Curriculum overview for Physics SL and HL (Physics at HL is studied in greater depth and breadth than at SL)
school year 2023/24 **Teacher: Zuzana Ješková**

Unit title	Content	Objectives/ Learning outcomes	Assessment tasks
YEAR 1			
Measurement and uncertainties (CORE) SL: 6 classes, HL: 8 classes			
Measurement in physics	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	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	Vector and scalar quantities Combination and resolution of vectors	• Solving vector problems graphically and algebraically	
Mechanics (CORE) SL: 29 classes, HL: 33 classes			
Motion	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 • Qualitatively describing the effect of fluid resistance on falling objects or projectiles, including reaching terminal speed	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations: What force is acting on a baseball? (Newton´s second law of motion) What does the friction depend
Forces	Objects as point particles Free-body diagrams Translational equilibrium Newton’s laws of motion	• Representing forces as vectors Sketching and interpreting free-body diagrams • Describing the consequences of Newton’s first law for translational	

	Solid friction	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 solid friction (static and dynamic) by coefficients of friction	on? (friction, coefficient of friction) How does a ball fall? (free fall, law of mechanical energy conservation) How much work is done by a weightlifter? (work, power) Reports on practical investigation End-of-unit tests
Work, energy and power	Kinetic energy Gravitational potential energy Elastic potential energy Work done as energy transfer Power as rate of energy transfer Principle of conservation of energy Efficiency	• Discussing the conservation of total energy within energy transformations • 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	
Momentum and 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	• 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	
Circular motion and gravity (CORE) SL: 6 classes, HL: 8 classes			
Circular motion	Period, frequency, angular displacement and angular velocity Centripetal force Centripetal acceleration	• 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	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations: How does a bicycle wheel turn? (circular motion, period, frequency, angular speed) Reports on practical investigation End-of-unit tests
Newton´ s law of gravitation	Newton’s law of gravitation Gravitational field strength	• 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	

Thermal physics (CORE) SL: 15 classes, HL: 18 classes			
Temperature and energy changes	Molecular theory of solids, liquids and gases Temperature and absolute temperature Internal energy Specific heat capacity Phase change Specific latent heat	• 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	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
Modelling a gas	Pressure Equation of state for an ideal gas Kinetic model of an ideal gas Mole, molar mass and the Avogadro constant 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	
Engineering physics (OPTION) SL: 23 classes, HL: 33 classes			
Rigid bodies and rotational dynamics	Torque Moment of inertia Rotational and translational equilibrium Angular acceleration Equations of rotational motion for uniform angular acceleration Newton's second law applied to angular motion Conservation of angular momentum	• Calculating torque for single forces and couples • Solving problems involving moment of inertia, torque and angular acceleration • Solving problems in which objects are in both rotational and translational equilibrium	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations: Investigation of rotational equilibrium by simulation or experimentally (torque) How does parachute jumper fall (air resistance, terminal velocity) - computer modelling Motion of rocket - computer
Thermodynamics	The first law of thermodynamics The second law of thermodynamics Entropy Cyclic processes and pV diagrams Isovolumetric, isobaric, isothermal and adiabatic processes Carnot cycle Thermal efficiency	• Describing the first law of thermodynamics as a statement of conservation of energy • Explaining sign convention used when stating the first law of thermodynamics as Q=DU+W • Solving problems involving the first law of thermodynamics Describing the second law of thermodynamics in Clausius form, Kelvin form and as a consequence of entropy • Describing examples of processes in terms of entropy change • Solving problems involving entropy changes • Sketching and interpreting cyclic processes	

		• Solving problems for adiabatic processes for monatomic gases using pV5/3 = constant • Solving problems involving thermal efficiency	modelling Reports on practical investigation End-of-unit tests
Fluids and fluid dynamics (AHL)	Density and pressure Buoyancy and Archimedes' principle Pascal's principle Hydrostatic equilibrium The ideal fluid Streamlines The continuity equation The Bernoulli equation and the Bernoulli effect Stokes' law and viscosity Laminar and turbulent flow and the Reynolds number	• Determining buoyancy forces using Archimedes' principle • Solving problems involving pressure, density and Pascal's principle • Solving problems using the Bernoulli equation and the continuity equation • Explaining situations involving the Bernoulli effect • Describing the frictional drag force exerted on small spherical objects in laminar fluid flow • Solving problems involving Stokes' law • Determining the Reynolds number in simple situations	
Forced vibrations and resonance (AHL)	Natural frequency of vibration Q factor and damping Periodic stimulus and the driving frequency Resonance	• Qualitatively and quantitatively describing examples of under-, over- and critically- damped oscillations • Graphically describing the variation of the amplitude of vibration with driving • frequency of an object close to its natural frequency of vibration • Describing the phase relationship between driving frequency and forced oscillations • Solving problems involving Q factor • Describing the useful and destructive effects of resonance	
Oscillations and waves (CORE)			
Oscillations	Simple harmonic oscillations Time period, frequency, amplitude, displacement and phase difference Conditions for simple harmonic motion	• 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
Travelling waves	Travelling waves Wavelength, frequency, period and wave speed Transverse and longitudinal waves The nature of electromagnetic waves The nature of sound 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	
Wave characteristics	Wavefronts and rays Amplitude and intensity Superposition Polarization	• Sketching and interpreting diagrams involving wavefronts and rays • Solving problems involving amplitude, intensity and the inverse square law • Sketching and interpreting the superposition of pulses and waves	

		• Describing methods of polarization • Sketching and interpreting diagrams illustrating polarized, reflected and transmitted beams • Solving problems involving Malus's law	and timber) How loud is too loud? (intensity and loudness) What is the speed of sound? Reports on practical investigation End-of-unit tests
Wave behaviour	Reflection and refraction Snell's law, critical angle and total internal reflection Diffraction through a single-slit and around objects Interference patterns Double-slit interference Path difference	• 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 • Qualitatively describing the diffraction pattern formed when plane waves are incident normally on a single-slit • Quantitatively describing double-slit interference intensity patterns	
Standing waves	The nature of standing waves Boundary conditions Nodes and antinodes	• Describing the nature and formation of standing waves in terms of superposition • Distinguishing between standing and travelling waves • Observing, sketching and interpreting standing wave patterns in strings and pipes • Solving problems involving the frequency of a harmonic, length of the standing wave and the speed of the wave	
Wave phenomena (AHL) – HL only, HL: 8 classes			
Simple harmonic motion	The defining equation of SHM Energy changes	• Solving problems involving acceleration, velocity and displacement during simple harmonic motion, both graphically and algebraically • Describing the interchange of kinetic and potential energy during simple harmonic motion • Solving problems involving energy transfer during simple harmonic motion, both graphically and algebraically	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations: What is the index of refraction? Reports on practical investigation End-of-unit tests
Single-slit diffraction	The nature of single-slit diffraction	• Describing the effect of slit width on the diffraction pattern • Determining the position of first interference minimum • Qualitatively describing single-slit diffraction patterns produced from white light and from a range of monochromatic light frequencies	
Interference	Young's double-slit experiment Modulation of two-slit interference pattern by one-slit diffraction effect Multiple slit and diffraction grating interference patterns	• Qualitatively describing two-slit interference patterns, including modulation by one-slit diffraction effect • Investigating Young's double-slit experimentally • Sketching and interpreting intensity graphs of double-slit interference patterns	

	Thin film interference	• Solving problems involving the diffraction grating equation • Describing conditions necessary for constructive and destructive interference from thin films, including phase change at interface and effect of refractive index • Solving problems involving interference from thin films	
Resolution	The size of a diffracting aperture The resolution of simple monochromatic two-source systems	• Solving problems involving the Rayleigh criterion for light emitted by two sources diffracted at a single slit • Resolvance of diffraction gratings	
The Doppler effect	The Doppler effect for sound waves and light waves	• 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	
YEAR 2			
Electricity and magnetism (CORE) SL: 20 classes, HL: 20 classes			
Electric fields	Charge Electric field Coulomb’s law Electric current Direct current (dc) Potential difference	• Identifying two forms of charge and the direction of the forces between them • Solving problems involving electric fields and Coulomb’s law • Calculating work done in an electric field in both joules and electronvolts Identifying sign and nature of charge carriers in a metal • Identifying drift speed of charge carriers Solving problems using the drift speed equation • Solving problems involving current, potential difference and charge	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
Heating effect of an electric current	Circuit diagrams Kirchhoff’s circuit laws Heating effect of current and its consequences Resistance expressed as R = V/I Ohm’s law Resistivity Power dissipation	• 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, Kirchhoff’s circuit laws, 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	

Electric cells	Cells Internal resistance Secondary cells Terminal potential difference Emf	• Investigating practical electric cells (both primary and secondary) • Describing the discharge characteristic of a simple cell (variation of terminal potential difference with time) • Identifying the direction of current flow required to recharge a cell • Determining internal resistance experimentally • Solving problems involving emf, internal resistance and other electrical quantities	
Magnetic effects of electric currents	Magnetic fields Magnetic forces	• 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 • Sketching and interpreting magnetic field patterns • Determining the direction of the magnetic field based on current direction • Solving problems involving magnetic forces, fields, current and charges	
Fields (AHL) SL: 5 classes, HL: 13 classes			
Describing fields	Gravitational fields Electrostatic fields Electric potential and gravitational potential Field lines Equipotential surfaces	• Representing sources of mass and charge, lines of electric and gravitational force, and field patterns using an appropriate symbolism • Mapping fields using potential • Describing the connection between equipotential surfaces and field lines	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) End-of-unit tests
Fields at work	Potential and potential energy Potential gradient Potential difference Escape speed Orbital motion, orbital speed and orbital energy Forces and inverse-square law behaviour	• Determining the potential energy of a point mass and the potential energy of a point charge • Solving problems involving potential energy • Determining the potential inside a charged sphere • Solving problems involving the speed required for an object to go into orbit around a planet and for an object to escape the gravitational field of a planet • Solving problems involving orbital energy of charged particles in circular orbital motion and masses in circular orbital motion • Solving problems involving forces on charges and masses in radial and uniform fields	
Electromagnetic Induction (AHL) SL: 10 classes, HL: 20 classes			
Electromagnetic induction	Emf Magnetic flux and magnetic flux linkage	• Describing the production of an induced emf by a changing magnetic flux and within a uniform magnetic field	Quizzes Problem solving

	Faraday’s law of induction Lenz’s law	• Solving problems involving magnetic flux, magnetic flux linkage and Faraday’s law • Explaining Lenz’s law through the conservation of energy	(Formative assessment tools including self-assessment and peer assessment) Practical investigations: What is the voltage induced in a coil? (Faraday´s law of electromagnetic induction) How can capacitor be charged or discharged? Reports on practical investigation End-of-unit tests
Power generation and transmission	Alternating current (ac) generators Average power and root mean square (rms) values of current and voltage Transformers Diode bridges Half-wave and full-wave rectification	• Explaining the operation of a basic ac generator, including the effect of changing the generator frequency • Solving problems involving the average power in an ac circuit • Solving problems involving step-up and step-down transformers • Describing the use of transformers in ac electrical power distribution • Investigating a diode bridge rectification circuit experimentally • Qualitatively describing the effect of adding a capacitor to a diode bridge rectification circuit	
Capacitance	Capacitance Dielectric materials Capacitors in series and parallel Resistor-capacitor (RC) series circuits Time constant	• Describing the effect of different dielectric materials on capacitance • Solving problems involving parallel-plate capacitors • Investigating combinations of capacitors in series or parallel circuits • Determining the energy stored in a charged capacitor • Describing the nature of the exponential discharge of a capacitor • Solving problems involving the discharge of a capacitor through a fixed resistor • Solving problems involving the time constant of an RC circuit for charge, voltage and current	
Energy production (CORE) SL: 11 classes, HL: 11 classes			
Energy sources	Specific energy and energy density of fuel sources Sankey diagrams Primary energy sources Electricity as a secondary and versatile form of energy Renewable and non-renewable energy sources	• Solving specific energy and energy density problems • Sketching and interpreting Sankey diagrams • Describing the basic features of fossil fuel power stations, nuclear power stations, wind generators, pumped storage hydroelectric systems and solar power cells • Solving problems relevant to energy transformations in the context of these generating systems	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations: How can capacitor be charged or discharged? How to keep house warm? Modelling temperature in a house Reports on practical investigation
Thermal energy transfer	Conduction, convection and thermal radiation Black-body radiation Albedo and emissivity The solar constant The greenhouse effect Energy balance in the Earth surface–atmosphere system	• 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 • Describing the effects of the Earth’s atmosphere on the mean surface Temperature • Solving problems involving albedo, emissivity, solar constant and the	

		Earth’s average temperature	End-of-unit tests
Atomic, particle and nuclear physics (CORE) SL: 19 classes, HL: 19 classes			
Discrete energy and radioactivity	Discrete energy and discrete energy levels Transitions between energy levels Radioactive decay Fundamental forces and their properties Alpha particles, beta particles and gamma rays Half-life Absorption characteristics of decay particles Isotopes Background radiation	• Describing the emission and absorption spectrum of common gases • Solving problems involving atomic spectra, including calculating the wavelength of photons emitted during atomic transitions • 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)	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment) Practical investigations: Modelling radioactive decay by simulation or experimentally using dice Reports on practical investigation End-of-unit tests
Nuclear reactions	The unified atomic mass unit Mass defect and nuclear binding energy Nuclear fission and nuclear fusion	• Solving problems involving mass defect and binding energy • Solving problems involving the energy released in radioactive decay, nuclear fission and nuclear fusion • Sketching and interpreting the general shape of the curve of average binding energy per nucleon against nucleon number	
The structure of matter	Quarks, leptons and their antiparticles Hadrons, baryons and mesons The conservation laws of charge, baryon number, lepton number and strangeness The nature and range of the strong nuclear force, weak nuclear force and electromagnetic force Exchange particles Feynman diagrams Confinement The Higgs boson	• Describing the Rutherford-Geiger-Marsden experiment that led to the discovery of the nucleus • Applying conservation laws in particle reactions • Describing protons and neutrons in terms of quarks • Comparing the interaction strengths of the fundamental forces, including gravity • Describing the mediation of the fundamental forces through exchange particles • Sketching and interpreting simple Feynman diagrams • Describing why free quarks are not observed	
Quantum and nuclear physics (AHL) SL: 4 classes, HL: 20 classes			
The interaction of matter with radiation	Photons The photoelectric effect Matter waves Pair production and pair annihilation Quantization of angular momentum in the Bohr model for hydrogen The wave function The uncertainty principle for energy and time	• Discussing the photoelectric effect experiment and explaining which features of the experiment cannot be explained by the classical wave theory of light • Solving photoelectric problems both graphically and algebraically • Discussing experimental evidence for matter waves, including an experiment in which the wave nature of electrons is evident • Stating order of magnitude estimates from the uncertainty principle	Quizzes Problem solving (Formative assessment tools including self-assessment and peer assessment)

	and position and momentum Tunnelling, potential barrier and factors affecting tunnelling probability		Practical investigations: How does light emit electrons out from metal (photoelectric effect) Reports on practical investigation End-of-unit test
Nuclear physics	Rutherford scattering and nuclear radius Nuclear energy levels The neutrino The law of radioactive decay and the decay constant	• Describing a scattering experiment including location of minimum intensity for the diffracted particles based on their de Broglie wavelength • Explaining deviations from Rutherford scattering in high energy experiments • Describing experimental evidence for nuclear energy levels • Solving problems involving the radioactive decay law for arbitrary time intervals • Explaining the methods for measuring short and long half-lives	