Stony Point High School
IB Diploma Programme
Course Syllabus

IB-HL Physics

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Tutorial Hours: Mon-Fri 8:30-9:00 AM

I. Course Description: Physics II (IB), 4346 & 4342(TAG)
This course includes selected topics in mechanics, thermal physics, oscillations and waves, electric currents, fields and forces, atomic and nuclear physics, and energy/power/climate change.

II. Prior Learning for Course:
Credit in/or concurrent enrollment in Precalculus, #3609. All Diploma Programme physics students should be able to:

- perform the basic arithmetic functions: addition, subtraction, multiplication and division
- carry out calculations involving means, decimals, fractions, percentages, ratios, approximations and reciprocals
- carry out manipulations with trigonometric functions
- carry out manipulations with logarithmic and exponential functions (HL only)
- use standard notation (for example, 3.6 × 106)
- use direct and inverse proportion
- solve simple algebraic equations
- solve linear simultaneous equations

III. Course Aims & Objectives:

Through studying biology, chemistry or physics, students should become aware of how scientists work and communicate with each other. While the scientific method may take on a wide variety of forms, it is the emphasis on a practical approach through experimental work that characterizes these subjects. The aims enable students, through the overarching theme of the Nature of science, to:

1. appreciate scientific study and creativity within a global context through stimulating and challenging opportunities
2. acquire a body of knowledge, methods and techniques that characterize science and technology
3. apply and use a body of knowledge, methods and techniques that characterize science and technology
4. develop an ability to analyse, evaluate and synthesize scientific information
5. develop a critical awareness of the need for, and the value of, effective collaboration and communication during scientific activities
6. develop experimental and investigative scientific skills including the use of current technologies
7. develop and apply 21st-century communication skills in the study of science
8. become critically aware, as global citizens, of the ethical implications of using science and technology
9. develop an appreciation of the possibilities and limitations of science and technology
10. develop an understanding of the relationships between scientific disciplines and their influence on other areas of knowledge.

The assessment objectives for biology, chemistry and physics reflect those parts of the aims that will be formally assessed either internally or externally. These assessments will centre upon the nature of science. It is the intention of these courses that students are able to fulfill the following assessment objectives:

1. Demonstrate knowledge and understanding of:
    a. facts, concepts and terminology
    b. methodologies and techniques
    c. communicating scientific information.
2. Apply:
    a. facts, concepts and terminology
    b. methodologies and techniques
    c. methods of communicating scientific information.
3. Formulate, analyse and evaluate:
    a. hypotheses, research questions and predictions
    b. methodologies and techniques
    c. primary and secondary data
    d. scientific explanations.
4. Demonstrate the appropriate research, experimental, and personal skills necessary to carry out insightful and ethical investigations.

IV. How the course will address TOK:

TOK lessons can support students in their study of science, just as the study of science can support students in their TOK course. TOK provides a space for students to engage in stimulating wider discussions about questions such as what it means for a discipline to be a science, or whether there should be ethical constraints on the pursuit of scientific knowledge. It also provides an opportunity for students to reflect on the methodologies of science, and how these compare to the methodologies of other areas of knowledge. It is now widely accepted that there is no one scientific method, in the strict Popperian sense. Instead, the sciences utilize a variety of approaches in order to produce explanations for the behaviour of the natural world.

The different scientific disciplines share a common focus on utilizing inductive and deductive reasoning, on the importance of evidence, and so on. Students are encouraged to compare and contrast these methods with the methods found in, for example, the arts or in history. In this way there are rich opportunities for students to make links between their science and TOK courses. One way in which science teachers can help students to make these links to TOK is by drawing students' attention to knowledge questions that arise from their subject content. Knowledge questions are open-ended questions about knowledge such as:

- How do we distinguish science from pseudoscience?
- When performing experiments, what is the relationship between a scientist's expectation and their perception?
- How does scientific knowledge progress?
- What is the role of imagination and intuition in the sciences?
- What are the similarities and differences in methods in the natural sciences and the human sciences?

V. How the course will address CAS:

Creativity, activity & service (CAS) is at the heart of the Diploma Programme. It is one of the three essential elements in every student's Diploma Programme experience. It involves students in a range of activities alongside their academic studies throughout the Diploma Programme. Examples of CAS opportunities in Physics can be the field trip to Teco-Westinghouse facility, helping other students to understand physics concepts, or realization of physics concepts in everyday life experience.

VI. How the course will address Approaches to Learning skills

Both SL and HL Physics courses are developed around the ATL principles set forth by the IB. ATL are as follows:

Thinking skills – students will explore the world around us and compare the physics concepts they learn with everyday life experience.

Communication skills – students will communicate with one another to discuss their understanding in the physics concepts and express their opinions/ideas both verbally and through written form.

Social skills – Students will interact with each other every class period through discussion, group projects, hands-on activities, collaborative work, and peer review.

Self-management skills – Students will learn to manage their time and resources with multiple subjects and extracurricular activities. They will be responsible for their own learning.

Research skills – Students will participate in a variety of scientific investigations, building their inquiry skills. Students will use these skills to complete IA for Physics.

VII. The approach to teaching the course.

There are a variety of approaches to the teaching of physics. By its very nature, physics lends itself to an experimental approach, and it is expected that this will be reflected throughout the course. In each 90 minutes class, the course will be designed to have class lectures, class discussions, demonstrations, hands-on labs, working problems, and formative assessments.

By providing students with the opportunity for hands-on experimentation, they are carrying out some of the same processes that scientists undertake. Experimentation allows students to experience the nature of scientific thought and investigation. All scientific theories and laws begin with observations. It is important that students are involved in an inquiry-based practical programme that allows for the development of scientific inquiry. It is not enough for students just to be able to follow directions and to simply replicate a given experimental procedure; they must be provided with the opportunities for genuine inquiry. Developing scientific inquiry skills will give students the ability to construct an explanation based on reliable evidence and logical reasoning. Once developed, these higher order thinking skills will enable students to be lifelong learners and scientifically literate. Also, Students are expected to work collaboratively with others during lab and discussion sessions. Formative assessments include problems from old IB tests to prepare for external assessment.

VIII. How the course will address the Learner Profile.

The physics course contributes to the development of the IB learner profile. For example, the requirements of the internal assessment provide opportunities for students to develop every aspect of the profile.

Learner profile attribute	Biology, Chemistry and Physics
Inquirers	Aims 2 and 6, Practical work and internal assessment
Knowledgeable	Aims 1 and 10, international-mindedness links, Practical work and internal assessment
Thinkers	Aims 3 and 4, theory of knowledge links, Practical work and internal assessment
Communicators	Aims 5 and 7, external assessment, Practical work and internal assessment, the group 4 project
Principled	Aims 8 and 9 Practical work and internal assessment, ethical behaviour/practice (*Ethical practice* poster, *Animal experimentation policy*), academic honesty
Open-minded	Aims 8 and 9, international-mindedness links, Practical work and internal assessment, the group 4 project
Caring	Aims 8 and 9, Practical work and internal assessment, the group 4 project, ethical behaviour/practice(*Ethical practice* poster, *Animal experimentation policy*)
Risk-takers	Aims 1 and 6, Practical work and internal assessment, the group 4 project
Balanced	Aims 8 and 10, Practical work and internal assessment, the group 4 project and field work
Reflective	Aims 5 and 9, Practical work and internal assessment, the group 4 project

IX. Assessment details for Internal and External Requirements:

External Assessment Details (HL): weight 80%

Component	Overall weighting (%)	Approximate weighting of objectives (%)		Duration (hours)	Format & Syllabus coverage
		1+2	3		
Paper 1	20%	10	10	1	➢40 multiple-choice questions on core, about 15 which are common with HL. ➢The questions on paper 1 test assessment objectives 1, 2 and 3. ➢The use of calculators is not permitted. ➢No marks are deducted for incorrect answers. ➢A physics data booklet is provided.
Paper 2	36%	18	18	2¼	➢ Short-answer and extended response questions on core material. ➢The questions on paper 2 test assessment objectives 1, 2 and 3. ➢ The use of calculators is permitted. (See calculator section on the OCC.) ➢ A physics data booklet is provided.
Paper 3	24%	12	12	1¼	➢This paper will have questions on core and HL option material. ➢ Section A: one data-based question and several short-answer questions on experimental work. ➢Section B: short-answer and extended-response questions from one option. ➢The questions on paper 3 test assessment objectives 1, 2 and 3. ➢The use of calculators is permitted. A physics data booklet is provided.

External Assessment Details (SL): weight 80%

Component	Overall weighting (%)	Approximate weighting of objectives (%)		Duration (hours)	Format & Syllabus coverage
		1+2	3		
Paper 1	20%	10	10	1	➢ 30 multiple-choice questions on core, about 15 which are common with HL. ➢ The questions on paper 1 test assessment objectives 1, 2 and 3. ➢ The use of calculators is not permitted. ➢No marks are deducted for incorrect answers. ➢A physics data booklet is provided.
Paper 2	40%	20	20	1¼	➢Short-answer and extended response questions on core material. ➢ The questions on paper 2 test assessment objectives 1, 2 and 3. ➢The use of calculators is permitted. ➢A physics data booklet is provided.
Paper 3	20%	10	10	1	➢This paper will have questions on core and SL option material. ➢Section A: one data-based question and several short-answer questions on experimental work. ➢ Section B: short-answer and extended-response questions from one option. ➢ The questions on paper 3 test assessment objectives 1, 2 and 3. ➢ The use of calculators is permitted. ➢A physics data booklet is provided.

Internal Assessment Details: weight 20%

Purpose: Internal assessment is an integral part of the course and is compulsory for both SL and HL students. It enables students the internal assessment should, as far as possible, be woven into normal classroom teaching and 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.

General Introduction: The individual investigation should cover a topic that is commensurate with the level of the course of study. Student work is internally assessed by the teacher and externally moderated by the IB. The performance in internal assessment at both SL and HL is marked against common assessment criteria, with a total mark out of 24. The internal assessment task will be one scientific investigation taking about 10 hours and the write-up should be about 6 to 12 pages long. Investigations exceeding this length will be penalized in the communications criterion as lacking in conciseness. The task produced should be complex and commensurate with the level of the course. It should require a purposeful research question and the scientific rationale for it.

Some of the possible tasks include:

- a hands-on laboratory investigation
- using a spreadsheet for analysis and modelling
- extracting data from a database and analysing it graphically
- producing a hybrid of spreadsheet/database work with a traditional hands-on investigation
- using a simulation, provided it is interactive and open-ended

Some task may consist of relevant and appropriate qualitative work combined with quantitative work.

The tasks include the traditional hands-on practical investigations as in the previous course. The depth of treatment required for hands-on practical investigations is unchanged from the previous internal assessment and will be shown in detail in the teacher support materials. In addition, detailed assessment of specific aspects of hands-on practical work will be assessed in the written papers as detailed in the relevant topic(s) in the "Syllabus content" section of the guide.

Internal Assessment Criteria: The new assessment model uses five criteria to assess the final report of the individual investigation with the following raw marks and weightings assigned:

Personal Engagement	Exploration	Analysis	Evaluation	Communication	Total
2(8%)	6(25%)	6(25%)	6(25%)	4(17%)	24(100%)

Levels of performance are described using multiple indicators per level. In many cases the indicators occur together in a specific level, but not always. Also, not all indicators are always present. This means that a candidate can demonstrate performances that fit into different levels.

Personal Engagement: This criterion assesses the extent to which the student engages with the exploration and makes it their own. Personal engagement may be recognized in different attributes and skills. These could include addressing personal interests or showing evidence of independent thinking, creativity or initiative in the designing, implementation or presentation of the investigation.

Exploration: This criterion assesses the extent to which the student establishes the scientific context for the work, states a clear and focused research question and uses concepts and techniques appropriate to the Diploma Programme level. Where appropriate, this criterion also assesses awareness of safety, environmental, and ethical considerations.

Analysis: This criterion assesses the extent to which the student's report provides evidence that the student has selected, recorded, processed and **interpreted** the data in ways that are relevant to the research question and can support a conclusion.

Evaluation: This criterion assesses the extent to which the student's report provides evidence of evaluation of the investigation and the results with regard to the research question and the accepted scientific context.

Communication: This criterion assesses whether the investigation is presented and reported in a way that supports effective communication of the focus, process and outcomes.

X. Grading Policy & Scale:

IB Physics class is weighted on a 6.0 scale.
In IB Physics, grades will be weighted as follows:

- Summative Assessments: 40 % tests and quizzes
- Formative Assessments: 60 % lab reports, notes, daily assignments

Teachers are required to have one grade per week beginning the first full week of school. Teachers update Home Access Center (HAC) weekly. Students are encouraged to check home access once a week in order to monitor their grades and progress. There will be at least 2 or 3 tests per marking period. The student has a responsibility to coordinate retakes and make-up work with his/her teacher.

XI. Course Sequence:

Core	95 hours
Topic 1: Measurements and uncertainties 1.1 – Measurements in physics 1.2 – Uncertainties and errors 1.3 – Vectors and scalars	**5**
Topic 2: Mechanics 2.1 – Motion 2.2 – Forces 2.3 – Work, energy and power 2.4 – Momentum and impulse	**22**
Topic 3: Thermal physics 3.1 – Thermal concepts 3.2 – Modelling a gas	**11**
Topic 4: Waves 4.1 – Oscillations 4.2 – Travelling waves 4.3 – Wave characteristics 4.4 – Wave behaviour 4.5 – Standing waves	**15**
Topic 5: Electricity and magnetism 5.1 – Electric fields 5.2 – Heating effect of electric currents 5.3 – Electric cells 5.4 – Magnetic effects of electric currents	**15**
Topic 6: Circular motion and gravitation 6.1 – Circular motion	**5**

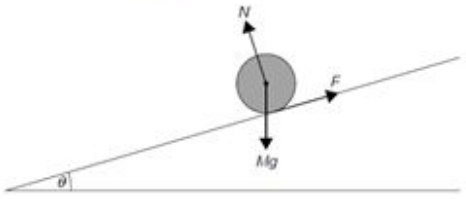
6.2 – Newton's law of gravitation	
Topic 7: Atomic, nuclear and particle physics 7.1 – Discrete energy and radioactivity 7.2 – Nuclear reactions 7.3 – The structure of matter	**14**
Topic 8: Energy production 8.1 – Energy sources 8.2 – Thermal energy transfer	**8**
Additional Higher Level (AHL)	**60 hours**
Topic 9: Wave phenomena 9.1 – Simple harmonic motion 9.2 – Single-slit diffraction 9.3 – Interference 9.4 – Resolution 9.5 – Doppler effect	**17**
Topic 10: Fields 10.1 – Describing fields 10.2 – Fields at work	**11**
Topic 11: Electromagnetic induction 11.1 – Electromagnetic induction 11.2 – Power generation and transmission 11.3 – Capacitance	**16**
Topic 12: Quantum and nuclear physics 12.1 – The interaction of matter with radiation 12.2 – Nuclear physics	**16**
Options	
B: Engineering physics (SL) B.1 – Rigid bodies and rotational dynamics B.2 – Thermodynamics	**15**
B: Engineering physics (HL) B.1 – Rigid bodies and rotational dynamics B.2 – Thermodynamics B.3 – Fluids and fluid dynamics B.4 – Forced vibrations and resonance	**25**

XII. IA Checkpoint Dates and Final IA Deadlines:

Failure to meet checkpoints will be communicated with the IB coordinator. All checkpoint submissions will be turned in electronically on the date listed below, regardless of A/B schedule. Rough draft and final submission dates are recorded on the SPHS IA Calendar.

	HL	**SL**
IA Topics/Proposals	Sept. 30th, 2020	Jan. 22nd, 2021
IA Rough Draft	Jan. 6th, 2021	Feb. 26th, 2021
IA Final Draft	Feb. 17th, 2021	Mar. 22nd, 2021

XIII. Sample Exam Questions:

Paper 1	A skydiver of mass 80 kg falls vertically with a constant speed of 50 ms^{-1}. The upward force acting on the skydiver is approximately A. 0 N B. 80 N C. 800 N D. 4000 N	Answer: C When object is moving at a constant velocity, net force is zero. The forces acting on the skydiver is F_g and the upward force. Therefore, $F_g = F_{upward}$
Paper 2	State what is meant by an *ideal* gas. [2]	Gas that obeys the equation pV=nRT / no forces between molecules (1pt); at all pressures, volumes and temperatures/or any other postulate (1pt);
Paper 3	A solid cylinder of mass M and radius R rolls without slipping down a uniform slope. The slope makes an angle θ to the horizontal.  The diagram shows the three forces acting on the cylinder. N is the normal reaction force and F is the frictional force between the cylinder and the slope. (a) State why F is the only force providing a torque about the axis of the cylinder. [1]	because Mg and N act through the axis ***OR*** only F has a non-zero lever arm «about the axis»

XIV. Stony Point Academic Honesty Policy:

All students are expected to abide by the SPHS Academic Honesty Policy. This policy is available on the SPHS IB website at www.stonypointib.com under Handbooks. The password is Tiger2021.

Here are some guidelines to help students define cheating and plagiarism. Students should report any suspected violations to these policies immediately.

Cheating

Looking off another person's exam for answers
Collaborating with others on work that is supposed to be completed independently
Copying another student's homework, written assignments, examination answers, electronic media, or other data.
Assisting or allowing someone else to cheat.
Willfully copying or allowing class assignments to be copied and falsely presenting them as your own work and effort.
Using unauthorized materials such as books, notes, or "cheat" sheets to answer examination questions
Using or consulting electronic equipment including cell phones, PDA's, IPODS, etc. during a testing situation.
Being informed or informing, verbally or otherwise, of test questions or answers either during or prior to the testing situation.

Plagiarism

Representing the ideas, expressions, or materials of another without due credit.
Paraphrasing or condensing ideas from another person's work without proper citation.
Failing to document direct quotations and paraphrases with proper citation.
Submitting a paper purchased from a research or term paper service, including the Internet.
Undocumented Web source usage.

XV. Writing an Extended Essay in Science:

An extended essay (EE) in physics provides students with an opportunity to apply a range of skills while researching a topic of personal interest in the field of physics. It should take the form of a research paper involving hypothesis or a model, or a critical analysis, that demonstrates argumentation, comparison, or the extraction of relevant information or data. Some topics may be unsuitable for investigation because of safety issues. For example, experiments involving dangerous or carcinogenic substances, radioactive materials, lasers, microwaves, UV light, noise or heavy equipment should be avoided unless adequate safety apparatus and qualified supervision are available.

Here are some examples of titles for physics EE (these are intended for guidance only):

Title	**The deflection of starlight by the Sun's gravitational field**
Research Question	What will be the angular deflection of starlight by the Sun if Newton's Universal Law of Gravitation is applied?
Approach	A theoretical (numerical) approach is taken. Assuming a corpuscular model of light, the motion of these corpuscles moving at the speed of light in a gravitational fields is followed by iteration. The results are compared to the one derived from general relativity.
Title	**The efficiency of electromagnetic damping**
Research Question	Is the efficiency of electromagnetic damping of a moving glider a function of the initial

	kinetic energy of the glider?
Approach	An experimental approach is taken. The energy budget of a coil-carrying glider going through magnetic braking on a linear air track is followed by comparing the mechanical energy lost to the thermal energy generated in the coil.

Research methods include experimental, data-based, or theoretical. For data-based research, students may use the SPHS library database.

XVI. Classroom Policy & Procedure:

Late Paper Policy: All work is due at the beginning of class. Late assignments will not be accepted after the 10th calendar day from when an assignment is due as specified in the gradebook. The maximum grade possible for late work is a 70.

Make Up Work Policy: Make up work will be accepted based upon student needs. All students can make up quizzes and tests by making corrections on each wrong question.

Classroom Expectations: All students will abide by the campus policies and procedures. Respect, integrity, and perseverance are expected within the classroom.