Objectives Electrostatics

Topic	Objectives
Electric charges (18.1, 18.2, Basic Phenomena)	Know examples of positive and negative charge
	Know different methods how to detect charges
	Describe how magnitude and sign of a charge can be measured (electroscope, neon bulb)
	Know the magnitude of the elementary charge and of typical charges in everyday situations
	Explain what a charge carrier is
	Explain the "creation" of charges using the concept of charge separation and conservation (e.g. Van-de-Graaff generator)
Conductors and Insulators (18.3, 18.8)	Describe charge distribution in conductors and insulators
	Explain what a Faraday cage is (electric shielding)
	Know typical examples of conductors and insulators
Induction (18.4)	Explain the term "electric induction"
	Explain induction with permanent or spontaneous dipoles
Coulomb's Law (18.5)	Calculate forces between point charges (magnitude and direction)
	Realise analogies with gravitational force
Electric field (18.6, 18.7)	Explain term "electric field"
	Distinguish charges producing a field and test charges in a field
	Sketch field lines for a given arrangement of charges
	Explain what a homogeneous field is and how it can be realised
	Calculations with homogeneous field or field of point charges
	Describe a method to determine the elementary charge
	Determine superposition of electric fields (graphically and/or algebraically)
Gauss' Law (18.9)	Explain term „electric flux" in words and/or with a sketch
	Calculate flux through a surface for simple situation
	Determine magnitude of electric field for a simple, symmetric charge distribution using Gauss' law (e.g. straight wire)
	Calculate magnitude of electric field on the surface of conductor from charge density (e.g. charged plate)

Potential and potential difference (19.1, 19.2, 19.3, 19.4)	Calculate work in a homogeneous field
	Explain the terms “electric potential energy“, “electric potential“, “potential difference“ and “voltage“
	Sketch equipotential surfaces for a given charge distribution
	Calculate potential difference between two points in a homogeneous electric field or in the field of point charges
	Describe the trajectory of a charged particle in a homogeneous field
	Describe Cathode Ray Tube (CRT) and Cathode Ray Oscilloscope (CRO)
	Match deflection voltages and CRO graph
	Calculations with conservation of energy in an electric field
	Calculate velocity from acceleration voltage
	Use energy unit eV
Capacitor (19.5)	Calculate charge on capacitor plates from capacitance and voltage
	Describe two different types of capacitors
	Calculate capacitance of a parallel plate capacitor
	Know typical values for capacitance
	Describe two applications of capacitors
	Know relation between permittivity of free space and Coulomb’s constant
	Explain dielectric constant with polarisation in dielectrics
	Calculate energy stored in a capacitor (any combination of capacity, charge and voltage)
	Calculate energy density from magnitude of electric field

Constant	Value
Elementary charge	$e = 1.6 \times 10^{-19}\,\mathrm{C}$
Electron mass	$m_e = 9.1 \times 10^{-31}\,\mathrm{kg} = 511\,\mathrm{keV/c^2}$
Nucleon mass	$m_p \approx m_n = 1.67 \times 10^{-27}\,\mathrm{kg} = 939\,\mathrm{MeV/c^2}$
Coulomb’s constant	$k = 9.0 \times 10^{9}\,\mathrm{N{\cdot}m^2/C^2}$
Permittivity of free space	$\varepsilon_0 = \dfrac{1}{4\pi k} = 8.854 \times 10^{-12}\,\mathrm{As/Vm}$

Property	Table in „Formeln, Tabellen, Begriffe“
Properties of electrons and nucleons	cover (inside page 1)
Conversion of mass/energy units	p 186
Dielectric constant	p 195 ($\kappa \mathrel{\hat{=}} \varepsilon_r$)