Curriculum overview for Physics SL and HL,3mn, School Year 2019/2020 **Teacher: Ines Dukić, M.Sc.**

Unit title / Month	Key concept(s)	Content	Objectives / Learning outcomes	Assessment tasks	ATL skills	Links to other subjects
UNIT 1 Uniform motion and uniformly accelerated motion September	Speed Velocity Acceleration	Speed and velocity Uniform motion – equations Uniform motion – graphs Acceleration Uniformly accelerated motion – graphs Uniformly accelerated motion – equations	Define distance, displacement, speed and velocity Distinguish average and instantaneous speed Solve problems with equations of motion Sketch and interprete uniform motion graphs Define acceleration. Define uniformly accelerated motion Distinguish average and instantaneous acceleration. Draw and analyse accelerated motion graphs Apply and solve equations of motion in realistic problems	Quiz Problem solving Test	● Communication skills (use and interpret mathematical notation: equations and graphs) ● Thinking - critical thinking skills (recognize general principles and apply to familiar situations to draw reasonable conclusions, evaluate evidence and arguments)	Mathematics
UNIT 2 Forces, momentum and impulse October November	Free-body diagram Forces and components Momentum Collisions Action and reaction	Forces –adition and resolving Newton's first law Newton's second law Friction Free-body diagrams Forces on the incline Linear momentum and impulse of force Change of momentum and 2nd Newton's law Propulsion Law of action and reaction Collisions and explosions Conservation of linear momentum	State and apply the law of inertia State and apply the law of force Describesolidfrictionbycoefficientsoffriction Sketch and interprete free-body diagrams. Define translational equilibrium Investigation of relation between pulling force, mass and acceleration Resolve vector of weight into components and interprete them Determine coefficient of static friction Define momentum and impulse Interpret force-time graph Explain work of propulsion mechanism in technology and nature Apply principle in head-on collisions (elastic and inelastic)	Quiz Problem solving Practical investigation: Measurement of friction on the wooden slope Report on practical investigation: Motion due to a steady force Test	● Thinking - critical thinking skills (recognize general principles and apply to familiar situations to draw reasonable conclusions, evaluate evidence and arguments) ● Research skills (state focused question, design or adjust the experimental method, use equipment effectively) ● Social collaboration skills (work collaboratively in teams during group work)	Mathematics

UNIT 3 Work and energy November December	Kinetic energy Gravitational potential energy Elastic potential energy	Work Work-energy principle Kinetic energy Gravitational potential energy Principle of conservation of energy Elastic potential energy Power and efficiency	Define work/ positive and negative work Derive expression for kinetic energy Analyse relation btw work and GPE State the work-energy principle and apply to free fall, frictionless slopes etc. Derive expression for elastic e. Apply principle of conservation of energy	Problem solving Peer evaluation Test	● Social- collaboration skills (negotiate ideas with peers and teacher concerning equivalence, generalization, validity)	
UNIT 4 Circular motion and gravity January	Centripetal force Frequency Period	Centripetal force Period, frequency and angular velocity Circular motion in vertical plane Universal gravitational force	Deduce direction and magnitude of centripetal acceleration from diagram. Identify examples of centripetal forces, apply formula. Define period, frequency and angular velocity. Solve problems involving F_{cp}, linear and angular velocity etc Analyse forces in the lowest and the highest point of circular path Verify the expression for centripetal force. Determine "g" by revolving mass on a string State Newton's universal law of gravity	Quiz Group work Report on practical investigation: circular motion	● Social collaboration skills (work collaboratively in teams during group work) ● Research skills (state focused question, design or adjust the experimental method, use equipment effectively)	Mathematics Astronomy
UNIT 5 Thermal physics February	Temperature Thermal capacity Latent heat Internal energy Kinetic model of gas	Molecular theory of solids, liquids and gas Temperature, heat and internal energy Thermal capacity and specific heat capacity Phase change and specific latent heat Practical investigation: Gas laws Gas laws and absolute zero Equation of state of ideal gas Kinetic model of ideal gas Real gas vs. ideal gas	Describe models of bonds in solids, liquids and gases Convert btw. temperature scales. Distinguish heat, temperature and intern E Define; calculate energy change by heating Calculate energy change involving latent heat of fusion and vaporization Draw and interpret phase change graphs Determine the latent heat of fusion of water Verify relation btw pressure and temperature at constant volume Use experimental data (or observation) to deduce ralation btw pressure, temperature and volume of the gas – three gas laws Describe state of gas, define mole and molar mass, Avogadro's constant. Derive and apply equation. State assumptions of the model Interpret the temperature as measure of average kinetic energy Discuss the difference btw ideal and realistic gas.	Quiz Test Problem solving Practical investigation: latent heat of ice Presentation	● Thinking-critical thinking skills (use models and simulations to explore complex systems and issues: applying in real-life contexts) ● Research skills (use and interprete numerical data or observation to answer the research question) ● Research skills (find different kinds of resources related to problem, evaluate and use them selectively)	Chemistry Mathematics

UNIT 6 Oscillations and waves March	Simple harmonic oscillator Transverse and longitudinal waves Reflection Refraction Interference Diffraction Polarization Standing wave	Conditions for SHM Frequency, period, amplitude and phase Graphicalpresentationof SHM Practical investigation: period of simple pendulum Wave production and characteristics Nature of sound waves Nature of EM waves Intensity of waves Reflection Refraction and Snell's law Total internal reflection Practical investigation: determining refractive index Superposition of waves Double-slit interference Diffracton on a single slit Polarization Nature of standing waves Standing wave on a string Standing wave in a pipe	Describe examples of oscillations and energy transformations. Define conditions for simple harmonic motion Define amplitude, frequency, period, phase difference Sketch and interprete graphs of SHM Describe wave pulse and travelling wave. Define terms displacement, amplitude, frequency, wavelength, wave speed. Derive and apply equation $v = \lambda f$. Draw displacement-distance and displacement-time graphs Describe longitudinal and transverse waves Describe the nature of electromagnetic waves Explain inverse square law for intensity Sketch and interprete incident, transmitted and reflected waves at boundaries Outline Snell's law Describe and apply total internal reflection. Describe superposition of waves Quantitatively describe double-slit interference. Explain path difference. Describe diffraction around objects and on a single slit qualitatively. Describe methods of polarization. Illustrate polarized light. State and apply Malus' law. Describe nature and formation of standing waves Observe standing wave on a string and derive wave frequencies Discuss modes of vibration of air in pipes and derive harmonic frequencies	Quiz Report on practical investigation: oscillation of simple pendulum Test	● Communication skills (use and interpret mathematical notation: equations and graphs) ● Thinking - critical thinking skills (recognize general principles and apply to familiar situations to draw reasonable conclusions, evaluate evidence and arguments) ● Thinking - transfer (apply skills in unfamiliar situations) ● Self-management - reflection skills (consider content, reflect on achievements, develop new techniques and strategies for effective learning) ● Research skills (state focused question, design or adjust the experimental method, use equipment effectively)	Mathematics

UNIT 7 **Wave phenomena (HL only)** March April	Diffraction and resolution Doppler effect	**Single-slit diffraction** **Diffraction grating** **Thin film interference** **Resolution and Rayleigh criterium** **Doppler effect for moving source of sound** **Effect for moving observer** **Doppler shift for EM waves** **Utilizations of Doppler effect**	**Analyse single slit diffraction including slit width and change of colours** **Investigate double slit interference. Discuss modulation of double slit interference pattern by one slit diffraction effect** **Analyse multiple slit diffraction and interference** **Describe conditions for constructive and destructive interference from thin films** **Discuss resolution power of single slit for two sources – Rayleigh criterium** **Sketch and interpret Doppler effect for source and observer in relative motion** **Solve problems with applied Doppler for sound.** **Use approximate equation for electromagnetic waves. Solve problems with applied Doppler for EM waves** **Explain usage in police radar, medicine, radar, astronomy…**	**Problem solving** **Practical investigation: Young double-slit experiment** **Presentation**	● **Thinking-critical thinking skills (use models and simulations to explore complex systems and issues: applying in real-life contexts)** ● **Research skills (find different kinds of resources related to problem, evaluate and use them selectively)**	Mathematics
UNIT 8 Option (Engineering physics) May	Angular velocity and acceleration Moment of inertia Heat engine Entropy **HL** **Pressure** **Buoyancy** **Resonance** **Damping**	Torque Moment of inertia Angular acceleration Laws of thermodynamics Cyclic processes and pV diagrames Carnot cycle **Density and pressure** **Buoyancy** **Hydraulic machines** **Ideal fluid dynamics** **Viscosity** **Natural frequency** **Damping** **Resonance** **Q factor**	Calculating torque Solving problems involving moment of inertia, angular acceleration and rotational energy Sketching and interpreting graphs of rotational motion, Solving problems involving the first law Describing second law in Kelvin and Clausius form, Describing examples of processes in terms of entropy change, Sketching and interpreting pV diagrams for various processes Solving problems involving thermal efficiency **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** **Qualitatively and quantitatively describing examples of under-, over- and critically-damped oscillations** **Graphically describing the variation of the amplitude of vibration with driving frequency**	Quiz **Group work** **Test**	● Thinking - critical thinking skills (recognize general principles and apply to familiar situations to draw reasonable conclusions, evaluate evidence and arguments) ● Communication skills (Take effective notes in class, use common terminology and notation) ● Social- collaboration skills (negotiate ideas with peers and teacher concerning equivalence, generalization, validity)	Mathematics

UNIT 9 Static electricity and DC circuits September	Electric charges Coulomb interaction Electric current Electric resistance DC sources	Electrostatic force Electric field Charge carriers in metal: electric current, drift speed Circuit diagrams Ohmic and non-ohmic resistors Parallel and series circuits Kirchoff's rules Power in DC circuit Internal resistance and EMF Primary and secondary cells	Solve problems involving Coulomb's law. Define electric field strength and describe el.fields using fieldlines. Derive mathematical expression and apply. Sketch the graph. Explain zero field inside the sphere. Describe uniform field. Calculate work done in electric field. Define eV. Solve problems involving current, potential difference and charge. Sketch and interprete circuit diagrams. Identify ohmic and non-ohmic conductors through a consideration of the *V/I* characteristic graph. Solve problems involving potential difference, current, charge, Kirchhoff's circuit laws, power, resistance and resistivity. Describe ideal and non-ideal ammeters and voltmeters Investigate one or more of the factors that affect resistance experimentally Describing the discharge characteristic of a simple cell (variation of terminal potential difference with time) Solving problems involving emf and internal resistance	Peer evaluation Quiz Problem solving Reports on investigations: I/V character. of filament lamp Determining internal resistance experimentally	● Thinking - critical thinking skills (recognize general principles and apply to familiar situations to draw reasonable conclusions, evaluate evidence and arguments) ● Research skills (state focused question, design or adjust the experimental method, use equipment effectively) ● Social- collaboration skills (negotiate ideas with peers and teacher concerning equivalence, generalization, validity) ● Social collaboration skills (work collaboratively in teams during group work)	Mathematics Chemistry
UNIT 10 Magnetic forces October November	Magnetic dipole Magnetic field Magnetic forces	Magnetic field of Earth Magnetic field of electric currents Magnetic forces: Lorentz's force, Ampere's force	Sketching and interpreting magnetic field patterns Determining the direction of force on a charge moving in B field Determining the direction of force on a current-carrying wire Describing DC motor principle Determining the direction of the magnetic field based on current direction Solving problems involving magnetic forces, fields, current and charges moving in magnetic and electric fields	Problem solving Test Report on investigation: magnetic field of Earth	● Thinking - critical think.skills (recognize general principles, apply to familiar situations to draw reasonable conclusions, evaluate evidence and arguments) ● Research skills (use +interprete numerical data or observation to answer the rq)	Mathematics

UNIT 11 **Fields and forces (HL only)** October	**Concept of field** **Potential at a point** **Orbital motion**	**Gravitational and electrostatic field** **Potential and potential energy** **Field-lines and potential gradient** **Energy in orbital motion** **Escape speed**	**Discuss similarities of two fields** **Define potential. Describe concept of potential difference.** **Mapping fields using potential** **Express work done in the field. Solve problems concerning potential energy** **Describe connection btw. field lines and potential gradient. Derive formula, discuss energy changes** **State/derive expressions for orbital speed and orbital energy.** **Solve problems involving orbital energy of charged particles in circular orbital motion and masses in circular orbital motion.** **Solve problems involving forces on charges and masses in radial and uniform fields**	**Problem solving** **Quiz**	● **Thinking-critical thinking skills (use models and simulations to explore complex systems and issues: applying in real-life contexts)**	Mathematics Astronomy
UNIT 12 **Electromagnetic induction (HL only)** November	**Magnetic flux** **Faraday's law** **AC current** **Capacitance**	**Magnetic flux and magnetic flux linkage** **Faraday's law of induction** **Lenz's law** **Alternating current (ac) generators** **Average power and root mean square (rms) values of current and voltage** **Transformers** **Diode bridges and Half-wave and full-wave rectification** **Capacitance** **Dielectric materials** **Capacitors in series and parallel** **Resistor-capacitor (RC) series circuits** **Time constant**	**Describing the production of an induced emf by a changing magnetic flux and within a uniform magnetic field** **Solving problems involving magnetic flux, magnetic flux linkage and Faraday's law** **Explaining Lenz's law through the conservation of energy** **Solving quantitative problems involving straight conductors moving in magnetic fields and rectangular coils moving in and out of fields and rotating in fields** **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** **Discussing features of real transformers that are not ideal (for example: flux leakage, joule heating, eddy current heating, magnetic hysteresis)** **Describing the effect of different dielectric materials on capacitance**	**Problem solving** **Test** **Investigate operation of step-up and step-down transformer**	● Thinking - critical thinking skills (recognize general principles and apply to familiar situations to draw reasonable conclusions, evaluate evidence and arguments) ● Research skills (use and interprete numerical data or observation to answer the research question) ● Self-management - reflection skills (consider content, reflect on achievements, develop new techniques and strategies for effective learning) ● Communication skills (Take effective notes in	Mathematics

			Solving problems involving parallel-plate capacitors (including model of cloud-earth system), Determining the energy stored in a charged capacitor, Describing the nature of the exponential discharge of a capacitor Solving problems involving the time constant of an RC circuit for charge, voltage and current		class, use common terminology and notation)	
UNIT 13 Atomic physics December	Planetary model of atom Quantum jumps Photons	Thomson 's discovery of electron Rutherford model Discrete energy and discrete energy levels: atomic spectra, Bohr model Transitions between energy levels Photons	Describing the emission and absorption spectrum of common gases Solving problems involving atomic spectra, including calculating the wavelength of photons emitted during atomic transitions	Group work Peer evaluation Test	Thinking-critical thinking skills (use models and simulations to explore complex systems and issues) ● Social- collaboration skills (negotiate ideas with peers and teacher concerning equivalence, generalization, validity)	Chemistry
UNIT 14 Quantum physics (HL only) January	**Photoelectric effect** **Wave nature of electron** **Wave function** **Uncertainty principle**	**Nature of light: radiation or corpusculae Einstein's explanation of PE effect De Broglie's idea and wave nature of electrons Pair production and pair annihilation Bohr model for hydrogen (Quantization of angular momentum) The wave function The uncertainty principle for energy and time and position and momentum Tunnelling, potential barrier and factors affecting tunnelling probability**	**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 Solving problems involving pair production Solving problems with discrete energies in hydrogen atom, discussing nature of electron in Bohr model (electron wavelength and orbits), Interpreting the wave function Stating order of magnitude estimates from the uncertainty principle (it may include estimates of the energy of the ground state of an atom, the impossibility of an electron existing within a nucleus, and the lifetime of an electron in an excited energy state) Qualitative description of tunnelling using the idea of continuity of wave functions**	**Quiz** **Investigation: diffraction of electrons on graphite**	● **Thinking-critical thinking skills (use models and simulations to explore complex systems and issues: applying in real-life contexts)** ● **Research skills (find different kinds of resources related to problem, evaluate and use them selectively)** ● Research skills (use and interprete numerical data or observation to answer the research question)	Mathematics

UNIT 15 Nuclear and particle physics February	Radioactive decay Isotopes Mass defect Fission and fusion Quarks	Radioactive decays (α, β, γ) Fundamental forces and isotopes Decay equations Half-life Energy-mass equivalence Mass defect and nuclear binding energy Nuclear fission Nuclear fusion Standard model The conservation laws of charge, baryon no., lepton no. and strangeness Exchange particles and Feynman diagrams	Completing decay equations for alpha and beta decay Determining the half-life of a nuclide from a decay curve Using the unified atomic mass unit 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 Discussing utilisation (power plants, weapons) Describing protons and neutrons in terms of quarks Comparing the interaction strengths of the fundamental forces, including gravity Applying conservation laws in particle reactions Describing the mediation of the fundamental forces through exchange particles Sketching and interpreting simple Feynman diagrams	Group work and peer evaluation Quiz Report on investigation: decay by dice Problem solving Test	● Thinking-critical thinking skills (use models and simulations to explore complex systems and issues) ● Research skills (use and interprete numerical data or observation to answer the research question ● Communication skills (Take effective notes in class, use common terminology and notation ● Social- collaboration skills (negotiate ideas with peers and teacher concerning equivalence, generalization, validity)	Mathematics Chemistry
UNIT 16 **Nuclear physics (HL only)** March	**Scattering of alpha particles** **Half life and decay constant**	**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**	**Problem solving**	● **Thinking - critical think. skills (recognize general principles,apply to familiar situations to draw reasonable concl, evaluate evidence + argum.)** ● **Self-management - reflection skills (consider content, reflect on achiev., develop new techn + strategies for effective learning)**	Mathematics

UNIT 17 Energy production April	Power plants Transport of heat Black body spectrum Albedo Grennhouse effect	Clasifications of sources Production of electricity: hydroelectric, fossil fuel, nuclear, wind and solar power plants Sankey diagrams Conduction, convection and thermal radiation Black-body radiation: Stefan-Boltzman law, Wien's law, BBR curve Albedo and emissivity The solar constant The greenhouse effect and energy balance	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 /photovoltaic cells Solving problems relevant to energy transformations in the context of these generating systems Discussing safety issues and risks associated with the production of nuclear power Qualitative discussion of conduction and convection Description of the absorption and the subsequent emission of infrared radiation by greenhouse gases in terms of the molecular energy levels Sketching and interpreting black-body radiation graphs 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	Presentation Peer evaluation Quiz	● Research skills (find different kinds of resources related to problem, evaluate and use them selectively) ● Social- collaboration skills (negotiate ideas with peers and teacher concerning equivalence, generalization, validity) ● Communication skills (Take effective notes in class, use common terminology and notation)	