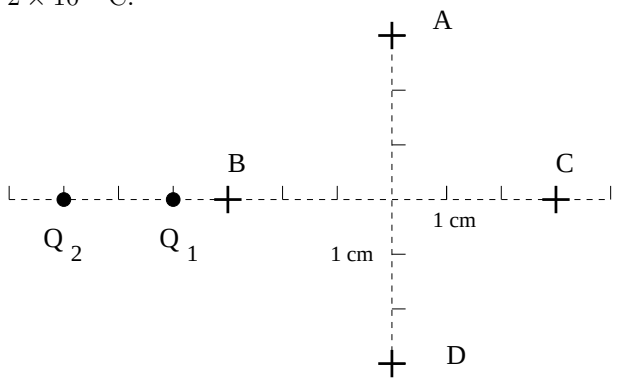


a.) The components of the electric filed at $\vec{r}_3$ are $\vec{E}_3 = (9000N/C, 0)$. Give the charge Q_1 at $\vec{r}_1$! 5 points

b.) Give the electric field at the place of Q_1 ($\vec{r}_1$)! 5 points

c.) Give the forces on the three charges! 5 points

2. There are two charges in the space according to the figure: $Q_1 = 10^{-5}$C, $Q_2 = -2 \times 10^{-5}$C.



Give the work we have to do in order to move a third charge of $q = 10^{-5}$C from

a) point **A** to point **C** 5 points

b) point **C** to point **B** 5 points

c) point **A** to point **D** 5 points

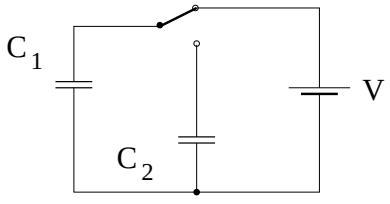
3. On the figure a network of capacitors is shown. At the first case C_1 is connected to the battery.

a.) Give the amount of charge stored in the capacitor! 5 points

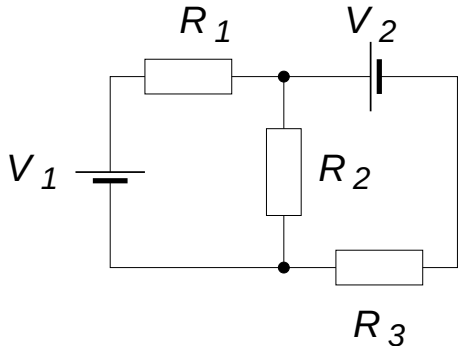
b.) In the second case the position of the switch is changed and the two capacitors C_1 and C_2 are connected. Give the voltage on the capacitors! 5 points

c.) Give the energy stored in the system in the two cases. 5 points!

$C_1 = 60\ \mu F$
$C_2 = 90\ \mu F$
$V = 12\ V$



4. The network of resistors is given by the figure below.

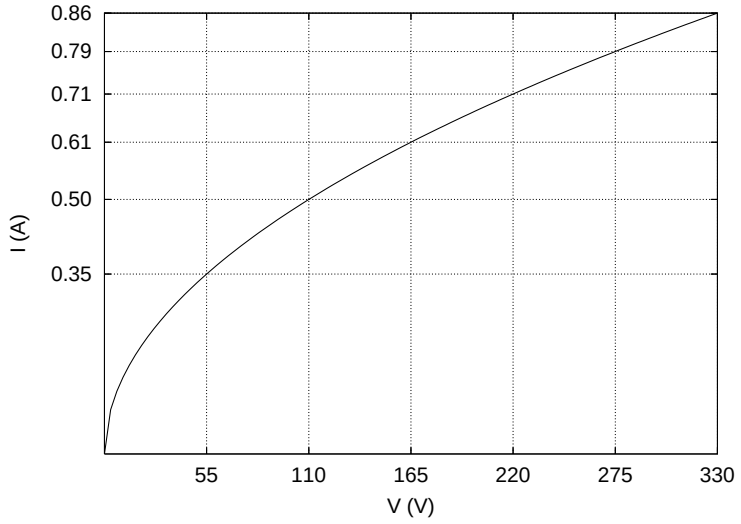


$R_1 = 45\Omega$
$R_2 = 90\Omega$
$R_3 = 30\Omega$
$V_1 = 9V$
$V_2 = 3V$

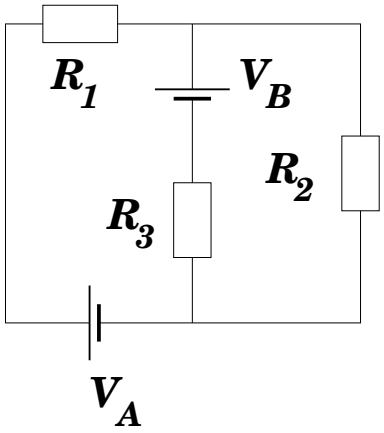
a.) Give the currents through the resistors and the voltages on the resistors! 9 points

b.) How much power is dissipated on the system? 6 points

1. On the following figure the current flowing through a lamp is depicted as a function of the applied voltage. Give the power dissipated on the lamp if the applied voltage is $V_1 = 110\,V$ and $V_2 = 220\,V$! **10 points**

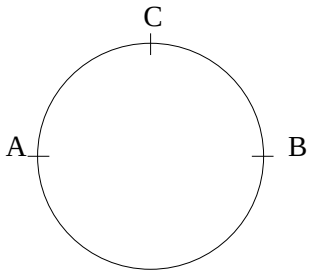


2. Give the voltage drops and the currents on the resistors for the following system! **20 points**

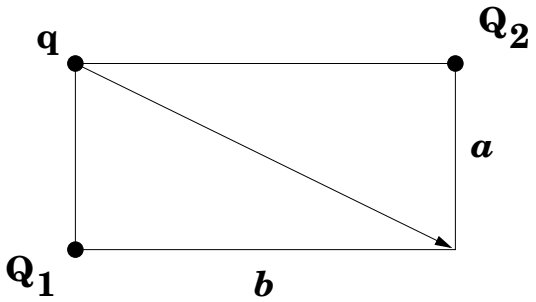


$R_1 = 15\,\Omega$
$R_2 = 30\,\Omega$
$R_2 = 10\,\Omega$
$V_A = 9\,V$
$V_B = 4\,V$

3. A circle is formed from a wire. The resistance between the points **A** and **B** of the circle is $R_{AB} = 100\,\Omega$. Give the resistance between the points **A** and **C**! **20 points**

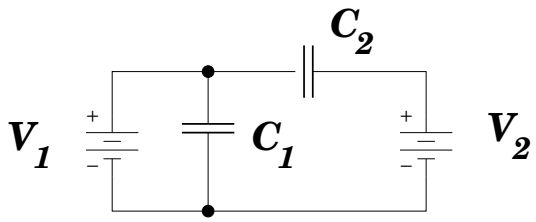


4. How much work has to be done in order to move the charge of $q = 10^{-5}\,C$ from one vertex of the rectangle to the other. **15 points**



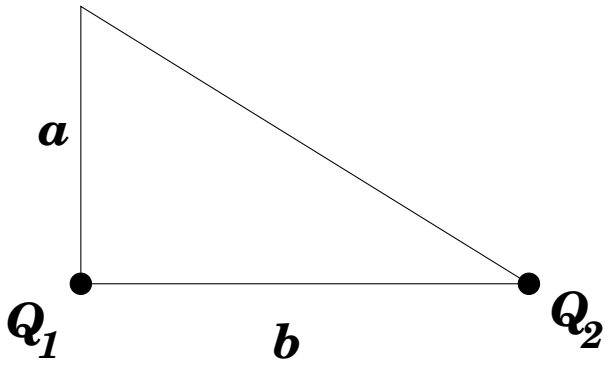
$$\begin{aligned} Q_1 &= -2 \times 10^{-4}\, C \\ Q_2 &= 10^{-4}\, C \\ q &= 10^{-5}\, C \\ a &= 0.2\, m \\ b &= 0.3\, m \end{aligned}$$

5. A network of capacitors is shown by the figure. Give the energy stored in the system. **15 points**



$$\begin{aligned} C_1 &= 10\, \mu F \\ C_2 &= 30\, \mu F \\ V_1 &= 9\, V \\ V_2 &= 6\, V \end{aligned}$$

6. There are two charges on two vertexes of a triangle as it is shown by the figure.



$$\begin{aligned} Q_1 &= 2 \times 10^{-5}\, C \\ Q_2 &= -4 \times 10^{-5}\, C \\ a &= 0.6\, m \\ b &= 0.8\, m \end{aligned}$$

Give the electric filed vector at the third vertex of the triangle! **20 points**

---

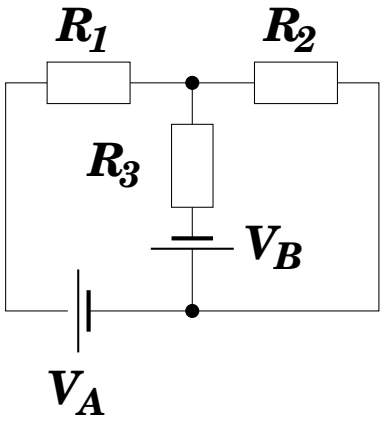
1. The electric potential of a point charge at a given point is $V = 10^5\ V$. The components of the electric field vector at the same point are $E_x = 5 \times 10^4\ N/C$ $E_y = 12 \times 10^4\ N/C$.

   How far is the charge from the point? **5 points**

   Give the charge producing the electric field! **5 points**

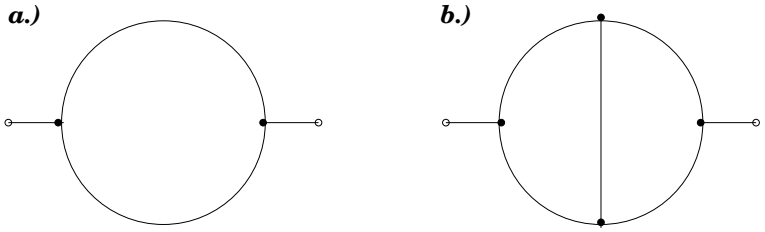
   Give the position of the point where the potential is given if the charge is at the origin! **5 points**

2. Give the voltage drops and the currents on the resistors for the following system! **20 points**

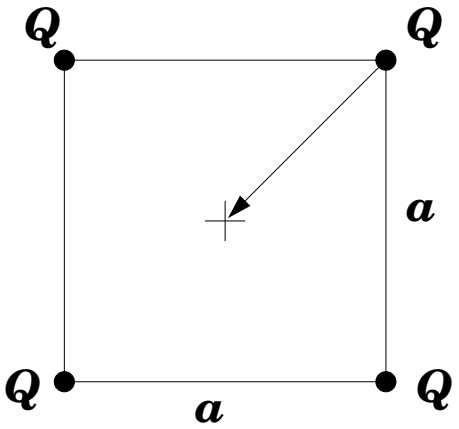


$R_1 = 25\ \Omega$
$R_2 = 100\ \Omega$
$R_2 = 300\ \Omega$
$V_A = 10\ V$
$V_B = 8\ V$

3. A circle with a radius of $R = 0.2\ m$ is made from a wire which has a diameter of $d = 4 \times 10^{-4}\ m$. The specific resistivity of the wire is $\rho = 4 \times 10^{-6}\ \Omega m$. The resistance of the piece of wires connected to the circle is negligible. Give the resistance of the two systems! **15 points**

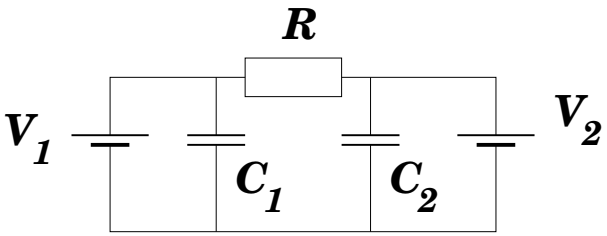


4. The same amount of charges are placed at the four vertices of a square. How much work has to be done in order to move one of the charges to the center of the square? **15 points**



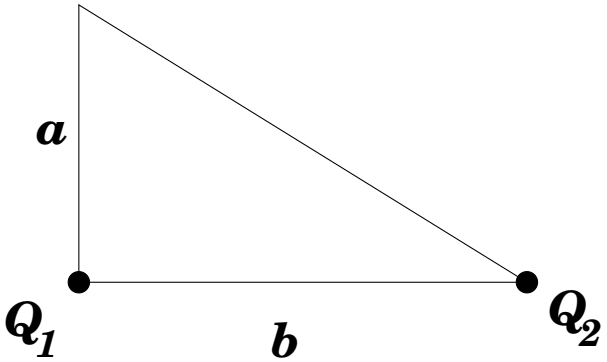
$Q = 2 \times 10^{-4}\ C$
$a = 0.2\ m$

5. Give the energy stored in the capacitors for the system shown by the figure! **15 points**



$C_1 = 10\ \mu F$
$C_2 = 30\ \mu F$
$V_1 = 9\ V$
$V_2 = 6\ V$

6. There are two charges on two vertices of a triangle as it is shown by the figure.



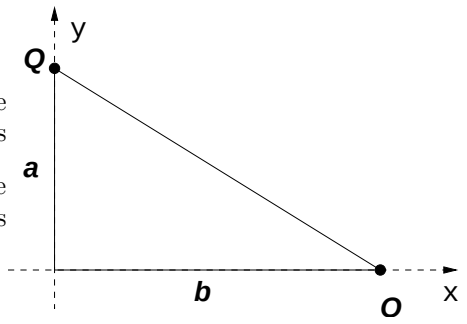
4

$Q_1 = -2 \times 10^{-5}\ C$
$Q_2 = 2 \times 10^{-5}\ C$
$a = 0.3\ m$
$b = 0.4\ m$

Give the electric filed vector at the third vertex of the triangle! **20 points**

---

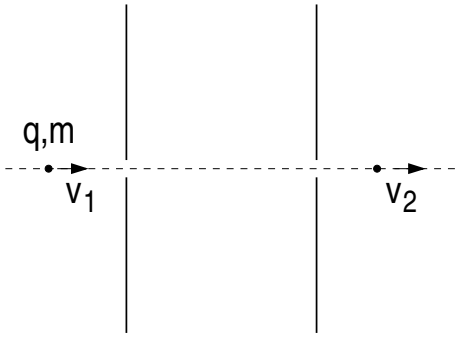
1. The same charges of $Q = 2 \times 10^{-4}\ C$ are put at two vertexes of a rectangular triangle as it is shown by the figure. The electric field at the third vertex of the triangle is $\vec{E} = (-800\ N/C, -1800\ N/C)$.



a.) Give the length of the sides of the triangle! 6 points

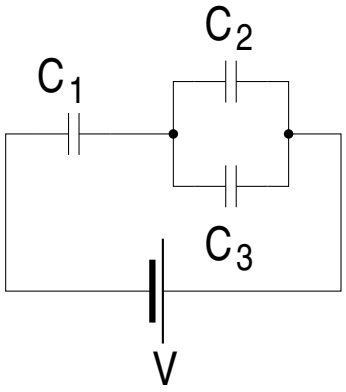
b.) How large is the force between the charges? 4 points

2. A charged particle is flying through a pair of holes on two charged parallel plates. (see the figure below) The velocity of the particle before entering and after leaving the plates is $\mathbf{v}_1$ and $\mathbf{v}_2$, respectively. How large is the electric potential difference between the plates ? (hint: apply the work theorem!) 10 points



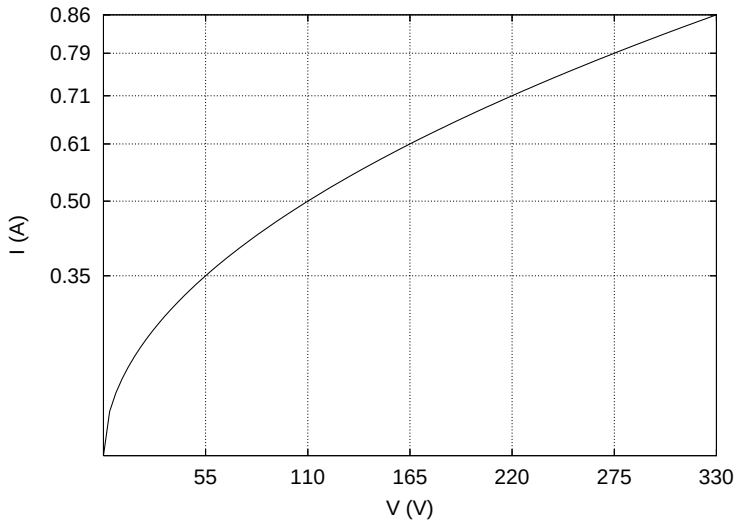
$$\begin{aligned} q &= 0.625 \times 10^{-4}\ C \\ m &= 10^{-4}\ kg \\ v_1 &= 10\ m/s \\ v_2 &= 15\ m/s \end{aligned}$$

3. Give the energy stored in the system! 15 points

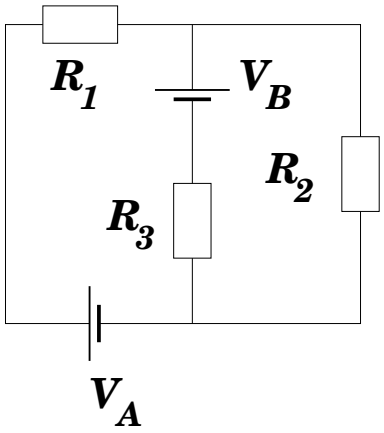


$$\begin{aligned} C_1 &= 30\ \mu F \\ C_2 &= 20\ \mu F \\ C_3 &= 40\ \mu F \\ V &= 12\ V \end{aligned}$$

4. On the following figure the current flowing through a lamp is depicted as a function of the applied voltage. Give the power dissipated on the lamp if the applied voltage is $V_1 = 110\ V$ and $V_2 = 220\ V$! 10 points

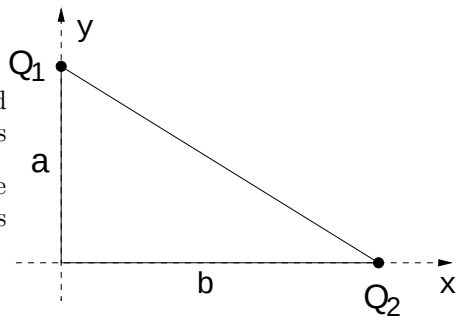


5. Give the voltage drops and the currents on the resistors for the following system! 15 points



$R_1 = 10\ \Omega$
$R_2 = 40\ \Omega$
$R_3 = 40\ \Omega$
$V_A = 9\ V$
$V_B = 3\ V$

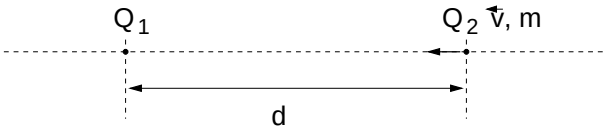
1. There are two charges at the vertexes of a triangle, as it is shown by the figure.
$Q_1 = 10^{-5}$ C, $Q_2 = 2 \times 10^{-5}$ C, $a = 0.3$ m, $b = 0.6$ m



a.) Give the electric field at the third vertex of the triangle! 10 points

b.) How large is the force between the charges? 5 points

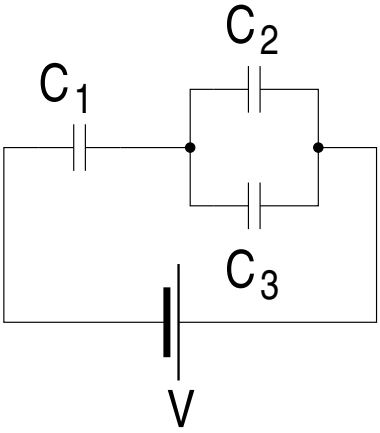
2. A charge of $Q_1 = 10^{-5}$ C is fixed at a point and another charge of $Q_2 = 10^{-5}$ C is moving towards it with the velocity of $v = 30$m/s. At that moment the distance between the charges is $d = 3$ m. How large will the smallest distance be between them? 15 points



3. There is a network of capacitors given by the figure.

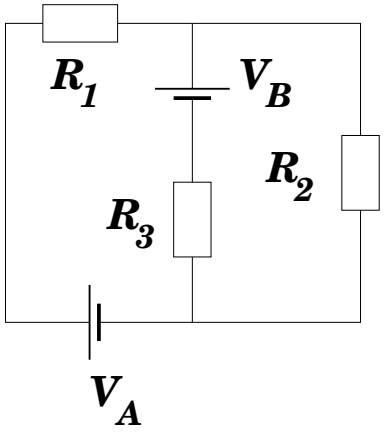
a.) How much energy is stored in the system? 5 points

b.) Give the voltages on each capacitors! 10 points



$C_1 = 30\ \mu F$
$C_2 = 20\ \mu F$
$C_3 = 40\ \mu F$
$V = 12\ V$

4. Give the voltage drops and the currents on the resistors for the following system! 15 points



$R_1 = 30\ \Omega$
$R_2 = 60\ \Omega$
$R_3 = 20\ \Omega$
$V_A = 9\ V$
$V_B = 3\ V$

1. There is a point charge at the origin. Give the position of the point where the electric field vector is $\vec{F} = (12\ N/C, 5\ N/C)$ and the electric potential is $V = 26\ V$. 12 points

2. There are three point charges: Q_1, Q_2, Q_3. The components of the force on the first charge is $F_{1x} = 100\ N$, $F_{1y} = -100\ N$ and the components of the force on the second charge is $F_{2x} = 200\ N$, $F_{2y} = 100\ N$.

$$Q_1 = 10^{-4}\ C, \quad Q_1 = 2 \times 10^{-4}\ C \quad Q_1 = -2 \times 10^{-4}\ C$$

a.) Give the force vector on the third charge! 6 points

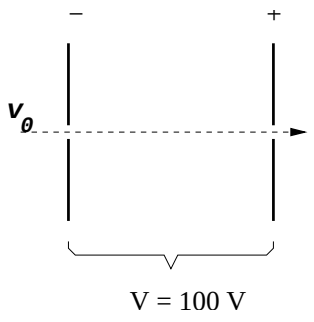
b.) Give the electric field vector at the place of each charges! 6 points

3. There is a positive point charge above a large metal plate as it is shown by the figure. Make a schematic picture of the electrostatic lines of force! 12 points

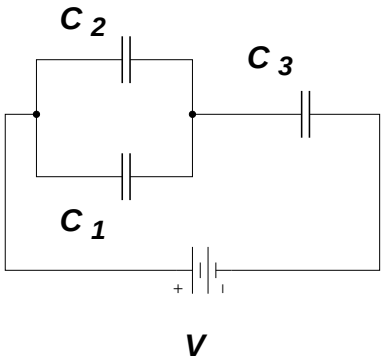
---

4. There are two parallel plates with a small hole in the middle as it is given by the figure. The potential difference between the plates is $V = 100\ V$. An electron with initial velocity of $v_0 = 10^4\ m/s$ arrives horizontally at the first plate. Give the velocity of the electron leaving the second plate! 12 points

$$m_e = 9.1 \times 10^{-31}\ kg \qquad Q_e = 1.6 \times 10^{-19}\ C$$



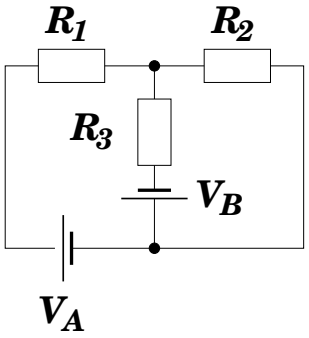
5. Find the voltages and the charges stored in each capacitor for the network given below! 20 points



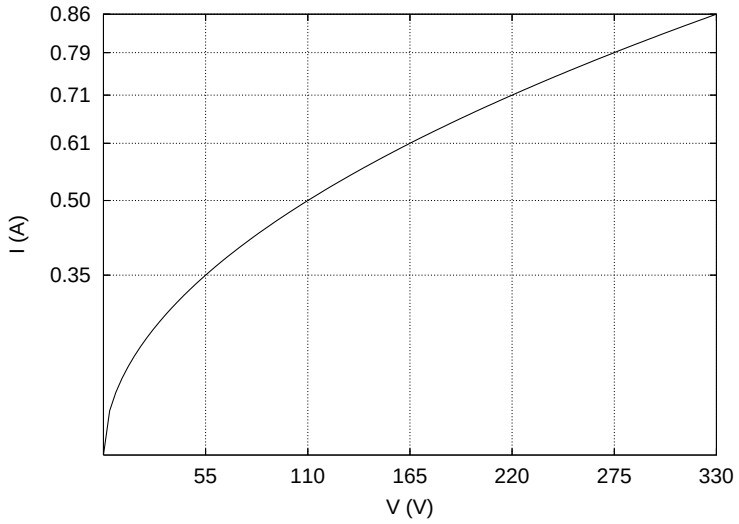
$C_1 = 15\ \mu F$
$C_2 = 30\ \mu F$
$C_3 = 90\ \mu F$
$V = 12\ V$

6. Give the currents through the resistors for the network given by the figure! 20 points

$R_1 = 100\ \Omega$
$R_2 = 100\ \Omega$
$R_3 = 100\ \Omega$
$V_A = 12\ V$
$V_B = 3\ V$



7. On the following figure the current flowing through a lamp is plotted as a function of the applied voltage. Give the power dissipated on the lamp if the applied voltage is $V_1 = 110\ V$ and $V_2 = 220\ V$! 12 points



1. There is a point charge at the origin. Give the position of the point where the electric field vector is $\vec{F} = (8\ N/C, -6\ N/C)$ and the electric potential is $V = 10\ V$. 12 points

2. There are three point charges: Q_1, Q_2, Q_3. The components of the force on the first charge is $F_{1x} = -100\ N$, $F_{1y} = 100\ N$ and the components of the force on the second charge is $F_{2x} = 200\ N$, $F_{2y} = 100\ N$.

$$Q_1 = 10^{-4}\ C, \quad Q_1 = 2 \times 10^{-4}\ C \quad Q_1 = -2 \times 10^{-4}\ C$$

a.) Give the force vector on the third charge! 6 points

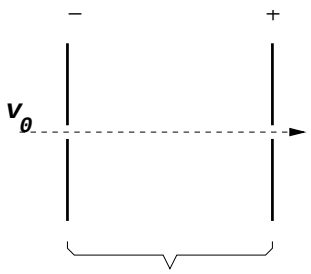
b.) Give the electric field vector at the place of each charges! 6 points

3. There is a negative point charge above a large metal plate as it is shown by the figure. Make a schematic picture of the electrostatic lines of force! 12 points

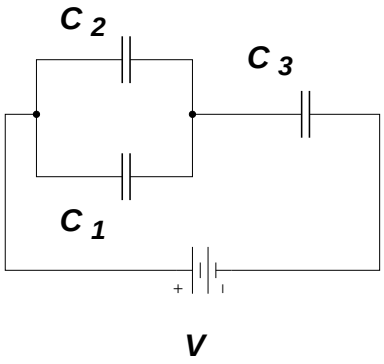
---

4. There are two parallel plates with a small hole in the middle as it is given by the figure. The potential difference between the plates is $V = 100\ V$. An electron with initial velocity of $v_0 = 2 \times 10^4\ m/s$ arrives horizontally at the first plate. Give the velocity of the electron leaving the second plate! 12 points

$$m_e = 9.1 \times 10^{-31}\ kg \qquad Q_e = 1.6 \times 10^{-19}\ C$$



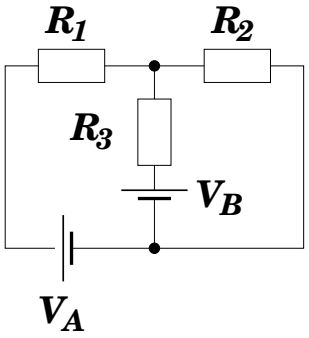
5. Find the voltages and the charges stored in each capacitor for the network given below! 20 points



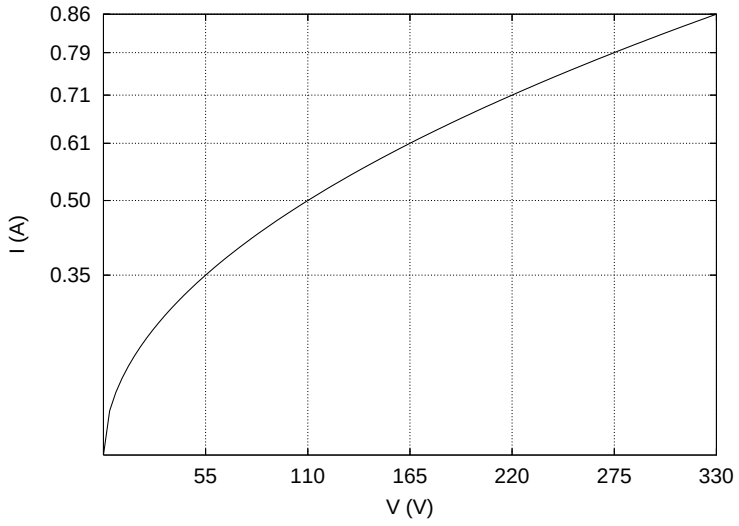
$C_1 = 10\ \mu F$
$C_2 = 20\ \mu F$
$C_3 = 60\ \mu F$
$V = 12\ V$

6. Give the currents through the resistors for the network given by the figure! 20 points

$R_1 = 100\ \Omega$
$R_2 = 100\ \Omega$
$R_3 = 100\ \Omega$
$V_A = 12\ V$
$V_B = 3\ V$

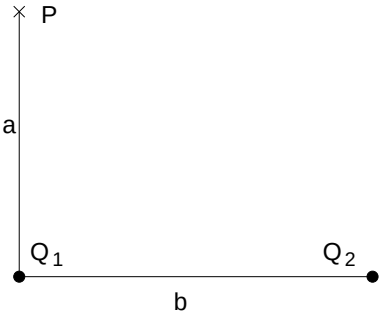


7. On the following figure the current flowing through a lamp is plotted as a function of the applied voltage. Give the power dissipated on the lamp if the applied voltage is $V_1 = 110\ V$ and $V_2 = 220\ V$! 12 points



1. There are two point charges as it is given by the figure. Give the electric field at point P (the third vertex of the triangle)! 20 points

$$\begin{aligned} a &= 0.3\ m \\ b &= 0.4\ m \\ Q_1 &= 2.5 \times 10^{-5}\ C \\ Q_2 &= -5 \times 10^{-5}\ C \end{aligned}$$



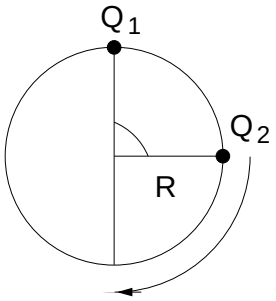
2. There is a point charge at the origin. The electric field and the electric potential at a point is $\vec{E} = (300\ N/C, 400\ N/C)$ and $V = 1000\ V$, respectively.

   a.) Give the position vector of the point! 15 points

   b.) How much charge is at the origin? 5 points

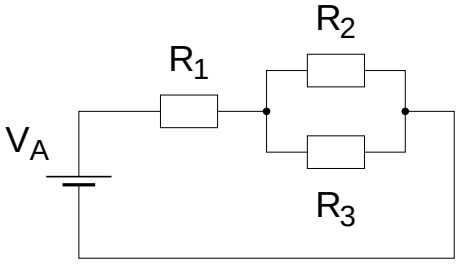
3. There are two charges as it is given on the figure. Q_1 is fixed and Q_2 can move without any friction on the circle. How much work has to be done in order to move Q_2 opposite to Q_1. 20 points

$$\begin{aligned} R &= 1\ m \\ Q_1 &= 10^{-5}\ C \\ Q_2 &= -10^{-5}\ C \end{aligned}$$



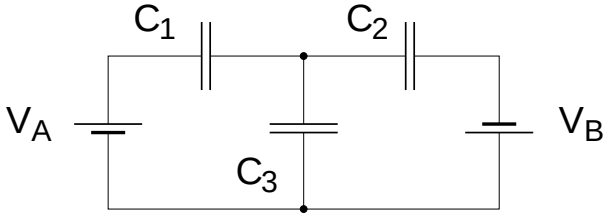
4. Give currents through the resistors in the following network! 20 points

$$\begin{aligned} R_1 &= 40\ \Omega \\ R_2 &= 30\ \Omega \\ R_3 &= 60\ \Omega \\ V_A &= 12\ V \end{aligned}$$



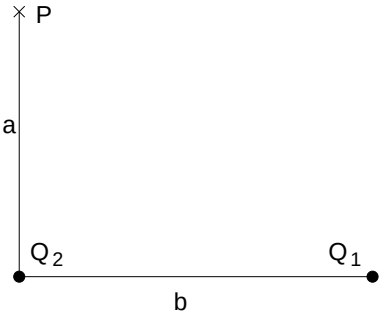
5. Find the charges stored in the capacitors in the following network! 20 points

$$\begin{aligned} C_1 &= 10\ \mu F \\ C_2 &= 10\ \mu F \\ C_3 &= 10\ \mu F \\ V_A &= 9\ V \\ V_B &= 3\ V \end{aligned}$$



1. There are two point charges as it is given by the figure. Give the electric field at point P (the third vertex of the triangle)! 20 points

$$\begin{aligned} a &= 0.3\ m \\ b &= 0.4\ m \\ Q_1 &= 2.5 \times 10^{-5}\ C \\ Q_2 &= -5 \times 10^{-5}\ C \end{aligned}$$



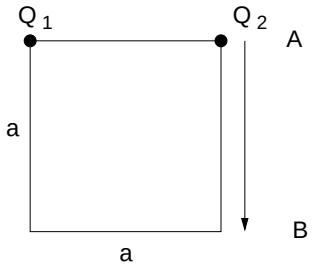
2. There is a point charge at the origin. The electric field and the electric potential at a point is $\vec{E} = (-800\ N/C, 600\ N/C)$ and $V = -1000\ V$, respectively.

   a.) Give the position vector of the point! 15 points

   b.) How much charge is at the origin? 5 points

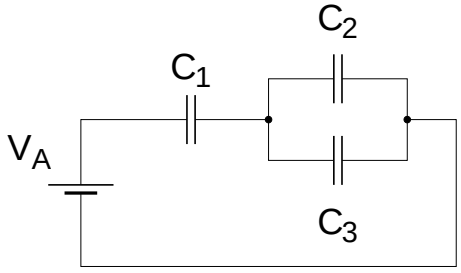
3. There are two charges as it is given on the figure. Q_1 is fixed and Q_2 can move without any friction on the sides of the square. How much work has to be done in order to move Q_2 from point A to point B. 20 points

$$\begin{aligned} R &= 1\ m \\ Q_1 &= 10^{-5}\ C \\ Q_2 &= -10^{-5}\ C \end{aligned}$$



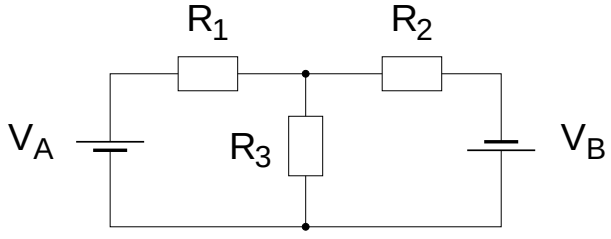
4. Find the charges stored in the capacitors in the following network! 20 points

$$\begin{aligned} C_1 &= 60\ \mu F \\ C_2 &= 10\ \mu F \\ C_3 &= 20\ \mu F \\ V_A &= 12\ V \end{aligned}$$



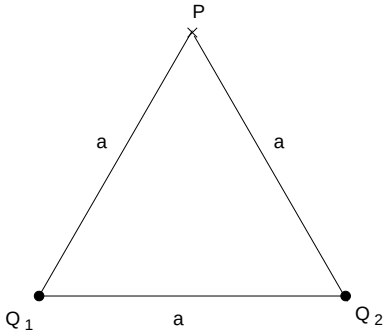
5. Find the currents through the resistors in the following network! 20 points

$$\begin{aligned} C_1 &= 10\ \Omega \\ C_2 &= 10\ \Omega \\ C_3 &= 10\ \Omega \\ V_A &= 9\ V \\ V_B &= 3\ V \end{aligned}$$



1. There are two point charges as it is given in the figure. Give the electric field at point P (the third vertex of the triangle)! 20 points

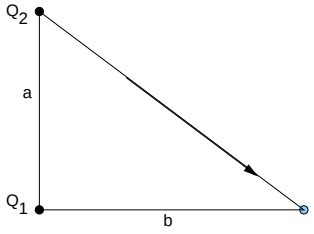
$$\begin{aligned} a &= 0.3\ m \\ Q_1 &= 2.5 \times 10^{-5}\ C \\ Q_2 &= -5 \times 10^{-5}\ C \end{aligned}$$



2. There is a point charge of $Q = 5 \times 10^{-7}\ C$ at the origin. The electric field vector at a point is $\vec{E} = (300\ N/C, 400\ N/C)$. Give the electric potential at the same point! 20 points

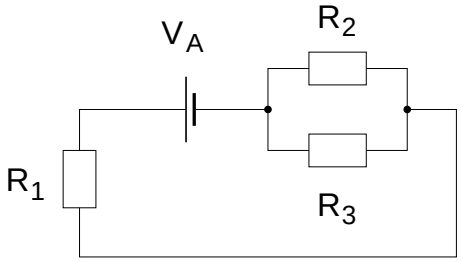
3. There are two charges as it is given in the figure. Q_1 is fixed and Q_2 can move without any friction on the longest side of the triangle. How much work has to be done in order to move Q_2 to the other corner of the triangle? 20 points

$$\begin{aligned} a &= 0.6\ m \\ b &= 0.8\ m \\ Q_1 &= 10^{-5}\ C \\ Q_2 &= -10^{-5}\ C \end{aligned}$$



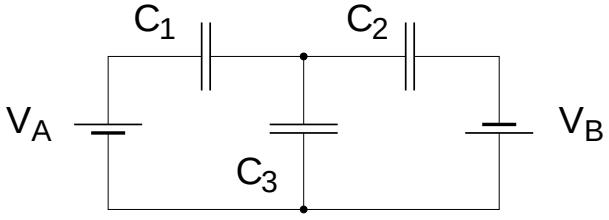
4. Give currents through the resistors in the following network! 20 points

$$\begin{aligned} R_1 &= 40\ \Omega \\ R_2 &= 30\ \Omega \\ R_3 &= 60\ \Omega \\ V_A &= 12\ V \end{aligned}$$

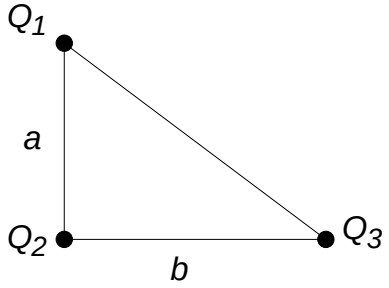


5. Find the charges stored in the capacitors in the following network! 20 points

$$\begin{aligned} C_1 &= 10\ \mu F \\ C_2 &= 10\ \mu F \\ V_3 &= 4\ V \\ V_A &= 9\ V \\ V_B &= 3\ V \end{aligned}$$



1. There are three charges as it is shown in the figure below. Give the force vector on the third charge! 20 points



$$\begin{aligned} Q_1 &= 2.5 \times 10^{-5}\ C \\ Q_2 &= -1.6 \times 10^{-5}\ C \\ Q_3 &= 10^{-5}\ C \\ a &= 0.3\ m \\ b &= 0.4\ m \end{aligned}$$

2. The electric field and the electric potential of a point charge at a given point are $V = 100\ V$ and $E = 1000\ N/C$, respectively.

   a.) Give the distance between the charge and the point! 10 points

   b.) How large is the charge? 10 points

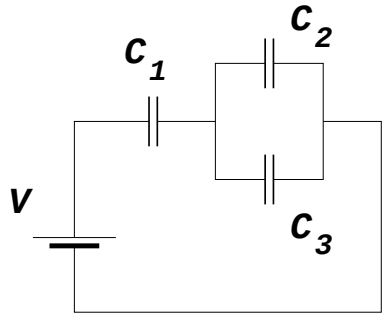
3. The capacity of a planar capacitor is $C = 1\ nF$ and it contains a charge of $Q = 100\ \mu C$. The space between the plates is filled by an insulator and a work of $W = 2\ J$ has to be done to remove it from the capacitor. Give the dielectric constant of the insulator! 20 points

4. The voltage on C_1 in the case of the following network is $V_1 = 3\ V$.

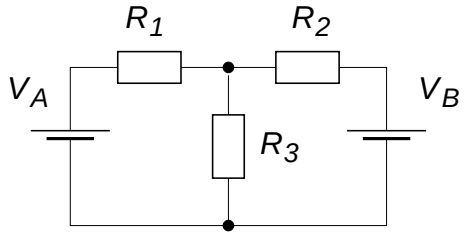
   a.) Give the charges and the voltages on each capacitors! 15 points

   b.) How large is the voltage of the battery? 5 points

$$\begin{aligned} C_1 &= 40\mu F \\ C_2 &= 30\mu F \\ C_3 &= 60\mu F \end{aligned}$$

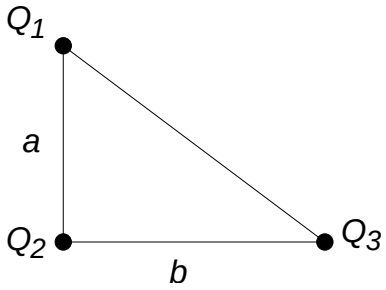


5. How much power is dissipated on R_3 in the case of the following network? 20 points



$$\begin{aligned} R_1 &= 30\ \Omega \\ R_2 &= 10\ \Omega \\ R_3 &= 60\ \Omega \\ V_A &= 9\ V \\ V_B &= 3\ V \end{aligned}$$

1. There are three charges as it is shown in the figure below. Give the force 20 points
vector on the Q_1!



$$\begin{aligned} Q_1 &= 5 \times 10^{-5}\ C \\ Q_2 &= -4 \times 10^{-5}\ C \\ Q_3 &= 10^{-4}\ C \\ a &= 0.6\ m \\ b &= 0.8\ m \end{aligned}$$

2. The electric field and the electric potential of a point charge at a given point are $V = 100\ V$ and $E = 1000\ V$, respectively.

   a.) Give the distance between the charge and the point! 10 points

   b.) How large is the charge? 10 points

3. The voltage on a planar capacitor which contains acharge of $Q = 10^{-4}\ C$ is $V = 10\ kV$.

   a.) How much work has to be done in order to double the distance between the plates of the capacitor? 10 points

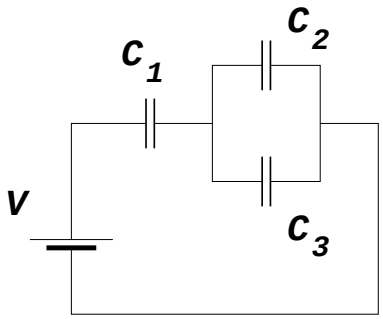
   b.) After increasing the distance we put an insulator into the empty space between the plates and the voltage changes to $V' = 15\ kV$. How large is the dielectric constant of the insulator? 10 points

4. The voltage on C_2 in the case of the following network is $V_2 = 3\ V$.

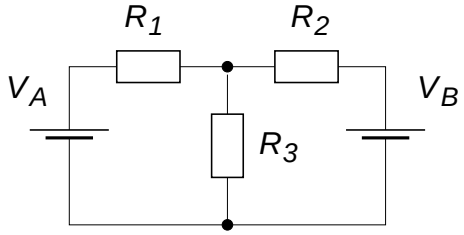
   a.) Give the charges and the voltages on each capacitors! 15 points

   b.) How large is the voltage of the battery? 5 points

$$\begin{aligned} C_1 &= 30\mu F \\ C_2 &= 20\mu F \\ C_3 &= 40\mu F \end{aligned}$$

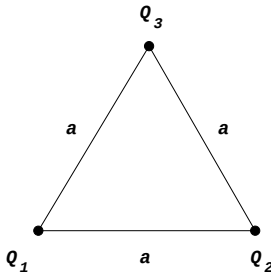


5. How much power is dissipated on R_3 in the case of the following network? 20 points



$$\begin{aligned} R_1 &= 30\ \Omega \\ R_2 &= 60\ \Omega \\ R_3 &= 60\ \Omega \\ V_A &= 9\ V \\ V_B &= 6\ V \end{aligned}$$

1. There are two charges at two vertexes of an equilateral triangle. Give the components of the electric field vector at the third vertex! 20 points



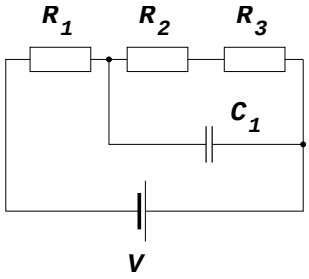
$$Q_1 = 10^{-5}\ C$$
$$Q_2 = -10^{-5}\ C$$
$$a = 0.1\ m$$

2. The charge stored in the capacitor in the following network is $Q = 40\ \mu C$.

   a.) Give the current through R_1! 10 points

   b.) How large is the voltage of the battery? 10 points

$$R_1 = 200\ \Omega$$
$$R_2 = 100\ \Omega$$
$$R_3 = 300\ \Omega$$
$$C_1 = 10\ \mu F$$



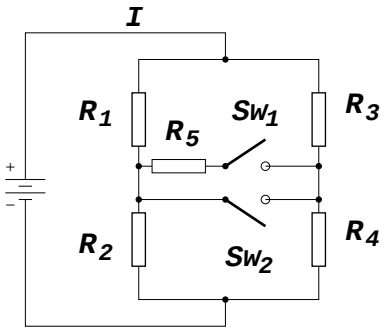
3. There is a charge of $Q = 10^{-5}\ C$ stored in a planar capacitor. A work of $W = 0.1\ J$ is needed to double the distance between the plates. How large is the capacity of the capacitor? 20 points

4. In the following network the current I does not depend on the state of the switches.

   a.) How large is the current through the resistor R_5 if the switch Sw_1 is closed. 6 points

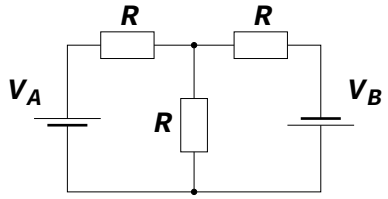
   b.) How large is the voltage on R_2 and R_4? 7 points

   c.) How large is R_4? 7 points



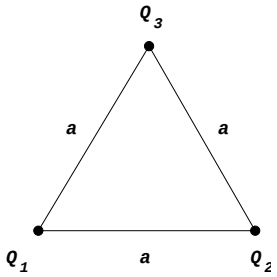
$$R_1 = 100\ \Omega$$
$$R_2 = 200\ \Omega$$
$$R_3 = 200\ \Omega$$
$$V = 9\ V$$

5. Find the current through each resistor in the case of the following network! 20 points



$$
\begin{aligned}
R &= 100\,\Omega \\
V_A &= 9\,V \\
V_B &= 6\,V
\end{aligned}
$$

1. There are three charges at the vertexes of an equilateral triangle. Give the components of the force vector on the charge at the third vertex! 20 points



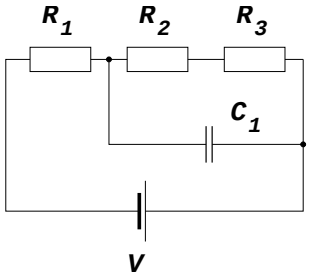
$$\begin{aligned} Q_1 &= 10^{-5}\ C \\ Q_2 &= -10^{-5}\ C \\ Q_3 &= 10^{-5}\ C \\ a &= 0.1\ m \end{aligned}$$

2. The energy stored in the capacitor in the following network is $E = 3.2 \times 10^{-4}\ J$.

   a.) Give the current through R_1! 10 points

   b.) How large is the voltage of the battery? 10 points

$$\begin{aligned} R_1 &= 200\ \Omega \\ R_2 &= 100\ \Omega \\ R_3 &= 300\ \Omega \\ C_1 &= 10\ \mu F \end{aligned}$$



3. There is a charge of $Q = 10^{-5}\ C$ stored in a planar capacitor. A work of $W = 0.1\ J$ is needed to triple the distance between the plates. How large is the capacity of the capacitor?

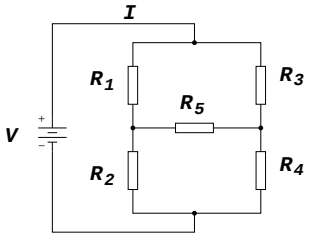
4. In the following network the voltage on the resistor R_2 is $V_2 = 6\ V$ and the voltage on R_3 is $V_3 = 3\ V$.

   a.) How large is the voltage on R_4? 5 points

   b.) How large is the current through the resistor R_5? 5 points

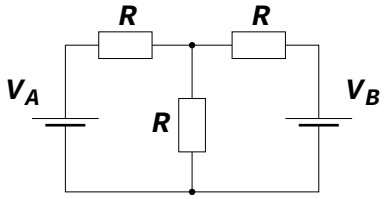
   c.) How large is R_4? 5 points

   d.) How large is the resistance of the system? 5 points



$$\begin{aligned} R_2 &= 200\ \Omega \\ R_3 &= 200\ \Omega \\ V &= 9\ V \end{aligned}$$

5. Find the current through each resistor in the case of the following network! 20 points



$$
\begin{aligned}
R &= 100\,\Omega \\
V_A &= 9\,V \\
V_B &= 6\,V
\end{aligned}
$$