Lecture tutorial 2C

`em03` Kräfte zwischen geraden Leitern
https://www.fnw.ovgu.de/nat_media/PDF_nat/lehre_online/vorlesungsvorbereitung/elektrik/elektromagnetismus/em03.pdf

`el09` - Wheatstonesche
https://www.fnw.ovgu.de/nat_media/PDF_nat/lehre_online/vorlesungsvorbereitung/elektrik/elektrische_leitungsvorgaenge/el09.pdf

`em39` e/m bestimmung
https://www.fnw.ovgu.de/nat_media/PDF_nat/lehre_online/vorlesungsvorbereitung/elektrik/elektromagnetismus/em39.pdf

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https://de.wikibooks.org/wiki/Datei:Wienscher_geschwindigkeitsfilter_massenspektroskopie.svg
https://en.wikipedia.org/wiki/File:Cathode_ray_tube_diagram-en.svg

Assuming a charged particle moving perpendicular to an uniform magnetic field, there will be a forces exerted on the particles. The force will deflect the particle and, as the force is always perpendicular to the direction of movement, causes the particle to move on a circular path (if the magnetic field is "large enough") with a centripetal acceleration magnitude of $a = \frac{v^2}{r}$ (see mechanics lectures). For a circular trajectory, the centripetal force and the force due to the magnetic field must be equal

$$\sum F = ma$$

$$qvB = m\frac{v^2}{r}$$

Therefore, the radius is:

$$r = \frac{mv^2}{qvB} = \frac{mv}{qB}$$

Determining electron's charge-to-mass ratio

Determining the electron's charge-to-mass-ratio

If an electron with charge e and mass m_e is first accelerated by an anode-cathode pair and subsequently entering perpendicular into a uniform magnetic field B, we can write:

$$evB = m_e\frac{v^2}{r}$$

$$\frac{e}{m_e} = \frac{v}{Br}$$

If we use a discharge tube, we can measure the radius r. While we can measure experimentally or estimate analytically B, we still need to determine v. To that end, we will use two plates to generate an electric field E perpendicular to the magnetic field B. This combination of E- and B-field is a so-called *velocity selector*. If the deflection of the particle due to both field is the same, i.e. the force due to the electric field and due to the magnetic field are equal, the electron moves in a straight line through the E-B-field combination:

$$F_{ele} = F_{mag}$$

$$eE = evB$$

Therefore, the velocity can be expressed as the ratio of both (non-zero) fields:

$$v = \frac{E}{B}$$

Using this relation, give us our final equation to estimate the electron's charge-to-mass-ratio:

$$\frac{e}{m_e} = \frac{E}{B^2 r}$$

The numerical value of $\frac{e}{m_e}$ is 1.76 × C/kg.

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two wires with em03 / https://de.wikipedia.org/wiki/Datei:AtractionTwoWires.svg

Task L2C.1

Circuit analysis