

1. Electrostatics

- (a) What is the electric field E of a point charge Q at a distance r ?
- (b) Write down the electric field E inside a capacitor with parallel plates of area A on which a charge Q is placed.
- (c) In which direction does it point (if the upper plate is positively charged)?
- (d) What would be the field outside?
- (e) State the electric force \vec{F} on a charge q in an electric field \vec{E} .
- (f) How is the electric field E related to the voltage U and the distance d of the plates of a parallel plate capacitor?
- (g) What energy W does a charge q with mass m gain when passing a parallel plate capacitor charged by a voltage U ?
- (h) State the voltage U needed to accelerated the point charge to a speed v after the capacitor if it is emitted from one of its plates with negligible speed.
- (i) What kind of motion does a charge q with mass m if it enters a parallel plate capacitor perpendicular to the electric field E ? Give explicit the $\vec{r}(t)$ and $\vec{v}(t)$ dependence and the geometrical path $y(x)$ for that kind of motion if it enters at the point of origin with velocity v_0 parallel to the plates.
- (j) Write down the absolute value of the velocity v which the charge posses after leaving the capacitor.
- (k) How can the angle α be obtained, describing the direction the charge leaves the capacitor?
- (l) State the voltage U which lies on a capacitor with capacitance C charged by Q .
- (m) How can the dielectric constant ϵ_r of a material be determined if the capacitance C of a parallel plate capacitor with edge length ℓ and distance d between the plates is known where the material is placed between its plates?

2. Electromagnetism

- (a) Explain the content of Maxwell's equations.
- (b) Write down the magnetic field B of a wire through which a current I runs depending to the distance r to it.
- (c) State the magnetic field B inside a coil with length ℓ , base area A and turns N through which runs a current I .
- (d) In which direction does it point (if the current runs anti-clockwise)?

- (e) What would be the magnetic field outside?
- (f) Write down the magnetic part of the Lorentz-Force, i.e. the force of a magnetic field \vec{B} on a charge q , that moves with velocity \vec{v} .
- (g) How can one calculate the force F of a magnetic field B on a wire of length ℓ carrying a current I ?
- (h) What kind of motion describes a point charge q with mass m in homogeneous magnetic field B if its velocity v would be perpendicular to the magnetic field? State its time and length characteristics T , r .
- (i) How would the motion change if the velocity is not perpendicular to the magnetic field?
- (j) Explain the function of a velocity selector.
- (k) State the definition of the magnetic flux Φ .
- (l) What is the induced voltage U of a quadratic frame with edge length ℓ rotating in a homogeneous magnetic field B for an initial maximum value?
- (m) Write down the definition of the self-inductance \mathcal{L} .
- (n) How is the self-inductance \mathcal{L} of a filled coil related to its geometric quantities?
- (o) What kind of energies are converted in a generator, an electric motor and a transformer? State the energy conservation laws in terms of powers for these cases.

3. Circuits

- (a) Explain the content of Kirchhoff rules.
- (b) How is the resistance R of a wire related to its geometric quantities?
- (c) State Ohm's law.
- (d) What is the power P is dissipated in a resistor R if it lies at a voltage U ?
- (e) How can the equivalent resistance R_{tot} of two parallel resistors R_1 and R_2 be calculated?
- (f) What is the equivalent resistance of two serial connected resistors?
- (g) Calculate the current I which would flow between two connected points which lie on the same potential.
- (h) Sketch the $I(t)$ dependence of the opening and closing (discharging and charging) of a $R\mathcal{L}$ circuit.
- (i) How is the charge depending on time if the capacitor in a RC circuit is charged or discharged?
- (j) After what time t posses the current I half its initial value I_0 in the chase of discharging a capacitor in an RC circuit?
- (k) What is period of a $R\mathcal{L}$ -circuit?