Curriculum overview for Physics SL
School year 2023/24 **Teacher: Zuzana Ješková**

Unit title	Content	Objectives/ Learning outcomes	Assessment tasks
YEAR 1 (125 classes)			
Measurement and uncertainties: 6 classes			
Measurement in physics 2 classes	Quantities and units Fundamental and derived units Scientific notation and metric multipliers Significant figures Orders of magnitude Estimation	• Using SI units in the correct format for all required measurements, final answers to calculations and presentation of raw and processed data • Using scientific notation and metric multipliers • Quoting and comparing ratios, values and approximations to the nearest order of magnitude • Estimating quantities to an appropriate number of significant figures	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations: **Determination of the volume of an object** Report on practical investigation End-of-unit tests
Uncertainties and errors 2 classes	Random and systematic errors Absolute, fractional and percentage uncertainties Error bars Uncertainty of gradient and intercepts	• Explaining how random and systematic errors can be identified and reduced • Collecting data that include absolute and/or fractional uncertainties and stating these as an uncertainty range (expressed as: best estimate ± uncertainty range) • Propagating uncertainties through calculations involving addition, subtraction, multiplication, division and raising to a power • Determining the uncertainty in gradients and intercepts	
Vectors and scalars 2 classes	Vector and scalar quantities Combination and resolution of vectors	• Solving vector problems graphically and algebraically	
Space, time and motion: 36 classes			
Kinematics 12 classes	Distance and displacement Speed and velocity Acceleration Graphs describing motion Equations of motion for uniform acceleration Projectile motion Fluid resistance and terminal speed	• Determining instantaneous and average values for velocity, speed and acceleration • Solving problems using equations of motion for uniform acceleration • Sketching and interpreting motion graphs • Determining the acceleration of free-fall experimentally • Analysing projectile motion, including the resolution of vertical and horizontal components of acceleration, velocity and displacement	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations:

		• Qualitatively describing the effect of fluid resistance on falling objects or projectiles, including reaching terminal speed	**What force is acting on a baseball? (Newton´s second law of motion)** **What does the friction depend on? (friction, coefficient of friction)** **How does a ball fall? (free fall, law of mechanical energy conservation)** **How does a bicycle wheel turn? (circular motion, period, frequency, angular speed)** **How much work is done by a weightlifter? (work, power)** Reports on practical investigation End-of-unit tests
Forces and momentum 13 classes	Objects as point particles Forces as interactions between bodies Free-body diagrams Newton's laws of motion Contact forces: normal force, surface frictional force, tension, elastic force, drag force, buoyancy Field forces: gravitational, electric, magnetic Linear momentum, impulse Newton's second law expressed in terms of rate of change of momentum Impulse and force–time graphs Conservation of linear momentum Elastic collisions, inelastic collisions and explosions Energy in collisions Circular motion Period, frequency, angular displacement and angular velocity Centripetal force Centripetal acceleration	• Representing forces as vectors • Sketching and interpreting free-body diagrams • Describing the consequences of Newton's first law for translational equilibrium • Using Newton's second law quantitatively and qualitatively • Identifying force pairs in the context of Newton's third law • Solving problems involving forces and determining resultant force • Describing different contact forces, solid friction (static and dynamic) by coefficients of friction • Describing field forces • Applying conservation of momentum in simple isolated systems including (but not limited to) collisions, explosions, or water jets • Using Newton's second law quantitatively and qualitatively in cases where mass is not constant • Sketching and interpreting force–time graphs • Determining impulse in various contexts including (but not limited to) car safety and sports • Qualitatively and quantitatively comparing situations involving elastic collisions, inelastic collisions and explosions • Identifying the forces providing the centripetal forces such as tension, friction, gravitational, electrical, or magnetic • Solving problems involving centripetal force, centripetal acceleration, period, frequency, angular displacement, linear speed and angular velocity • Qualitatively and quantitatively describing examples of circular motion including cases of vertical and horizontal circular motion	
Work, energy and power 11 classes	Kinetic energy Gravitational potential energy Elastic potential energy	• Discussing the conservation of total energy within energy transformations	

	Work done as energy transfer Power as rate of energy transfer Principle of conservation of energy Efficiency	• Sketching and interpreting force–distance graphs Determining work done including cases where a resistive force acts • Solving problems involving power • Quantitatively describing efficiency in energy transfers	
Fields: 7 classes			
Gravitational fields 7 classes	Kepler´s three laws of orbital motion Newton’s law of gravitation Gravitational field strength Gravitational field lines	• Understanding Kepler´s laws of orbital motion • Describing the relationship between gravitational force and centripetal force • Applying Newton’s law of gravitation to the motion of an object in circular orbit around a point mass • Solving problems involving gravitational force, gravitational field strength, orbital speed and orbital period • Determining the resultant gravitational field strength due to two bodies	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Reports on practical investigation End-of-unit tests
The particulate nature of matter: 24 classes			
Thermal energy transfers 8 classes	Molecular theory of solids, liquids and gases Temperature and absolute temperature Internal energy Specific heat capacity Phase change Specific latent heat Mechanism of thermal energy transfer Quantitative description of rate of thermal energy transfer by conduction Qualitative description of rate of thermal energy transfer by convection Apparent brightness Luminosity Emission spectrum, Wien´s displacement law	• Describing temperature change in terms of internal energy • Using Kelvin and Celsius temperature scales and converting between them • Applying the calorimetric techniques of specific heat capacity or specific latent heat experimentally • Describing phase change in terms of molecular behaviour • Sketching and interpreting phase change graphs • Calculating energy changes involving specific heat capacity and specific latent heat of fusion and vaporization • Sketching and interpreting graphs showing the variation of intensity with wavelength for bodies emitting thermal radiation at different temperatures • Solving problems involving the Stefan–Boltzmann law and Wien’s displacement law	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations: **How is a metal heated? (specific heat capacity)** **How does a gas behave? (gas laws)** Reports on practical investigation End-of-unit tests
Greenhouse effect 8 classes	the conservation of energy emissivity, albedo radiative power main greenhouse gases absorption of infrared radiation resonance model and molecular energy levels	• Describing the effects of the Earth’s atmosphere on the mean surface temperature • Solving problems involving albedo, emissivity, solar constant and the Earth’s	

Gas laws 8 classes	Pressure Equation of state for an ideal gas Kinetic model of an ideal gas Mole, molar mass and the Avogadro constant Pressure related to the average translational speed of molecules internal energy Differences between real and ideal gases	• Solving problems using the equation of state for an ideal gas and gas laws • Sketching and interpreting changes of state of an ideal gas on pressure–volume, pressure–temperature and volume–temperature diagrams • Investigating at least one gas law experimentally	
Wave behaviour: 23 classes			
Simple harmonic motion 4 classes	Simple harmonic oscillations Time period, frequency, amplitude, displacement and phase difference Conditions for simple harmonic motion Time period for mass-spring system Time period for simple pendulum	• Qualitatively describing the energy changes taking place during one cycle of an oscillation • Sketching and interpreting graphs of simple harmonic motion examples	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations: **How does a weight on a spring oscillate? (simple harmonic motion, period, frequency, energy changes)** **What do sounds look like? (pitch and timber)** **How loud is too loud? (intensity and loudness)** **What is the speed of sound?** **What is the index of refraction?** Reports on practical investigation End-of-unit tests
Wave model 4 classes	Travelling waves Wavelength, frequency, period and wave speed Transverse and longitudinal waves The nature of electromagnetic waves The nature of sound waves The differences between mechanical waves and electromagnetic waves	• Explaining the motion of particles of a medium when a wave passes through it for both transverse and longitudinal cases • Sketching and interpreting displacement–distance graphs and displacement– time graphs for transverse and longitudinal waves • Solving problems involving wave speed, frequency and wavelength • Investigating the speed of sound experimentally • Identify differences between mechanical and electromagnetic waves	
Wave phenomena 7 classes	Wavefronts and rays Reflection and refraction Snell's law, critical angle and total internal reflection Superposition superposition of waves and wave pulses double-source interference from coherent sources the condition for constructive interference as given by path difference the condition for destructive interference as given by path difference Young's double-slit interference	• Sketching and interpreting diagrams involving wavefronts and rays • Sketching and interpreting the superposition of pulses and waves • Sketching and interpreting incident, reflected and transmitted waves at boundaries between media • Solving problems involving reflection at a plane interface • Solving problems involving Snell's law, critical angle and total internal reflection • Determining refractive index experimentally	

		• Quantitatively describing double-slit interference intensity patterns	
Standing waves and resonance 5 classes	the nature and formation of standing waves in terms of superposition of two identical waves travelling in opposite directions nodes and antinodes, relative amplitude and phase difference of points along a standing wave standing waves patterns in strings and pipes the nature of resonance including natural frequency and amplitude of oscillation based on driving frequency the effect of damping on the maximum amplitude and resonant frequency of oscillation the effects of light, critical and heavy damping on the system.	• Understanding of formation of standing waves in terms of superposition of two identical waves travelling in opposite directions • Describing standing waves in open and closed pipes • Describing standing waves in strings, including two fixed boundaries, one fixed and one free boundary, and two free boundaries. • describing vibration modes of air in pipes in terms of displacement nodes and antinodes • determination of the wavelength and the frequency of the first harmonic and nth harmonic given the length of the string or pipe and the speed of the wave • qualitative analysis of the impact of damping on the frequency response of a driven oscillator. • Understanding of the useful and destructive effects of resonance	
Doppler effect 3 classes	the nature of the Doppler effect for sound waves and electromagnetic waves the representation of the Doppler effect in terms of wavefront diagrams when either the source or the observer is moving the relative change in frequency or wavelength observed for a light wave due to the Doppler effect where the speed of light is much larger than the relative speed between the source and the observer shifts in spectral lines - information about the motion of bodies like stars and galaxies in space.	• Sketching and interpreting the Doppler effect when there is relative motion between source and observer • Describing situations where the Doppler effect can be utilized • Solving problems involving the change in frequency or wavelength observed due to the Doppler effect to determine the velocity of the source/observer	
Experimental programme 16 classes	Practical activities included in the above mentioned topics (examples of practical investigations in the assessment tasks column)		
Collaborative sciences project 13 classes			
YEAR 2 (90 classes)			
The particular nature of matter: 9 classes			

Current and circuits 9 classes	Cells as source of emf Chemical and solar cells Circuit diagrams Direct current Electric potential difference Conductors and insulators Electric resistance Resistivity Ohm´s law Ohmic and non-ohmic behaviour of conductors Heating effect of resistors Electric power Combination of resistors in series and in parallel	• Describing chemical and solar cells • Understanding Ohm´s law for a closed circuit • Measuring internal resistance of a cell • Drawing and interpreting circuit diagrams • Identifying ohmic and non-ohmic conductors through a consideration of the V/I characteristic graph • Solving problems involving potential difference, current, charge, power, resistance and resistivity • Investigating combinations of resistors in parallel and series circuits • Describing ideal and non-ideal ammeters and voltmeters • Describing practical uses of potential divider circuits, including the advantages of a potential divider over a series resistor in controlling a simple circuit • Investigating one or more of the factors that affect resistance experimentally	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations: **How does resistor (bulb, thermistor, LED) behave in electric circuit? (resistivity, Ohm´s law)** **What are the properties of an electric cell? (electromotive force, internal resistance)** Reports on practical investigation End-of-unit tests
Fields: 23 classes			
Electric and magnetic fields 13 classes	Electric charge Forces between the two types of electric charge Coulomb's law the conservation of electric charge Millikan's experiment Transfer of electric charge through friction, electrostatic induction and by contact Electric field, Electric field strength, Electric field lines Field line density and field strength Uniform electric field Work done in electric field Electric potential Magnetic field, Magnetic field lines	• Identifying two forms of charge and the direction of the forces between them • Describing electric field around a point charge, inside and outside a spherical charged conductor, around two point charges and around two oppositely charged parallel plates, including edge effects and draw electric field lines for these electric fields • Solving problems involving electric fields and Coulomb's law • Representing sources of charge, lines of electric force, and field patterns using an appropriate symbolism • Understanding the concept of electric potential and zero level of electric potential • Mapping electric field using potential	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) End-of-unit tests

		• Describing the connection between equipotential surfaces and field lines • Drawing equipotential lines for electric field of a point charge, a collection of up to four point charges, inside and outside a solid charged conducting sphere, inside and outside a hollow charged conducting sphere, between two oppositely charged parallel plates. • Sketching and interpretation of magnetic field lines • Determination of the direction of the magnetic field based in the current direction in a current-carrying straight wire • Representing magnetic field with magnetic field lines around bar magnet, current carrying straight wire, circular coil, air-core solenoid	
Motion in electromagnetic fields 10 classes	the motion of a charged particle in a uniform electric field or in a uniform magnetic field the magnitude and direction of the force on a charge moving in a magnetic field the magnitude and direction of the force on a current-carrying conductor in a magnetic field the force per unit length between parallel wires	• Determining the direction of force on a charge moving in a magnetic field • Determining the direction of force on a current-carrying conductor in a magnetic field • Solving problems involving magnetic forces, fields, current and charges • Solving problems involving motion of charge particle in magnetic and electric fields • Solving problems involving current-carrying conductor in a magnetic field • Solving problems involving interaction between two paralel current-carrying conductors	
Nuclear and quantum physics: 31 classes			
Structure of the atom 9 classes	the Geiger–Marsden–Rutherford experiment and the discovery of the nucleus nuclear notation emission and absorption spectra, discrete atomic energy levels photons, frequency of the photon released during an atomic transition	• Describing the Rutherford-Geiger-Marsden experiment that led to the discovery of the nucleus • Describing the emission and absorption spectrum of common gases • Solving problems involving atomic spectra, including calculating the wavelength of photons emitted during atomic transitions	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations:

Radioactive decay 9 classes	isotopes nuclear binding energy and mass defect the variation of the binding energy per nucleon with nucleon number the mass-energy equivalence as given by $E=mc^2$ in nuclear reactions the existence of the strong nuclear force, a short-range, attractive force between nucleons the random and spontaneous nature of radioactive decay the changes in the state of the nucleus following alpha, beta and gamma radioactive decay the radioactive decay equations involving α, β−, β+, γ the existence of neutrinos ν and antineutrinos the penetration and ionizing ability of alpha particles, beta particles and gamma rays the activity, count rate and half-life in radioactive decay the changes in activity and count rate during radioactive decay using integer values of half-life the effect of background radiation on count rate.	• Completing decay equations for alpha and beta decay • Determining the half-life of a nuclide from a decay curve • Investigating half-life experimentally (or by simulation) • Describing the Rutherford-Geiger-Marsden experiment that led to the discovery of the nucleus • Applying conservation laws in particle reactions • Solving problems involving the energy released in radioactive decay	**Modelling radioactive decay by simulation or experimentally using dice** Reports on practical investigation End-of-unit tests
Fission 5 classes	The unified atomic mass unit Mass defect and nuclear binding energy energy released in spontaneous and neutron-induced fission chain reactions in nuclear fission reactions nuclear power plant properties of the products of nuclear fission and their management	• Solving problems involving mass defect and binding energy • Solving problems involving the energy released nuclear fission • Sketching and interpreting the general shape of the curve of average binding energy per nucleon against nucleon number	
Fusion and stars 8 classes	stability of stars fusion as a source of energy in stars conditions leading to fusion in stars in terms of density and temperature effect of stellar mass on the evolution of a star the main regions of the Hertzsprung–Russell (HR) diagram and main properties of stars in these regions	• Solving problems involving the energy released in nuclear fusion • Solving problems on conversion between astronomical units (AU), light years (ly) and parsecs (pc) • sketching and interpretation of HR diagrams, including the location of main sequence stars, red giants, super giants, white dwarfs, the instability strip and lines of constant radius	

	stellar parallax as a method to determine the distance d to celestial bodies stellar radii	• understanding diagrams with luminosity on the vertical axis and temperature on the horizontal axis • determination of surface temperature and composition of a star from the stellar spectrum • determination of stellar radii using luminosity and surface temperature	
Experimental programme 11 classes	Practical activities included in the above mentioned topics (examples of practical investigations in the assessment tasks column)		
Scientific investigation 13 classes			