Physics Syllabus

The syllabus has been prepared on the basis of attainment standards for the Matura Exam (standard level). The Matura Exam is obligatory for all graduates of general secondary schools and specialized secondary schools in Poland. This exam is also the basis for entry into universities and colleges of further education.

Scalars and Vectors

- Distinction between scalar and vector quantities
- Addition and subtractions of vectors
- Multiplication and division of vectors by scalars
- Decomposition of vectors into parallel and perpendicular components along chosen axes

Motion

- Kinematic concepts (displacement, distance, trajectory, velocity, speed, acceleration)
- Frames of reference
- Instantaneous and average values of speed, velocity and acceleration
- Relative motion (relative velocity, relative acceleration)
- Uniform motion in a straight line
- Uniformly accelerated motion in a straight line
- Uniform circular motion (centripetal acceleration)
- Harmonic motion (simple harmonic oscillator)
  - Models: mass on a spring, simple pendulum
  - Period and frequency of harmonic oscillations
- Graphical representation of motion
- Elements of relativistic mechanics (speed of light, time dilation, length contraction, relativistic mass, momentum and energy)

Forces and dynamics

- Newton's laws of motion
  - Newton's first law
    - translational equilibrium
    - inertial reference frames
  - Newton's second law (momentum and impulse)
  - Newton's third law
- Law of conservation of linear momentum (isolated system, inertial frame)
  - Inelastic collisions
  - Rockets (reaction engine)
- Fictitious forces, analysis of motion in noninertial reference frames
- Dry friction
  - Static friction
  - Kinetic friction
- Force due to air resistance (terminal velocity)

Fundamental interactions (gravitation, electromagnetic, strong interaction, week interaction)

- Elementary particles (bosons, fermions: leptons, quarks (hadrons))
- Gravitational field
  - Newton's law of universal gravitation
  - Visualization of gravitational field - gravitational field lines
  - First and second cosmic velocities
  - Weightlessness and overload
  - Vertical free fall, vertical throw and horizontal throw near the Earth's surface
- Electric field
  - Electric charge and Coulomb's law
  - Visualization of static electric field - electrostatic field lines
  - Motion of charged particles in static electric field
- Magnetic field
  - Visualization of magnetic field - magnetic field lines
  - Magnetic field around a cylindrical current-carrying conductor
  - Magnetic field in a solenoid
  - Motion of charged particles in static magnetic field (Lorentz force)
- Electromagnetic waves (properties, spectrum)
- Strong interaction, week interaction

Matter properties

- Atomic structure and physical properties of matter
  - Solid phase
    - Amorphous body
    - Cristal body
    - Thermal expansion of a solid body
  - Liquid phase
    - Internal structure of liquids
    - Models of water structure
    - Surface tension, meniscus
  - Gaseous phase
- Electric properties of matter
  - Electric conductors (metals)
    - Electrical conductivity of metals as a function of temperature
  - Insulators
  - Semiconductors
- Magnetic properties of matter
  - Diamagnetic materials
  - Paramagnetic materials
  - Ferromagnetic materials

Order and chaos in nature

- Kinetic model of an ideal gas
- The ideal gas equation
  - Boyle's law (T=const isothermal process)

- Charles' law (p=const; changes of thermal energy and work done by a gas in isobaric process)
- Gay-Lussac's law (V=const; changes of thermal energy in isochoric process)
- First law of thermodynamics (practical calculations/usage/application)
- Entropy and Second Law of Thermodynamics (formulate the law and resulting conclusions only)
- Heat engines
  - The Carnot engine
  - Efficiency of thermodynamic engines
  - Reversible/irreversible process (examples)

Optics

- The nature of light
  - Speed of light
  - Relation of speed, frequency and wavelength
  - Visible light spectrum
- Reflection of light
  - Reflection in a plane and in a curved mirror (mirror equation)
  - Constructing images formed by mirrors (type of image, magnification)
- Refraction of light
  - Refractive index
  - Snell's law
  - Dispersion due to a prism
  - Critical angle and total internal reflection
  - Lenses
    - Types of lenses
    - Focus, focal length, optical power, magnification
    - Image formation
    - Thin lens equation
    - Optical power of a thin lens (lens maker's formula)
  - Optical instruments
    - Microscope
    - Telescope
    - Aberrations
- Diffraction
  - Diffraction grating
- Interference
  - Interference from two point source
  - Young's double slit experiment
- Polarization and polarizer
  - Absorptive polarizer
  - Beam-splitting polarizer
    - Polarization by reflection (Brewster angle)
    - Birefringent polarizer
- External photoelectric effect (photoelectric cell)
- Bohr's model of the hydrogen atom
  - Atomic energy states
  - Emission spectrum (frequencies, wavelengths)

Absorption and emission spectra – application of spectrum analysis
Laser – design and practical application
The eye and sight
    Myopia (nearsightedness) and hyperopia (farsightedness)
    Correction of vision defects

Energy transport and transformation

Work, energy and power
Kinetic energy
Potential energy
    Gravitational potential energy
    Elastic potential energy
Transformation of energy in harmonic motion
Mechanical resonance
The Principle of Energy Conservation
The Equivalence of Mass and Energy ($E=mc^2$)
Nuclear fission
    Nuclear structure
        Mass number, atomic number
        Nuclear energy levels
Isotope, nucleon
Uranium-235 chain reaction
Nuclear mass defect, nuclear binding energy
Radioactive decay law
Half-live of nuclear decay
Nuclear radiation (α particles, β particles, γ radiation) applications
Description of energy transport in wave movement
Description of thermal energy transfer
    convection
    conduction
    radiation

Structure and evolution of Universe

Analysis of thermonuclear fusion in stars
Solar System – sizes and distances between astronomic objects
Planet movement – Kepler's laws
Star evolution, H-R diagram
The Big-Bang Model

Unity of micro-world and macro-world

De Broglie's hypothesis – a matter wave
Experimental confirmation of de Broglie hypothesis
Wave–particle duality
Heisenberg uncertainty principle