
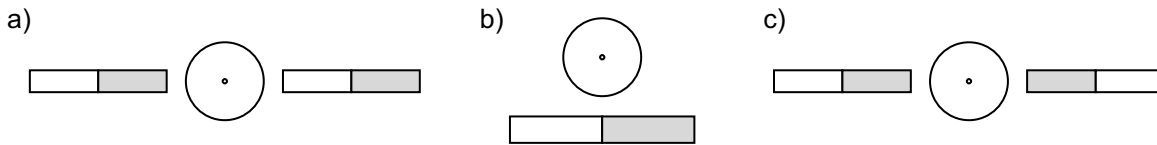


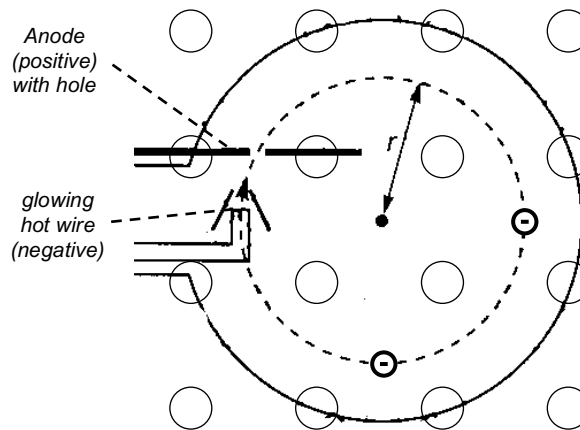
- In the pictures below the electrons are moving towards you, experiencing a magnetic force. What is the direction in which are they deflected?
Hint: First draw the representation of the magnetic field of the magnets (N  S) using arrows.



- In a teltron tube (see picture and link) electrons enter a magnetic field perpendicular to the field lines. First, a wire that is heated until it glows emits electrons. The electrons are accelerated in an electric field, towards the (positive) anode. The anode is a plate with a hole, the electrons pass through and move on into a glass sphere filled with a gas at a very low pressure. The electrons collide with some of the gas atoms, make them emit light and a glowing circle can be seen.

https://www.vacak.cz/data/android/physicsatschool/template.php?s=mag_wehnet&l=en

- Do the electrons move clockwise or counter-clockwise?
- At the location of the two electrons in the picture, draw the direction of the velocity vector as well as the direction of the magnetic force using arrows.
- Show the direction of the magnetic field by completing the drawing, placing a \odot (field lines towards you) or a \otimes (field lines away from you) into the circles \circ .



- In a teltron tube (see picture problem 2), electrons are accelerated by a voltage of 210.0 V. The electrons move perpendicularly to the magnetic field in a circular path of radius 4.0 cm.
 - What is the kinetic energy of an electron in eV and in J?
 - What is the speed of an electron?
 - Calculate the magnitude of the magnetic field.

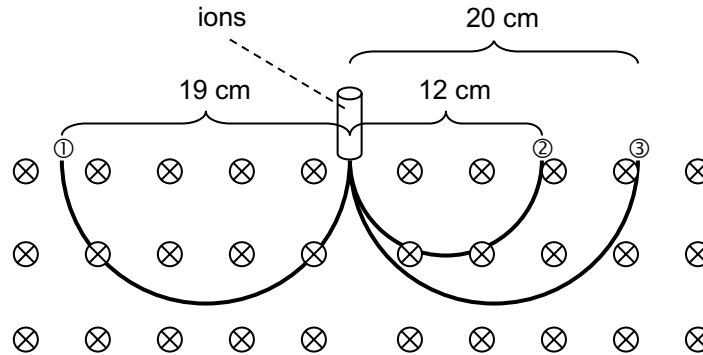
- An electron was accelerated by $U = 200.0 \text{ V}$ and moves perpendicular the field lines of the magnetic field of the Earth ($B = 4.0 \cdot 10^{-5} \text{ T}$).
 - Calculate the electron's velocity.
 - Determine the radius of the electron's circular path.
 - What is the time required for one complete revolution?

- The mass of an electron can be determined using a teltron tube (see picture problem 2). An electron accelerated by a voltage U enters a magnetic field B , and moves in a circular path of radius r .

Find an expression for calculating $\frac{q}{m}$ from U , B and r .

6. The mass of ions can be determined with a mass spectrometer. Charged ions with identical speeds are directed into a magnetic field, perpendicular to the field lines. They experience a magnetic force and thus move in a circular path. After completing a semicircle they strike a detector, and the radius of the circle can be measured. The mass of the ion is determined from the radius of the circle, the charge and the velocity of the ions, and the magnetic field.

Here three charged particles enter the magnetic field ($B = 0.208 \text{ T}$) at $v = 1.00 \cdot 10^5 \frac{\text{m}}{\text{s}}$. They all have a similar mass. Two of the particles carry one elementary charge while the third one carries two elementary charges. The magnetic field lines are pointing away from you.



- Which ones of the particles are positively charged, which ones are negatively charged?
 - Which one of the particles carries two elementary charges?
 - Calculate the masses of the particles ①, ② and ③.
7. The mass of chlorine atoms is to be determined in a mass spectrometer (see problem 6). Chlorine atoms carrying one elementary charge enter a magnetic field ($B = 0.300 \text{ T}$), and move perpendicularly to the field lines at $v = 1.00 \cdot 10^5 \frac{\text{m}}{\text{s}}$. Chlorine atoms are detected at $r_1 = 12.08 \text{ cm}$ and $r_2 = 12.77 \text{ cm}$.
- What are the ions' masses?
 - Give the masses in the atomic mass unit u ($1 u = 1.6606 \cdot 10^{-27} \text{ kg}$).
 - Each chlorine atom has 17 protons. How many neutrons does a chlorine atom possess? How can the difference in mass be explained?

solutions

- downwards
 - upwards
 - no deflection
- $210 \text{ eV} = 3.36 \cdot 10^{-17} \text{ J}$
 - $8.6 \cdot 10^6 \frac{\text{m}}{\text{s}}$
 - 1.2 mT
- $8.4 \cdot 10^6 \frac{\text{m}}{\text{s}}$
 - 1.2 m
 - $8.9 \cdot 10^{-7} \text{ s}$
- $$\frac{q}{m} = \frac{2 \cdot U}{r^2 \cdot B^2}$$
- ① negative, ② and ③ positive
 - ②
 - $3.16 \cdot 10^{-26} \text{ kg} = 19 \text{ u (F}^{\text{I}^-})$
 - $3.99 \cdot 10^{-26} \text{ kg} = 24 \text{ u (Mg}^{2+})$
 - $3.32 \cdot 10^{-26} \text{ kg} = 20 \text{ u (Ne}^+)$
- $m_1 = 5.806 \cdot 10^{-26} \text{ kg}$, $m_2 = 6.137 \cdot 10^{-26} \text{ kg}$
 - $m_1 = 35 \text{ u}$, $m_2 = 37 \text{ u}$
 - 18 neutrons und 20 neutrons.