Diploma Programme subject outline—Group 4: experimental sciences			
School name	Haganässkolan	**School code**	051587
Name of the DP subject	Physics		
Level *(indicate with X)*	Higher: X; Standard completed in two years: ; Standard completed in one year *:		
Name of the teacher who completed this outline	Anders Levin	**Date of IB training**	23 Nov – 21 Dec 2016
Date when outline was completed	October 27, 2016	**Name of workshop** *(indicate name of subject and workshop category)*	DP Physics Category 1 online workshop

* All Diploma Programme courses are designed as two-year learning experiences. However, up to two standard level subjects, excluding languages ab initio and pilot subjects, can be completed in one year, according to conditions established in the *Handbook of procedures for the Diploma Programme*.

1. **Course outline**

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	Topic/unit (as identified in the IB subject guide) *State the topics/units in the order you are planning to teach them.*	Contents	Allocated time HL students approx 3.5 hrs a week over approx. 64 weeks SL students have approx. 1.5 hrs a week over 65 weeks	Assessment instruments to be used	Resources *List the main resources to be used, including information technology if applicable.*
Year 1	Measurements and uncertainties	•Using SI units, scientific notation and metric multipliers in the correct format for all required measurements, final answers to calculations and presentation of raw and processed data • Quoting and comparing ratios, values and approximations to the nearest order of magnitude • Estimating quantities to an appropriate number of significant figures • 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) and the propagation of uncertainties through calculations • Determining the uncertainty in gradients and intercepts • Solving vector problems graphically and algebraically	5h	• Lab reports •End of unit tests The External Assessment is divided into three different papers. Paper 1 is a 1 hour test with an overall weighting of 20 %. Paper 2 is a 2 hour 15 min. test with an overall weighting of 36 %. Paper 3 is a 1 hour 15 min. test with an overall weighting of 24 %. The Internal Assessment covers the last 20 %.	Physics IB guide Laboratory equipment (meter rule, stopwatch, data logger etc..) Internet resources TI 84 Calculators Textbook
	Mechanics	•Determining instantaneous and average values for velocity, speed and acceleration. Sketching and interpreting motion graphs • Solving problems using equations of motion for uniform acceleration	22 h		

	• 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 • Representing forces as vectors and sketching 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 solid friction (static and dynamic) by coefficients of friction • 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 • 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	
Thermal physics	• Describing temperature change in terms of internal energy • Using Kelvin and Celsius temperature scales and converting between them	11 h

		• Applying the calorimetric techniques of specific heat capacity or specific latent heat experimentally • Describing phase change in terms of molecular behaviour and sketching and interpreting phase change graphs • Calculating energy changes involving specific heat capacity and specific latent heat of fusion and vaporization • 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			
	Waves & Wave phenomena	•Qualitatively describe the energy changes taking place during one cycle of an oscillation. •Sketch and interpret graphs of simple harmonic motion. •Explain the motion of particles of a medium when a wave passes through both transverse and longitudinal cases. •Sketch and interpret displacement-time graphs and displacement-time graphs for transverse and longitudinal waves. •Solve problems involving wave speed, frequency and wavelength. •Investigate the speed of sound experimentally. • 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 • Sketching and interpreting incident, reflected and transmitted waves at boundaries between media	15 h + 17 h		

		• 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 • 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 • 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 • 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 • 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			

		• 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 • Solving problems involving the Rayleigh criterion for light emitted by two sources diffracted at a single slit • Resolvance of diffraction gratings • 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			
	Circular motion and gravitation & Fields	• 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 • 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. • Representing sources of mass and charge, lines of electric and gravitational force, and field patterns using an appropriate symbolism	5h + 11 h		

		• Mapping fields using potential • Describing the connection between equipotential surfaces and field lines • 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			
Year 2	Electricity and magnetism & Electromagnetic induction	• 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 • 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	15 h + 16 h		

		• 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 • 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 • 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 • 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 • 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			
	Atomic, nuclear and particle physics & Quantum and nuclear physics	• 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) • 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 • 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	14 h + 16 h		

	• 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 • 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	
Energy production	• 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 • Discussing safety issues and risks associated with the production of nuclear power • Describing the differences between photovoltaic cells and solar heating panels • Sketching and interpreting graphs showing the variation of intensity with wavelength for bodies emitting thermal radiation at different temperatures	8h

	• 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	
Relativity	• Solving problems involving the muon decay experiment • Representing events on a spacetime diagram as points • Representing the positions of a moving particle on a spacetime diagram by a curve (the worldline) • Representing more than one inertial reference frame on the same space time diagram • Determine the angle between a world line for specific speed and the time axis on a space time diagram • Solving problems on simultaneity and kinematics using space time diagrams • Representing time dilation and length contraction on space time diagrams • Describing and resolving the twin paradox • Describing the laws of conservation of momentum and conservation of energy within special relativity • Determining the potential difference necessary to accelerate a particle to a given speed of energy • Solving problems involving relativistic energy and momentum conservation in collisions and particle decays • Using the equivalence principle to deduce and explain light bending near massive objects and gravitational time dilation • Calculating gravitational frequency shifts • Describing an experiment in which gravitational redshift is observed and measured • Calculating the Schwarzschild radius of a black hole • Applying the formula for gravitational time dilation near the event horizon of a black hole	25 h

2. **The group 4 project**

As the IB guides say, ―The group 4 project is a collaborative activity where students from different group 4 subjects work together on a scientific or technological topic, allowing for concepts and perceptions from across the disciplines to be shared in line with aim 10—that is, to ‗encourage an understanding of the relationships between scientific disciplines and the overarching nature of the scientific method.'‖ Describe how you will organize this activity. Indicate the timeline and subjects involved, if applicable.

Group 4 project will be completed at the end the students first year. It will involve biology, physics and chemistry. The overall topic will concern sustainable living.

- Information handouts to students a week in advance, for them to take home, read and think about before the first session of planning.
- First meeting with all group 4 students (1h) for the students to share their ideas decide on a topic.
- Second meeting for the students to plan and schedule their work (1h)
- Depending on what subject the students choose (and the teacher approve) the action stage will be scheduled accordingly. Either in lessons during a week or a whole day will be set aside to work with the project. (6h)
- We will arrange a morning symposium for the student groups to present and evaluate their projects. (2h)

3. **IB practical work and the internal assessment requirement to be completed during the course**

As you know, students should undergo 40 hours (at standard level) or 60 hours (at higher level) of practical work related to the syllabus. Use the table below to indicate the name of the experiment you would propose for the different topics in the syllabus. Indicate which experiments you would use for assessing each of the internal assessment criteria—design (D), data collection and processing (DCP) and conclusion and evaluation (CE).

An example is given. Add as many rows as necessary.

Name of the topic	**Experiment**	**Indicate the experiments you would use for assessing design (D), data collection and processing (DCP) and conclusion and evaluation (CE)** *(use D, DCP or CE)*	**Any ICT used?** *Remember you must use all five within your programme.*
Acids and bases	Titration	DCP	Yes
Measurement and uncertainties	Measuring techniques	DCP	Spreadsheets

Mechanics	Uniform motion	DCP and CE	Simulations Video analysis
Mechanics	Determining the mass of unknown objects	D	
Mechanics	Retarding force	DCP	Simulations
Mechanics	Distance, velocity and acceleration	DCP	Data logging Simulations
Mechanics	Work – kinetic energy	DCP	Data logging
Mechanics	Free fall	DCP	Simulations
Mechanics	Explosion	DCP and CE	Data logging
Thermal physics	Specific heat capacity of water	DCP	Spreadsheets
Thermal physics	Gas thermometer for constant volume	DCP	Spreadsheets Simulations
Waves & Wave phenomena	The refraction of light	DCP	Simulations
Waves & Wave phenomena	Standing waves	DCP and CE	Simulations
Waves & Wave phenomena	Harmonic oscillations	DCP	Data logging
Waves & Wave phenomena	Determining the speed of sound in air	DCP	Spreadsheets
Waves & Wave phenomena	Young´s double-slit	DCP	Simulations
Waves & Wave phenomena	Determining the wavelength of a laser beam	DCP and CE	Spreadsheets
Electricity and magnetism & Electromagnetic induction	Resistivity	DCP and CE	Spreadsheets Databases

Electricity and magnetism & Electromagnetic induction	Resistance in a metal wire	DCP	Spreadsheets Graph plotting
Electricity and magnetism & Electromagnetic induction	Potential in a wire	DCP	
Electricity and magnetism & Electromagnetic induction	Emf and internal resistance	DCP	Spreadsheets Graph plotting
Electricity and magnetism & Electromagnetic induction	The magnetic field in a coil	DCP	Spreadsheets
Electricity and magnetism & Electromagnetic induction	Earth´s magnetic field	DCP	Spreadsheets
Electricity and magnetism & Electromagnetic induction	The capacitance of a capacitor	DCP	Spreadsheets Graph plotting Databases
Electricity and magnetism & Electromagnetic induction	Charging a capacitor	DCP and CE	Spreadsheets
Circular motion and gravitation & Fields	Circular motion	DCP and CE	Spreadsheets Simulations
Circular motion and gravitation & Fields	Conical pendulum	DCP	Spreadsheets
Circular motion and gravitation & Fields	Simple gravity pendulum	DCP	Spreadsheets
Circular motion and gravitation & Fields	Electrical fields	DCP	
Atomic, nuclear and particle physics & Quantum and nuclear physics	The Photoelectric effect	DCP and CE	
Atomic, nuclear and particle physics & Quantum and nuclear physics	Hydrogen spectrum	DCP	
Atomic, nuclear and particle physics & Quantum and nuclear physics	Half-life	DCP and CE	Simulation Graph plotting
Atomic, nuclear and particle physics & Quantum and nuclear physics	Gamma-ray absorption	DCP and CE	Data logging

Atomic, nuclear and particle physics & Quantum and nuclear physics	Radioactivity	DCP	Data logging
Atomic, nuclear and particle physics & Quantum and nuclear physics	Beta spectrometer	DCP	Data logging

4. Laboratory facilities

Describe the laboratory and indicate whether it is presently equipped to facilitate the practical work that you have indicated in the chart above. If it is not, indicate the timeline to achieve this objective and describe the safety measures that are applicable.

The laboratory is adequate to accomplish the intended labs. There are eight tables that can be used for the labs. The room is equipped with projection equipment and a white board.

5. Other resources

Indicate what other resources the school has to support the implementation of the subject and what plans there are to improve them, if needed.

- The school has two billiard tables that can be used to demonstrate different types of collisions.
- There is a swimming pool that can be used to demonstrate fluid resistance. (The swimming pool will undergo an overhaul during 2017)

6. Links to TOK

You are expected to explore links between the topics of your subject and TOK. As an example of how you would do this, choose one topic from your course outline that would allow your students to make links with TOK. Describe how you would plan the lesson.

I found this lesson from La Bocage International School and will adapt them to our classes at Haganäs.

Topic	Link with TOK (including description of lesson plan)
Measurement and uncertainties	- What has influenced the common language used in science? To what extent does having a common standard approach to measurement facilitate the sharing of knowledge in physics? - “One aim of the physical sciences has been to give an exact picture of the material world. One achievement of physics in the twentieth century has been to prove that this aim is unattainable.” – Jacob Bronowski. Can scientists ever be truly certain of their discoveries? - What is the nature of certainty and proof in mathematics?

Mechanics	• The independence of horizontal and vertical motion in projectile motion seems to be counter-intuitive. How do scientists work around their intuitions? How do scientists make use of their intuitions? Classical physics believed that the whole of the future of the universe could be predicted from knowledge of the present state. To what extent can knowledge of the present give us knowledge of the future? • To what extent is scientific knowledge based on fundamental concepts such as energy? What happens to scientific knowledge when our understanding of such fundamental concepts changes or evolves? • Do conservation laws restrict or enable further development in physics?

7. Approaches to learning

Every IB course should contribute to the development of students' approaches to learning skills. As an example of how you would do this, choose one topic from your outline that would allow your students to specifically develop one or more of these skill categories (thinking, communication, social, self-management or research).

Topic	Contribution to the development of students' approaches to learning skills (including one or more skill category)
Circular motion and gravitation	Students will work in groups with exams from previous years. They will then show the class how they solved these problems. Together we will then evaluate their solution, finding other ways of solving the problem and discussing different approaches. This will benefit the students communication skills: - written and oral - listening - formulate arguments in speaking and writing

8. International mindedness

Every IB course should contribute to the development of international mindedness in students. As an example of how you would do this, choose one topic from your outline that would allow your students to analyse it from different cultural perspectives. Briefly explain the reason for your choice and what resources you will use to achieve this goal.

Topic	Contribution to the development of international mindedness (including resources you will use)

Energy production (Energy sources)	The production of energy from fossil fuel has a clear impact on the world we live in and therefore involves global thinking. The geographic concentrations of fossil fuels have led to political conflict and economic inequalities. The production of energy through alternative energy resources demands new levels of international collaboration.

9. Development of the IB learner profile

Through the course it is also expected that students will develop the attributes of the IB learner profile. As an example of how you would do this, choose one topic from your course outline and explain how the contents and related skills would pursue the development of any attribute(s) of the IB learner profile that you will identify.

Topic	Contribution to the development of the attribute(s) of the IB learner profile
Circular motion	- The students will study circular motion experimentally. They will learn the importance of making accurate readings and thus improving their research skills. Writing lab reports including making tables and drawing diagrams will develop the students´ communication skills. - When solving problems involving centripetal force and centripetal acceleration students will be encouraged to share their solutions with each other. Using creative thinking skills to analyze complex problems and communicating their solutions. - Inquirers: They develop their own natural curiosity. - Communicators: They understand and express ideas and information confidently.

This portion of the course outline highlights our IB practices. Each section gives a taste or example of how we meet the IB standards and practices in our program.

Inquiry (Approaches to Teaching 1)

You will be given opportunities to follow your interests, actively explore, or make your own choices in certain circumstances:

When writing your IA, you are encouraged to do that about a topic that you are especially interested in. In physics there is also an optional topic where you can choose from four different topics (relativity, engineering physics, imaging and astrophysics). There will also will also be possibilities to do experiments on topics that you find particularly interesting (I we have the equipment).

If you are very interested in this subject, you might wish to have certain CAS experiences that are quite connected to this subject. Some examples are:
Physics support.

Conceptual focus (Approaches to Teaching 2)
Research shows that when learning focuses on conceptual understanding, the learning is richer and more sustained. Here are some examples of places in the course where we work rather explicitly to develop conceptual understanding:

Theories, laws and hypotheses are concepts used by scientists. These will constantly be studied in physics. Though these concepts are connected, there is no progression from one to the other. These words have a special meaning in science, and it is important to distinguish these from their everyday use.

Local and/or Global links (Approaches to Teaching 3)
Global relevance is at the heart of the DP curriculum, within nearly every subject guide, the content is already baked in. But here are some of the local links we will make in our subject:

Discussing the use of primary and secondary energy resources.

Collaboration (Approaches to Teaching 4)
Sometimes what you will be learning will be linked to another subject area and sometimes we as teachers like to collaborate to articulate those links for you, we find it can make learning more meaningful. How we do this may vary from year to year, but here is an example of places in the curriculum where you might find that we will work in an interdisciplinary fashion:

Mathematical skills will be used throughout the course.

We will also collaborate, you and I as the teacher on certain parts of the course.

Some examples are: We will always be collaborating during classes, it is difficult to learn on your own.

And there will be times you collaborate with your classmates, such as:

During experiments you will collaborate with other students.

Removal of barriers to learning: (Approaches to Teaching 5)

We all have our strengths and areas to develop. If you are experiencing some form of barrier to your learning, here's what I expect you will do:

Tell me what barrier you have encountered. I will then try and either help you directly or find exercises that can help you overcome the barrier.

If I or another teacher detects that there might be a barrier to your learning, we will follow our Inclusion Policy.

Varied assessment (Approaches to Assessment 2)
These are the kinds of assessments used in this course *(prior to official IB assessments and including mocks)*:

Mocks, tests, MCQ, Kahoots.

Formative assessments:

After each topic there will be a test with exam style questions, so you can see how much you have learnt of the topic and where you need to improve. In some topics there will also be tests on subtopics. You will get some sort of feedback (written or verbal) on your result. There will also be mock exams.

Summative assessments allow for you to **consolidate your learning,** some examples of summative assessments in this course are:

Mock exams and other tests will be used to predicting your grades.

In the end there will be an external examination on which your grade will be based (together with the IA)

Here is some information about how your work will be marked or assessed:

Exam style questions will be used and the mark scheme to those questions will support the marking.
Approximate grade boundaries and grade descriptors will be used to give a predicted grade.

Feedback (Approaches to Assessment 1)
You can expect to receive feedback from me on formative and summative assessments in this way:

Written or oral

You will also have an opportunity to give feedback to me in this subject, here is how:

***(this may be something we co-create so wait on this one for a minute)*

To get to know our Assessment Policy in better detail, you can find it here.