Objectives Magnetism

Topic	Objectives
Basic Phenomena	There are no magnetic monopoles. Explain magnetisation with elementary magnets
Describing Magnetic Fields	Sketch magnetic fields of bar and horseshoe magnet Earth's magnetic field: explain declination and inclination, know Typical value for the horizontal component of the field vector Explain the operational definition of a magnetic field's magnitude
Magnetic Force on a Current (Biot-Savart)	Determine the direction using the right hand rule Calculate forces using Biot-Savart's law Describe important applications (dc motor, loudspeaker, galvanometer)
Force on Charged Particles (Lorentz)	Determine the direction of the force on a moving, charged particle in a magnetic field (left hand for negative particles!) Explain the Hall voltage using a sketch and know its applications Explain how a velocity filter works, know the relation between fields and velocity Calculations with the Lorentz force acting as centripetal force (cyclotron radius and frequency) Explain how the mass of an electron can be measured Explain important applications (mass spectrometer, cyclotron, synchrotron)
Creating Magnetic Fields	Calculate the field near a straight wire, determine its direction Calculate the force between (parallel) currents Sketch the field of a current loop and link it to Ampère's idea of elementary magnets Calculate the magnetic field in a coil and in a solenoid, determine the direction Calculate the magnetic field in a Helmholtz coil Describe two applications of coils (e.g. deflection coil in a TV tube, write/read head in a hard disk drive)
Ampère's Law	Explain in a simple way what a line integral is Apply Ampère's law to simple, symmetric current systems
Magnetic Fields in Matter	Sketch the magnetic field in a massive object (ferro-, para- and diamagnetic materials) Explain the behaviour of para- and diamagnetic materials in an inhomogeneous field Draw and explain a hysteresis Know a positive and a negative example of residual magnetism

Induced emf	Explain the motional emf in a wire Explain the formula for the generator voltage, sketch the ac signal, calculate the amplitude Calculate the emf induced in a loop from the area's rate of change (also for rotation) Realise that a varying magnetic field can also induce an emf Calculate the magnetic flux in simple situations Draw the derivative and the integral of a graph (derive flux from emf and vice versa)
Induced Current	Calculate the induced current in a closed loop State Lenz's law in your own words, realise that it is a direct consequence of energy conservation Determine the direction of an induced current using Lenz's law Qualitatively explain eddy currents Describe two applications of eddy currents

Constant	**Value**
Horizontal component of Earth's magnetic field in Zurich	$B_H = 21\ \mu T$
Mass and charge of an electron	$m_e = 9.1 \cdot 10^{-31}$ kg, $e = 1.6 \cdot 10^{-19}$ C
Permeability of free space	$\mu_o = 4\pi \cdot 10^{-z}$ Vs/Am
magnetic permeabilty of iron (typical value)	$\mu_r = 5'000$