Karlsruhe Institute of Technology - International Department GmbH

Pre-Semester 2010 - Physics Course - Extra Tutorial

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1. Lorentz Force

In a constant magnetic field $\vec{B}$ which points upwards (in y-direction), a point with charge $q > 0$ moves with velocity $\vec{v}$ to the right (along the x-axis) .

(a) In which direction does the Lorentz force $\vec{F}_L$ point?

(b) What is its magnitude F_L?

(c) Suppose you want to compensate the force exerted by $\vec{B}$ via an electric field $\vec{E}$. In which direction does it have to point and what magnitude E should it have?

(d) Calculate F_L and E for $q = 1.6 \cdot 10^{-19}\,\mathrm{C}$, $v = 10^5\,\mathrm{m/s}$, and $B = 100\,\mathrm{mT}$.

2. Two Coils

Consider two coils - a small one inside a larger one - having the same axis. The larger one has length ℓ_1 and consists of N_1 turns. An alternating current $I(t) = I_0 \cos(\omega t)$ is flowing through it.

The smaller coil has N_2 turns, its cross section is A_2. What voltage $U_{\mathrm{ind}}(t)$ is induced between its ends? *Remark:* Assume that no current flows through the small coil and neglect all effects that it may have on the magnetic field produced by the large one.

3. Loop in Magnetic Field

Consider a wire in shape of a rectangle which may rotate around one of its axes. The edges parallel to the rotation axis each have length $\ell = 10\,\mathrm{cm}$, the perpendicular edges each have length $d = 8\,\mathrm{cm}$. The wire carries a current $I = 100\,\mathrm{mA}$. A magnetic field $B = 1\,\mathrm{mT}$ perpendicular to the rectangle's rotation axis is present and exerts a moment of torque of $M = 4 \cdot 10^{-7}\,\mathrm{Nm}$ on the wire. What is the angle α that the rectangle makes with the magnetic field?

4. Rotating Bar-Generator

A conducting bar of length r rotates with angular frequency ω around a pivot P at one end of the bar. The other end of the bar is in slipping contact with a stationary wire in the shape of a circle. Point P and the wire are connected via a resistor R. Thus the bar, the resistor and the wire form a closed conducting loop. The resistance of the bar and the circular wire are negligibly small. There is a uniform magnetic field B everywhere, it is perpendicular to the plane of the paper. What is the induced current in the loop?