Diploma Programme subject outline—Group 4: sciences			
School name	**Gymnazium a SOS Rokycany**	**School code**	**061768**
Name of the DP subject *(indicate language)*	**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	Helena Cizkova	**Date of IB training**	06/2021
Date when outline was completed	05/2023	**Name of workshop** *(indicate name of subject and workshop category)*	Physics Cat. 1

* 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

- Use the following table to organize the topics to be taught in the course. If you need to include topics that cover other requirements you have to teach (for example, national syllabus), make sure that you do so in an integrated way, but also differentiate them using italics. Add as many rows as you need.
- This document should not be a day-by-day accounting of each unit. It is an outline showing how you will distribute the topics and the time to ensure that students are prepared to comply with the requirements of the subject.
- This outline should show how you will develop the teaching of the subject. It should reflect the individual nature of the course in your classroom and should not just be a "copy and paste" from the subject guide.
- If you will teach both higher and standard level, make sure that this is clearly identified in your outline.

	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 One class is 45 minutes. In one week there are 5 classes.	Assessment instruments to be used	Resources *List the main resources to be used, including information technology if applicable.*
Year 1	Theme A Space, time and motion	A1 – Kinematics A2 – Forces and momentum A3 – Work, energy and power A4 – Rigid body mechanics A5 – Galilean and special relativity	9 hours (11 classes 10 hours (13 classes) 8 hours (10 classes)	**Summative assessments** will be used as IB exam based tests at the end of every topic **Formative assessments** Quizzes Discussions Labs assessment according to IB methodology	K. A. Tsokos Physics for the IB Diploma, Coursebook CAMBRIDGE university press 2023 D. Homer, M. Pietka, W. Heathcote Physics course companion OXFORD 2023 PHET - Interactive simulation for science, University of Colorado Veritasium - YouTube MOZAIK education
	Theme B The particulate nature of matter	B1 – Thermal energy transfer B2 – Greenhouse effect B3 – Gas laws B4 – Thermodynamics B5 – Current and circuits	6 hours (7,5 classes) 6 hours (7,5 classes) 6 hours (7,5 classes) 6 hours (7,5 classes)		
	Theme C Wave behaviour	C1– Simple harmonic motion C2 – Wave model C3 – Wave phenomena	3 hours (3,5 classes) 3 hours (3,5 classes) 5hours (6,5 classes)		

	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 One class is 45 minutes. In one week there are 5 classes.	Assessment instruments to be used	Resources *List the main resources to be used, including information technology if applicable.*
Year 2	Theme C Wave behaviour	C4 – Standing waves and resonance C5 – Doppler effect	4 hours (5 classes) 2 hours (2,5 classes)	**Summative assessments** will be used as IB exam based tests at the end of every topic MOCK **Formative assessments** Quizzes Discussions Labs assessment according to IB methodology	K. A. Tsokos Physics for the IB Diploma, Coursebook CAMBRIDGE university press 2023 D. Homer, M. Pietka, W. Heathcote Physics course companion OXFORD 2023 PHET - Interactive simulation for science, University of Colorado Veritasium - YouTube MOZAIK education
	Theme D Fields	D1 – Gravitational fields D2– Electric and magnetic fields D3 – Motion in electromagnetic fields D4 – Induction	5 hours (6,5 classes) 8 hours (10 classes) 6 hours (7,5 classes)		
	Theme E Nuclear and quantum physics	E1 – Structure of the atom E2 – Quantum physics E3 – Radioactive decay E4 – Fission E5 – Fusion and stars	6 hours (7,5 classes) 7 hours (9 classes) 4 hours (5 classes) 6 hours (7,5 classes)		

2. The collaborative sciences project

As the IB guides say, “The collaborative sciences project is an interdisciplinary sciences project, providing a worthwhile challenge to DP students, addressing real-world problems that can be explored through the sciences. The nature of the challenge should allow students to integrate factual, procedural and conceptual knowledge developed through the study of their disciplines.’” Describe how you will organize this activity. Indicate the timeline and subjects involved, if applicable.

As the CSP aims at collaboration between the Group 4 Science subjects, our students will work through a project connecting a minimum of two such subjects: Biology and Chemistry, Biology and Physics or Chemistry and Physics. The whole process will especially develop their collaboration and communication skills.
After a discussion with teachers, each working group of 3 to 4 participants will be asked to give the specifics of their project. Using selected scientific method(s), the groups will then work towards their set goals that should be related to a real-world issue. Nevertheless, they should also engage with a local context.
Each group will spend 2.25 hours on planning, 4.5 hours on execution, 2 hours on finalizing their results and 1.75 hours on presenting their findings to both the other groups as well as other pupils (e.g., pre-IB cohort). While working on the projects, teachers will be available to discuss the findings and support all students.
The CSP will start in March and finish in April of the first IB DP year as per Internal IB Calendar. After the CSP is completed, students will write a 100-word reflection and submit it to ManageBac.

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

As you know, students should undergo practical work related to the syllabus.
Practical activities (see below) Total 54 class (40,5 hours)
Individual investigation (internal assessment–IA) 10 hours
The collaborative sciences project 10 hours

Use the table below to indicate the name of the experiment you would propose for the different topics in the syllabus

Name of the topic Year 1	Experiment	Any ICT used? *Remember you must use all five within your programme.*
Tools for physics	Investigating the relationship between the diameter of a plasticine ball and its mass (2 class)	Processing and analysis, Statistic (Excel)
Theme A Space, time and motion	The research of uniformly accelerated motion without an initial speed (2 classes)	Processing and analysis, Graph plotting (Video editor, Excel)
	Determining the acceleration of free-fall (2 classes)	Processing and analysis, Statistic (Excel)
	Projectile motion (1 class)	Video editor, Modelling, Simulation
	Investigating the relationship between acceleration and force (1 class)	Data logger - PASCO
	Measuring of the weight component down the slope (1 class)	Processing and analysis
	Measuring the coefficient of dynamic friction (2 classes)	Data logger - PASCO Processing and analysis Graph plotting
	Measuring of the centripetal force (1 class)	Data logger - PASCO Processing and analysis Graph plotting
	Investigation of relationship between spring force and extension Hooks law (1 class)	Processing and analysis Graph plotting
	Verifying equations of rotational motion (2 classes)	Processing and analysis

	The research of the angular momentum of the Solar system object (2 classes)	Processing and analysis, Graph plotting
	Investigating the principle of conservation of momentum (1 class)	Smart Cart - PASCO
Theme B The particulate nature of matter	Measuring the specific heat capacity of a metal or water by the method of mixtures (2 classes)	Processing and analysis (Excel)
	Investigation of the conversion of work into heat (2 classes)	Processing and analysis (Excel)
	Investigation of the black body radiation (1 class)	Simulation
	Investigation of Boyle's law, Pressure law and Charles' law (2 classes)	Processing and analysis (Excel)
	Verifying of equation of state for an ideal gas (2 classes)	Processing and analysis (Excel)
	Measuring the resistivity of metal conductor (1 class)	Processing and analysis (Excel)
	Measuring the internal resistance (1 class)	Data logger- PASCO Graph plotting

Name of the topic Year 2	Experiment	Any ICT used? *Remember you must use all five within your programme.*
Theme C Wave behaviour	Measuring the mass of a body oscillating on a spring (2 classes)	Data logger PASCO
	Investigation how does damping affects periodic motion (1 class)	Simulation
	Measuring the speed of sound (2 classes)	Processing and analysis (Audio software)
	Investigation of propagation electromagnetic waves (microwaves) (2 classes)	Any, only observing
	Investigation of Doppler effect (1 class)	Simulation
	Measuring the refractive index of glass (2 classes)	Processing and analysis, Statistic (Excel)
	Measuring of wavelength using a diffraction grating (2 classes)	Processing and analysis, Statistic (Excel)
Theme D Fields	Gravity and orbits (1 class)	Simulation
	Performing experiments with charging and discharging bodies, observing the force interaction between charged bodies, observing electrostatic induction. (1 class)	Real observation, Data logger Pasco
	Investigation the variation of magnetic field strength due to a bar magnet (2 classes)	Data logger (smartphone), Processing and analysis, Graph plotting
	Investigation of Faraday's law of induction (2 classes)	Data logger PASCO
Theme E: Nuclear and quantum physics	Observing of the emission spectra (hydrogen, neon, sodium) (1 class)	Observing and working with database
	Investigation of wavelengths of the hydrogen spectrum (2 classes)	Processing and analysis, working with database

	Investigating half-life (2 classes)	Processing and analysis, Graph plotting (Video editor, Excel)
	Measuring the range of an alpha particle in air (2 classes)	Data logger Edupix
	Investigation of mass-luminosity relationship for main sequence stars above 2M⊙ in mass	Processing and analysis, working with database

General information
Internal assessment is an integral part of the course and is compulsory for both SL and HL students. It enables students to demonstrate the application of their skills and knowledge and to pursue their personal interests, without the time limitations and other constraints that are associated with written examinations. The internal assessment requirements at SL and at HL are the same.
The internal assessment task will be one scientific investigation taking the write up should be about 6 to 12 pages long. The maximum overall word count for the report is 3000 words. Investigations exceeding this length will be penalized in the communication criterion as lacking in conciseness.

Scheduling
Y1: By the half of May of the first IB DP year, students are introduced to the IA principles. In the following 2 weeks (half of June), students are shown sample IAs and the students brainstorm ideas matching their interests which they can imagine working on in their own IAs. Before the end of the first school year each student submits the final version of their topic and the research question.
Y2: At the beginning of the second school year, students conduct experiments and collect raw data. The first draft has to be submitted in mid-September and the final draft in the first week of October.

Assessment criteria
During the process of evaluation, Research design (25%), Data analysis (25%), Conclusion (25%), Evaluation (25%) will be considered.

For more detail see the Physics guide.

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 was modernised in 2021. It is equipped with a data projector and a smart board. There is a sufficient number of demonstration equipment and measuring instruments. These are both modern and historically valuable devices. Kits for independent work of students in groups are available for mechanics, electricity, optics and thermodynamics. Each workgroup has a laptop at its disposal. We own the PASCO digital measuring system (8 sets). Each kit contains a digital force meter, voltmeter, ammeter, position sensor, 2 Smart Carts, pressure gauge, thermometer and a magnetic induction probe. There is one set of EDUPix - Education laboratory set with Timepix particle detector.

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's classrooms are all equipped with computers, multimedia projectors, touch boards, speakers, and high-speed Wi-Fi. There is a computer lab and a well-equipped library with several multimedia and VR stations accessible to students. School library has a large number of books about physics in Czech language and there is the Scientific American magazine in Czech language available. The school has purchased resource materials for every subject including textbooks, subject guides and teaching methodology material available for all teachers. There is also online access to the library of Western Bohemia University in Pilsen which enables students and teachers to use a wide variety of resources, magazine articles, fiction and non-fiction literature, etc.
There are also printing and scanning stations available to students and teachers enabling them to work with and create various teaching and learning materials.
Overall, the amount and quality of available resources is sufficient to provide effective support to the Physics course.

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.

Topic	Link with TOK (including description of lesson plan)
D4 Electromagnetic induction	First, students will be asked to sketch the magnetic field around a bar magnet. They will be familiar with pictures of magnetic field lines from previous lessons. They will discuss in pairs what they know about the shape and meaning of these lines. What it means that somewhere these lines are denser together, somewhere they are thinner. An important question is whether these lines exist. The answer is that they don't exist. However, students can observe their shape using iron filings. Faraday's law of electromagnetic induction says: "The induced Emf in a circuit is equal to the rate of change of magnetic flux linkage trough the circuit." Magnetic flux equals to magnetic flux density times area. Magnetic flux density is defined in terms of field lines per area. But those field lines don´t exist, they are only representation of the shape the field takes. **They can take away questions from this activity for their TOK lessons:** To what extent can visual representation of abstract concept produce reliable knowledge? Are there ideas that we are unable comprehend without a visual representation? What about ideas that it's impossible to represent visually, does that mean that it is impossible for us to understand them (for example multiple dimensions).

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)
A2 Forces and momentum	**Thinking skills:** Students will become familiar with Newton's laws of motion and the law of the conservation of momentum, then students should be able to predict how an object will move when they know the forces that affect it. **Communication, social and research skills:** Small groups of students will investigate the relationship between force and acceleration and measure the acceleration of a free fall. They will present their results to the others. **Self-management skills**: Doing physics homework in the time given and with the desired level of knowledge and expertise.

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)
B1 Thermal energy transfer	At the beginning of the lesson, students will be given the following situation: Imagine flying to the USA for holidays. In the hotel room, the air conditioner is set to 66. Do you know what this number means? Assuming you feel comfortable at 21 °C, do you need to increase or decrease the temperature? Students can vote. This task is the motivation to discuss different temperature scales used in different countries. Students will work in small groups. Each group will be tasked with finding information about Celsius and another temperature scale (Rankin, Reamur, Farenheit). They will have to find out if and where this scale is still in use, what its reference points are and how a temperature value of this scale is converted to Celsius, which is common in Europe. Representatives of each group will present their findings about their temperature scale not commonly used in our country.

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
B5 Current and circuit	**Inquirers:** The lab exercises require students to design a procedure to study natural phenomena (Ohm's law, internal resistance of battery) and measure material property (resistivity). This enables students to develop applicable laboratory and research skills. **Thinkers:** Students will understand how resistors in series and in parallel affect the electrical current in the circuit. Based on this, they will be able to calculate the electric current in more complex circuits. **Communicators**: In the laboratory, students work in groups and learn to communicate effectively **Open-minded:** Students will understand that physics describes the world and seeks to reveal the laws of nature. Some of the qualities we attribute to matter are the result of an agreement among scientists. Physics has revealed the existence of two kinds of electrical charge, but the fact that we refer to the electron charge as negative and the proton charge as positive is just an agreement, and this designation could be assigned the other way around. **Caring**: Electrical cells and batteries contain chemicals that are harmful to the environment. After they are discharged, they should be disposed of or recycled in a specific way and students learn to consider environmental issues **Risk-takers:** Working with high voltage and electric current can be life-threatening. Nevertheless, people have been able to build power grids all over the world which may seem dangerous but are very beneficial.