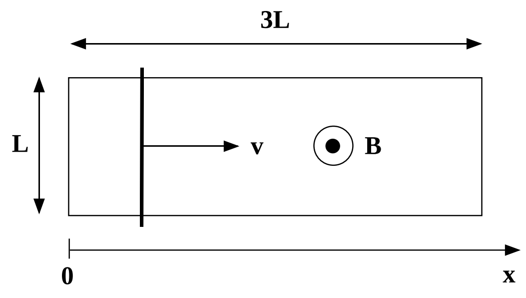
Electrodynamics, spring 2003

Exercise 6 (Thu 6.3., Fri 7.3.)

1. A permanent magnet has a shape of a circular cylinder (length L, radius R). Its axis is along the z-axis so that the origin is at the centre of the magnet. The magnet has a uniform magnetisation $M_0\mathbf{e}_z$. Calculate the z-component of the magnetic field $\mathbf{B}$ along the z-axis both inside and outside of the magnet.
2. The space is divided into two uniform regions by the plane $z = 0$: $z > 0$ (permeability μ_0) and $z < 0$ (permeability μ). Above the plane at the height h there is an infinitely long line current whose amplitude is I. Calculate the magnetic field everywhere. Tip: method of images.
3. A classic electron moves along a circular path (radius $5,3 \cdot 10^{-11}$ m) due to the electrostatic interaction by a proton.
   a) How large is the corresponding current?
   b) How large is the torque on this "current loop" in a magnetic field of 2,0 T?
   c) How large is the magnetic field at the proton due to the circular motion of the electron?
4. Faraday's homopolar generator is a metal disk (radius a) rotating around the axis through the centre of the disk so that the disk is perpendicular to a uniform magnetic field $\mathbf{B}_0$. The angular velocity is a constant ω. A current circuit is made by connecting one end of a wire to the axis and connecting another end to the edge of the disk with a smooth contact (and there is some useful machine in between). The total resistance of this circuit is R. Calculate the current flowing in the circuit.
5. A conducting rod moves with a constant velocity $\mathbf{v}$ along a circuit as shown in the figure. There is a uniform magnetic field $\mathbf{B}$ transverse to the plane of the circuit. Calculate currents in this system when the rod is at $x = L$. All conductors have the same resistance r per unit length. Inductance can be ignored.



Return answers until Tuesday 4.3. at 12 o'clock.