German International Abitur*
Physics-Curriculum

*Diploma from German secondary school qualifying for university admission

Semester	Content
11 **1st semester**	**Electric fields and interaction** **Electric field and electric charge** • Electric charge and electric field strength • The uniform electric field and its interaction with punctiform charges ⇒ E = U/d • student's presentation (engl.): electrostatics in the baroque era **Capacitors** • Capacity, charging and discharging capacitors: Q = C · U • Dependency of the capacity of a capacitor from its configuration: ⇒ C = $\varepsilon_0 \cdot \varepsilon_r \cdot \frac{A}{d}$ • Capacitor to store energy: E = ½ C · U^2 • Series an parallel connection of capacitors: ⇒ $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ and $C = C_1 + C_2 + C_3$ **Applications in the uniform electric field** • student's presentation (engl.): Millikans experiment • Electrons in a longitudinal electric field: Accelerating electrons in a Braun • tube (cathode ray tube). • Coulombs law: $F = \frac{1}{4 \cdot \pi \cdot \varepsilon_0} \cdot \frac{Q_1 \cdot Q_2}{r^2}$ • Comparison between electric and gravitational field **Charged particles in fields and electromagnetic induction** • Fields of permanent magnets, of straight conductors (Oersteds experiment), of coils and of the earth • Lorentzforce on conductor carrying a current and on free charged particles (electron and ions): $F_L = B \cdot I \cdot s$ and $F_L = B \cdot q \cdot v$ • Student's presentations (engl.): Hall-effect, Electron microscopes, Particle accelerators.

	• Determination of the specific charge of the electron: e/m (experiment) • Mass spektrograph and Wien-Filter (speed-filter in rectangled electric-and magnetic fields)
11 **2nd semester**	**Electromagnetic induction** • Induction through motion resp. change of area: $(V_{ind} = n \cdot B \cdot d \cdot v = n \cdot B \cdot \dot{A})$ • General law of induction: $V_{ind} = -n \cdot \dot{\Phi} = -(n \cdot B \cdot \dot{A} + n \cdot \dot{B} \cdot A)$) (Faraday) • Lenz´ law (conservation of energy): application eddy currents. • Inductivity of a long coil. self-induction (Lenz): $V_{ind} = -L \cdot \dot{I}$ • How does a generator and a transformer work **Alternating current** • Justification, how the phases of current $I = I(t)$ and Voltage $V = V(t)$ behave, in case of a resistor, a capacitor and a coil(ideal case) • Electric work: $W = \int_0^T P_t \, dt = \frac{1}{2} \cdot \hat{P} \cdot T = \frac{1}{2} \cdot \hat{I} \cdot \hat{U} \cdot T$ • Dependency of the frequency of the AC-resistors: $\boxed{X_c = \frac{1}{\omega \cdot C}} \boxed{X_L = \omega \cdot L}$ • R-L-C in series: impedance $Z = \frac{U_{eff}}{I_{eff}} = \sqrt{R^2 + (X_L - X_C)^2}$ mit $I_{eff} = \frac{U_{eff}}{Z}$ reactance: $X = \omega L - \frac{1}{\omega C}$, $\tan \varphi = \frac{X_L - X_C}{R} = \frac{\omega L - \frac{1}{\omega C}}{R} = \frac{X}{R}$ Mechanical oscillations Simple harmonic motions: definition, requirements, **differential equation and its solution**.: – $k \cdot s_t = m \cdot \ddot{s}_{(t)}$ (diff. eq. with solution: $s_{(t)} = s \cdot \sin \omega t$)
12 **1st semester**	**Resonance:** Connection between exctation-and eigen-frequency, conditions for resonance **Oscillating circuit** • Build-up of a oscillating circuit • Description and explanation of the electrodynamic reasons for the appearance of oscillations, incl. energy • Analogies between the mech. harmonic oscillator and the osc. circuit: $\ddot{Q} = -\frac{1}{C \cdot L} \cdot Q$ (diff. eq.), solution: $Q_{(t)} = \hat{Q} \cdot \sin \omega t$ leads to ⇒Thomsons equation of oscillations $T = 2\pi \sqrt{LC}$

	Waves • Wave as a spatiotemporal periodic process • Velocity of waves • Longitudinal waves, transversal waves: characteristics • standing waves • Student's presentation: Resonance and Kundt's tube (engl.). • Student's presentation: Huygens' priciple (engl.), • Interference in water-and light-waves **Quantum physics** • The photoelectric effect ⇒ dualism of wave and particle*. • Einsteins equation: E = h·f (h: Planck constant) • Interference: single slit and grid • Double-slit experiment with **single** photons and single particles (de Broglie-wavelength) ⇒ quantumobjects*
12 **2nd semester**	**Quantum physics of the atomic shell** • Experiments of Rutherford and Franck-Hertz • Line spectrum of the H-atom **Nuclear physics** • Radioactive decay (α, β, γ), inkl. excited atomic daughter-cores (γ-rays: quantum physics of the atomic core), neutrinos, 4 natural radioactive series • Fisson and fusion of atomic cores • Mass defect (incl. Einsteins formula: $E = \Delta m \cdot c^2$) and binding energie ⇒calculating of the released energy: fission-and fusion • Nuclear reactions and applications (Ra-Be-source for neutrons) • Radiation protection

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