University Karlsruhe - International Department

Physics Course - Exercises Summer 2009

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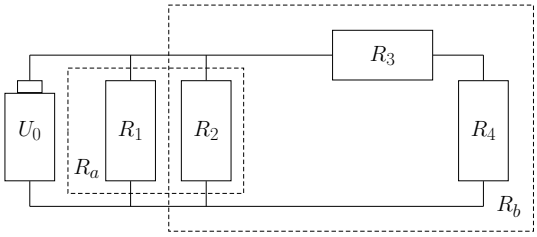
Homework (Sheet 8)
23.9.2009

State the ansatz, the formula and the result of the following exercises:

(i) An empty capacitor consists of two parallel planes with area $S = 0.5\,\mathrm{km}^2$ which are separated by a distance of $\ell = 1\,\mathrm{m}$. Calculate the capacity.

(ii) What is the angle φ of a perpendicular triangle if the side opposite to the angle is $\ell = 1\,\mathrm{mm}$ long and the side which is perpendicular to this side has a length of $s = 1\,\mathrm{km}$.

(iii) What is the equivalent resistance R_a and R_b sketched in the following circuit:



Calculate the voltage U_p provided by the battery if it has an internal resistance of $r = \frac{R_1}{10} = \frac{R_2}{10} = \frac{R_3}{10} = \frac{R_4}{10} = 0.1\,\Omega$ and a voltage of $U_0 = 2\,\mathrm{V}$.

(iv) Determine the terminal current I_c through a coil of length $d = 30\,\mathrm{cm}$ with $N_c = 20$ turns and an inner resistance $R_c = 2\,\Omega$, which is connected to a battery of $U_b = 1.5\,\mathrm{V}$ with an internal resistance of $R_b = 1\,\Omega$. How large would be the magnetic field inside the coil?

(v) How is the magnetic field B at a distance $\ell = 20\,\mathrm{cm}$ of a wire connected to the current I_w that is running through it?

(vi) What motion performs an electron with mass m_e and charge e in a magnetic field $\vec{B} = B_z\vec{e}_z$? State the position $\vec{r}(t) = \begin{pmatrix} x(t) \\ y(t) \\ z(t) \end{pmatrix}$ of the electron from its origin at $t = 0\,\mathrm{s}$ where it moves with the velocity v_0 parallel to the x-axis.

(vii) Determine the potential difference $\Delta\phi$ that has to be applied to two parallel plates which are separated by a distance $\ell = 1\,\mathrm{m}$, so that electrons passing through them with velocity $v_e = 10\,\frac{\mathrm{m}}{\mathrm{s}}$ are not deflected, if between them a magnetic field of strength $B = 100\,\mathrm{mT}$ parallel to the plates and perpendicular to the velocity of the electrons is present.

Note:

- Elementary charge: $e = 1.6 \cdot 10^{-19}\,\mathrm{C}$
- Permittivity of free space: $\epsilon_0 = 8.85 \cdot 10^{-12}\,\frac{\mathrm{As}}{\mathrm{Vm}}$
- Permeability of vacuum: $\mu_0 = 1.26 \cdot 10^{-6}\,\frac{\mathrm{Vs}}{\mathrm{Am}}$
- Lorentz force: $\vec{F_L} = q(\vec{E} + \vec{v} \times \vec{B})$