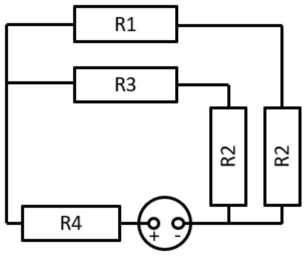
1. A 5 V USB power adapter charges a smartphone ($R_1 = 2\,\Omega$) and a tablet ($R_3 = 1\,\Omega$) at the same time. The power supply is not ideal and has an internal resistance of $R_4 = 0.1\,\Omega$. The devices are also not ideal and each has an internal resistance $R_2 = 0.5\,\Omega$.

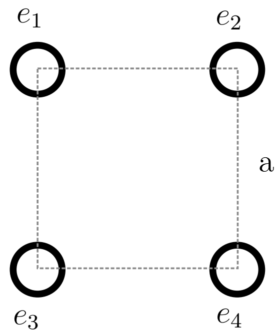
   

   a) Calculate the equivalent resistance of the complete circuit.

   b) Calculate the currents flowing into the phone and into the tablet.

   c) Calculate the electric power in resistor R_4.

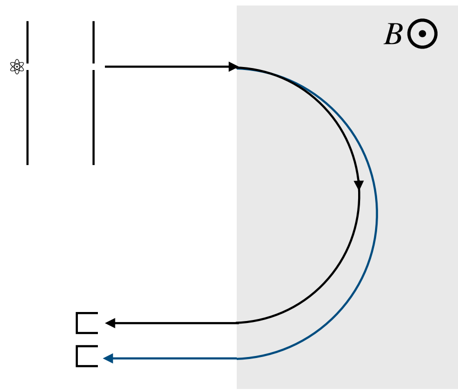
2. We have a system of point charge particles, fixed at the vertices of a square with side $a = 5\,\text{cm}$, as shown in the sketch. Charge sizes are $e_1 = 5\,\mu\text{A s}$, $e_2 = e_3 = 2\,e_1$ and $e_4 = -3\,e_1$.

   a) What is the magnitude and the direction of the force on charge e_1?

   b) How much work is done by removing the charge e_4 from the system?

3. We design a mass spectrometer consisting of an electron gun, a magnet and a detector. The electron gun is used to accelerate $^3He^+$ particles with a voltage of $U = 10\,\text{kV}$. Fast ions then enter a homogeneous magnetic field with density $B = 1.1\,\text{T}$ (see sketch).

   a) At what speed does $^3He^+$ enter the magnetic field?

   b) Where, relative to the point of entry, does $^3He^+$ fly out of the magnet?

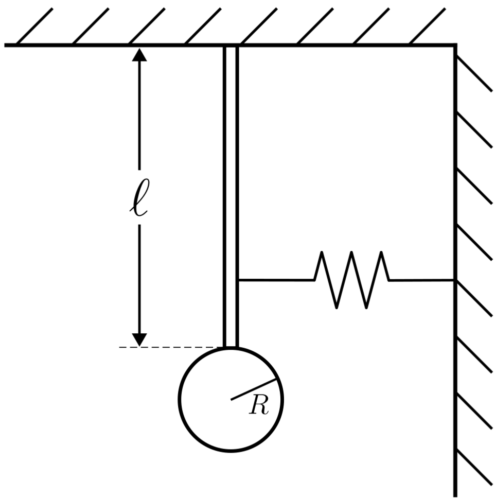
   c) What must be the distance between the pixels on the detector to distinguish between $^3He^+$ and $^4He^+$ in the spectrometer?

   Note that the mass of $^3He^+$ is equal to $4.98 \cdot 10^{-26}\,\text{kg}$ and the mass of $^4He^+$ is equal to $6.64 \cdot 10^{-26}\,\text{kg}$.

4. In the attic of grandpa's house we find an abandoned wall clock, which is missing its pendulum. Wishing to restore the clock, we find a $\ell = 1.2\,\mathrm{m}$ long rod with a mass of $1\,\mathrm{kg}$, to the end of which we attach a disk with radius $R = 8\,\mathrm{cm}$ and mass $2\,\mathrm{kg}$. For an accurate calibration of the oscillation time, we attach a light spring with a coefficient of $6.65\,\mathrm{N/m}$ to the rod from the side at $4/5$ of its length.

   a) What is the moment of inertia of the new pendulum?
   The moment of inertia of a disk around an axis that perpendicularly pierces the disk at its center is $J = mR^2/2$.

   b) What is the oscillation time of the pendulum in this configuration?
   Assume that the pendulum is in equilibrium when it is vertical (as shown on the figure), and that the amplitude of oscillations is small.



5. Through two long parallel conductors at a distance of $r_0 = 10\,\mathrm{cm}$, flows a current of $I_1 = I_2 = 4\,\mathrm{A}$ in the same direction. The conductors have linear mass density $\lambda = 1.4\,\mathrm{g/m}$. One conductor is firmly attached, while the other is released at $t = 0$ to move freely. How does the velocity of the free conductor $v(r)$ change with the distance between the conductors?