Ontario eSecondary School
Course Outline
2024-2025

Ministry of Education Course Title: Physics, Grade 12, University Preparation	
Ministry Course Code: SPH4U	
Course Type: University Preparation	
Grade: 12	
Credit Value: 1.0	
Prerequisite(s): Physics, Grade 11, University Preparation	
Department: Science	
Course developed by: **George Murzaku**	**Date: September 1, 2017** **Revised: May 30, 2019**
Length: **One Semester**	**Hours:** **110**

This course has been developed based on the following Ministry documents:

1. *The Ontario Curriculum, Grades 11 and 12 Science, Revised 2008*
2. *Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools (2010)*
3. *Learning for All (2013)*

COURSE DESCRIPTION/RATIONALE

This course enables students to deepen their understanding of physics concepts and theories. Students will continue their exploration of energy transformations and the forces that affect motion, and will investigate electrical, gravitational, and magnetic fields and electromagnetic radiation. Students will also explore the wave nature of light, quantum mechanics, and special relativity. They will further develop their scientific investigation skills, learning, for example, how to analyse, qualitatively and quantitatively, data related to a variety of physics concepts and principles. Students will also consider the impact of technological applications of physics on society and the environment.

OVERALL CURRICULUM EXPECTATIONS

A. Scientific Investigation skills and Career Exploration

By the end of this course, students will:

- A1. demonstrate scientific investigation skills (related to both inquiry and research) in the four areas of skills (initiating and planning, performing and recording, analysing and interpreting, and communicating)
- A2. identify and describe careers related to the fields of science under study, and describe the contributions of scientists, including Canadians, to those fields.

B. Dynamics

By the end of this course, students will:

- B1. analyse technological devices that apply the principles of the dynamics of motion, and assess the technologies' social and environmental impact;
- B2. investigate, in qualitative and quantitative terms, forces involved in uniform circular motion and motion in a plane, and solve related problems;
- B3. demonstrate an understanding of the forces involved in uniform circular motion and motion in a plane.

C. Energy and Momentum

By the end of this course, students will:

- C1. analyse, and propose ways to improve, technologies or procedures that apply principles related to energy and momentum, and assess the social and environmental impact of these technologies or procedures;
- C2. . investigate, in qualitative and quantitative terms, through laboratory inquiry or computer simulation, the relationship between the laws of conservation of energy and conservation of momentum, and solve related problems;
- C3. demonstrate an understanding of work, energy, momentum, and the laws of conservation of energy and conservation of momentum, in one and two dimensions.

D. Gravitational, Electric, and Magnetic Fields

By the end of this course, students will:

- D1. analyse the operation of technologies that use gravitational, electric, or magnetic fields, and assess the technologies' social and environmental impact;
- D2. . investigate, in qualitative and quantitative terms, gravitational, electric, and magnetic fields, and solve related problems;
- D3.demonstrate an understanding of the concepts, properties, principles, and laws related to gravitational, electric, and magnetic fields and their interactions with matter

E. The wave nature of Light

By the end of this course, students will:

- E1. analyse technologies that use the wave nature of light, and assess their impact on society and the environment;

- E2. investigate, in qualitative and quantitative terms, the properties of waves and light, and solve related problems;
- E3. demonstrate an understanding of the properties of waves and light in relation to diffraction, refraction, interference, and polarization.

COURSE CONTENT

Unit	*Length*
Unit 0: Skills Handbook	5 hours
Unit 1: Motion on a Plane	30 hours
Unit 2: Work, Energy, and Momentum	20 hours
Unit 3: Gravitational, Electric, and Magnetic Field	22 hours
Unit 4: Wave Nature of Light	13 hours
Unit 5: Modern Physics	13 hours
Culminating Project and Final Exam	7 hours
Total	**110 Hours**

UNIT DESCRIPTIONS

Unit 0 - Skills handbook
Students will learn how to properly use significant digits in their measurements and problem solving situations. They will learn to use unit analysis techniques to verify the correctness of their solutions or derived formula in their lab activities. Students will learn how to analyze measurement errors quantitatively and qualitatively.

Unit 1 - Motion on a plane
Students will investigate, in qualitative and quantitative terms, forces involved in uniform circular motion and motion in a plane, and solve related problems. They will demonstrate an understanding of the forces involved in uniform circular motion and motion in a plane. Students will analyse technological devices that apply the principles of the dynamics of motion, and assess the technologies' social and environmental impact. Students will use critical thinking and inquiry skills to prepare, conduct, and write a lab investigation.

Unit 2 - Momentum and Energy
Students will investigate, in qualitative and quantitative terms, through laboratory inquiry or computer simulation, the relationship between the laws of conservation of energy and conservation of momentum, and solve related problems. They will demonstrate an understanding of work, energy, momentum, and the laws of conservation of energy and conservation of momentum, in one and two dimensions. Students will analyse, and propose ways to improve, technologies or procedures that apply principles related to energy and momentum, and assess the social and environmental impact of these technologies or procedures. Students will use critical thinking and inquiry skills to prepare, conduct, and write a lab investigation.

Unit 3- Gravitational, Electric, Magnetic Field
Students will investigate, in qualitative and quantitative terms, gravitational, electric, and magnetic fields, and solve related problems. They will demonstrate an understanding of the concepts, properties, principles, and laws related to gravitational, electric, and magnetic fields and their interactions with matter. Students will analyse the operation of technologies that use gravitational, electric, or magnetic fields, and assess the technologies' social and environmental impact.

Students will use critical thinking and inquiry skills to prepare, conduct, and write a lab investigation.

Unit 4 - Wave Nature of Light

Students will investigate, in qualitative and quantitative terms, the properties of waves and light, and solve related problems. They will demonstrate an understanding of the properties of waves and light in relation to diffraction, refraction, interference, and polarization. Students will analyse technologies that use the wave nature of light, and assess their impact on society and the environment. They will use critical thinking and inquiry skills to prepare, conduct, and write a lab investigation.

Unit 5 - Modern Physics; Quantum mechanics and Relativity

Students will investigate special relativity and quantum mechanics, and solve related problems. They will demonstrate an understanding of the evidence that supports the basic concepts of quantum mechanics and Einstein's theory of special relativity. Students will analyse, with reference to quantum mechanics and relativity, how the introduction of new conceptual models and theories can influence and/or change scientific thought and lead to the development of new technologies. They will use critical thinking and inquiry skills to prepare, conduct, and write a lab investigation.

TEACHING AND LEARNING STRATEGIES

In this course, students will experience the following activities.

Presentations with embedded videos are utilized to outline concepts, explain theory with the use of examples and practice questions, and incorporate multi-media opportunities for students to learn more (e.g. online simulations, quizzes, etc.).

End of unit conversations and Poodlls are opportunities for students to express their ideas, problem solving, and thought processes with a teacher who provides timely feedback.

Reflection is an opportunity for students to look back at concepts and theories with new eyes, to relate theory to practice, and to align learning with their own values and beliefs.

Discussions with the instructor are facilitated through video conferencing, discussing the concepts and skills being studied. This enables two-way communication between the student and the instructor, to share ideas and ask questions in dialogue. This also helps to build a relationship between the student and instructor.

Instructor demonstrations (research skills, etc.) are opportunities for the instructor to lead a student through a concept or skill through video conferencing, videos, or emailing with the student.

Discussion forums are an opportunity for students to summarize and share their ideas and perspectives with their peers, which deepens understanding through expression. It also provides an opportunity for peer-to-peer feedback.

Practical extension and application of knowledge are integrated throughout the course. The goal is to help students make connections between what they learn in the classroom and how they understand and relate to the world around them and their own lives. Learning becomes a dynamic opportunity for students to be more aware that their learning is all around them and enable them to create more meaning in their lives.

Individual activities/assignments assessments are completed individually at a student's own pace and are intended to expand and consolidate the learning in each lesson. Individual activities allow the teacher to accommodate interests and needs and to assess the progress of individual students. For this reason, students are encouraged to discuss IEPs (Individual Education Plans) with their

teacher and to ask to modify assessments if they have a unique interest that they feel could be pursued in the assessment. The teacher plays an important role in supporting these activities by providing ongoing feedback to students, both orally and in writing.

Research is an opportunity to apply inquiry skills to a practical problem or question. Students perform research to gather information, evaluate quality sources, analyze findings, evaluate their analysis, and synthesize their findings into conclusions. Throughout, students apply both creative thinking and critical thinking. New questions are also developed to further learning.

Writing as a learning tool helps students to think critically about course material while grasping, organizing, and integrating prior knowledge with new concepts. Good communication skills are important both in and out of the classroom.

Virtual simulations are interactive websites that provide students with an opportunity to ask questions, explore hypotheses, relate variables, examine relationships, and make connections between theory and application in a safe environment that promotes intellectual risk taking and curiosity.

Virtual labs are interactive websites that provide students with an opportunity to follow a procedure to test hypotheses using scientific apparatus, gather and record observations, analyze observations using formula and relevant theory/concepts, and then formulate conclusions that relate hypotheses to analysis.

Diagrams are visual representations of scientific ideas and concepts. They provide another perspective to organize ideas. Visuals are thought to promote cognitive plasticity - meaning, they can help us change our minds or help us to remember an idea.

Graphics/images are visual representations of ideas/concepts. Visuals are thought to promote cognitive plasticity - meaning, they can help us change our minds or help us to remember an idea.

Charts are visual representations of scientific ideas and concepts using math that support analysis. For example, you can have a pie chart that shows Canada's energy sources.

Tables involve organizing information in terms of categories (rows and columns). This helps us to understand the relationships between ideas and data, as well as highlight trends.

Drawings and schematics are scientific and engineering ideas explained visually. For example, an electric circuit can be explained using symbols, which makes it possible to communicate ideas universally, clearly, and succinctly.

Articles are examples of concepts and theories being discussed in the public realm and with respect to current events. They are snapshots not only of why scientific theories/concepts/applications are relevant but also provide a window into the broader context of scientific knowledge and understanding. Students learn through reading and analysis that science is deeply related to, and intertwined with, society and the diverse perspectives of lived experience.

Practice problems provide students with a scenario/problem to solve by applying concepts and skills learned in a context. This helps students to understand the relevance of their learning.

ASSESSMENT, EVALUATION, AND REPORTING

Assessment: The process of gathering information that accurately reflects how well a student is achieving the identified curriculum expectations. Teachers provide students with descriptive feedback that guides their efforts towards improved performance.

Evaluation: Assessment of Learning focuses on Evaluation which is the process of making a judgement about the quality of student work on the basis of established criteria over a limited, reasonable period of time.

Reporting: Involves communicating student achievement of the curriculum expectations and Learning Skills and Work Habits in the form of marks and comments as determined by the teacher's use of professional judgement.

STRATEGIES FOR ASSESSMENT

Assessment practices can nurture students' sense of progress and competency and information instruction. Many diagnostic tools, e.g. checklists, are used at regular intervals throughout the units to encourage students' understanding of their current status as learners and to provide frequent and timely reviews of their progress. Assessment of student acquisition of learning skills also occurs regularly through unobtrusive teacher observation and conferencing.

Teachers are encouraged to share goals with students early in the course and to connect unit learning experiences frequently and explicitly with big ideas, overall expectations, and performance tasks. The teacher is encouraged to involve students in the discussion, modification, or creation of rubrics, and teach students to use rubrics as a learning tool.

ASSESSMENT ACTIVITIES

- ❑ Homework assignments
- ❑ Individual conference meetings
- ❑ Discussion Forums
- ❑ Diagnostic tests and writing tasks
- ❑ Completed Templates & Graphic Organizers
- ❑ Lab report
- ❑ Video Assignment
- ❑ Reflections
- ❑ Oral presentations & Active Listening
- ❑ Tests & Exam
- ❑ Evaluations

	Weight
Course Work	**70**
Knowledge/Understanding (K)	20
Thinking/Inquiry (T)	15
Communication (C)	15
Application (A)	20
Final	**30**
Exam (5K, 5T, 5C, 5A)	20
Culminating Project (2.5K, 2.5T, 2.5C, 2.5A)	10

TERM WORK EVALUATIONS (70%)

Evaluation Item	Description	Category	Weight
Unit 0 Online Quiz	Multiple choice quizzes will evaluate the understanding of the content learned	K,T	5
Unit 1 Kinematics Quiz	Multiple choice quizzes will evaluate the understanding of the content learned	K,T	15
Unit 1 Lab	Video Lab report and lab reports are used to evaluate students' thinking and communication skills. Live interviews are used to evaluate students through observation and conversation.	T,C	
Unit 1 Test	These tests will evaluate the ability of a student to tackle own misconceptions	K,A	
Unit 2 Energy and momentum quiz	Multiple choice quizzes will evaluate the understanding of the content learned	K,T	15
Unit 2 Lab	Video Lab report and lab reports are used to evaluate students' thinking and communication skills. Live interviews are used to evaluate students through observation and conversation.	T,C	
Unit 2 Test	These tests will evaluate the ability of a student to tackle own misconceptions	K,A	
Unit 3 Gravity, Electricity, and Magnetism Quiz	Multiple choice quizzes will evaluate the understanding of the content learned	K,T	12
Unit 3 Lab	Video Lab report and lab reports are used to evaluate students' thinking and communication skills. Live interviews are used to evaluate students through observation and conversation.	T,C	
Unit 3 Test	These tests will evaluate the ability of a student to tackle own misconceptions	K,A	
Unit 4 Optics Quiz	Multiple choice quizzes will evaluate the understanding of the content learned	K,T	12
Unit 4 Lab	Video Lab report and lab reports are used to evaluate students' thinking and communication skills. Live interviews are used to evaluate students through observation and conversation.	T,C	
Unit 4 Test	These tests will evaluate the ability of a student to tackle own misconceptions	K,A	
Unit 5 Modern Physics Quiz	Multiple choice quizzes will evaluate the understanding of the content learned	K,T	11
Unit 5 Lab	Video Lab report and lab reports are used to evaluate students' thinking and communication	T,C	

	skills. Live interviews are used to evaluate students through observation and conversation.		
Unit 5 Presentation	Research-based projects for each unit based on applications of learned concept/law to real life problems	K, T, C, A	

FINAL EVALUATIONS (30%)

Evaluation Item	Description	Category	Weight
Final Project	A comprehensive project, covering all overall curriculum expectations for the course.	K, T, C, A	10
Final Exam	A final, written examination, covering all curriculum expectations for the course.	K, T, C, A	20

AFL/AAL/AOL Tracking Sheet

Unit 0:

AAL	**AFL**	**AOL**
Lesson notes	Online quiz	Online Quiz
Discussion forum	Lesson Problem Set [Self-Check Answers]	
Gizmos Investigation		

Unit 1:

AAL	**AFL**	**AOL**
Discussion Forum	Conceptual test 1D Conceptual test 2D Conceptual test Dynamics Conceptual test Circular Motion	Quiz on Kinematics 1D, 2D, Dynamics, Circular Motion
Lesson notes	Online quiz 1D Online quiz 2D Online quiz Dynamics Online quiz Circular Motion	Unit Lab (Circular Motion) video report and written report
Gizmo investigation	Lesson Problem Sets [Self-Check Answers] → Kinematics 1D → Kinematics 2D → Dynamics → Circular Motion	Unit Test

Unit 2:

AAL	**AFL**	**AOL**
Discussion Forum	Conceptual test Energy Conceptual test Momentum	Quiz on Energy and Momentum
Lesson notes	Online quiz Energy Online quiz Momentum	Unit Lab (elastic energy) video report and written report
Gizmo investigation	Lesson Problem Sets [Self-Check Answers] → Energy → Momentum	Unit Test

Unit 3:

AAL	**AFL**	**AOL**
Discussion Forum	Conceptual test Electricity Conceptual test Magnetism	Quiz on Gravity, Electricity, and Magnetism
Lesson notes	Online quiz Gravitational Field Online quiz Electric Field Online quiz Magnetic Field	Unit Lab (Magnetic force) video report and written report
Gizmo investigation	Lesson Problem Sets [Self-Check Answers] → Electricity → Magnetism	Unit Test

Unit 4:

AAL	**AFL**	**AOL**
Discussion Forum	Conceptual test Optics	Quiz on Optics
Lesson notes	Online quiz Optics	Unit Lab (Double Slit) video report and written report
Gizmo investigation	Lesson Problem Sets [Self-Check Answers] → Optics (double slit, single slit, thin film interference)	Unit Test

Unit 5:

AAL	**AFL**	**AOL**

Discussion Forum	Conceptual test Relativity	Quiz on Modern Physics
Lesson notes	Online quiz Relativity Online quiz Quantum Mechanics	Unit Lab (Photoelectric Effect); video report and written report
Gizmo investigation	Lesson Problem Sets [Self-Check Answers] → Relativity → Quantum Mechanics	Unit Project: Video presentation of photons polarization and quantum mechanics

Finals

AOL
Culminating Activity; two options
Final Exam (6 complex problems with full solutions)

EVALUATION

The final grade will be determined as follows:

- ❑ 70% of the grade will be based on evaluation conducted throughout the course. This portion of the grade should reflect the student's most consistent level of achievement throughout the course, although special consideration will be given to more recent evidence of achievement.
- ❑ 30% of the grade will be based on a final evaluation administered at or towards the end of the course. This evaluation will be based on evidence from one or a combination of the following: an examination, a performance, and/or another method of evaluation suitable to the course content. The final evaluation allows the student an opportunity to demonstrate comprehensive achievement of the overall expectations for the course.

  (*Growing Success: Assessment, Evaluation and Reporting in Ontario Schools*. Ontario Ministry of Education Publication, 2010 p.41)

CONSIDERATION FOR PROGRAM PLANNING

PLANNING PROGRAMS FOR STUDENTS WITH SPECIAL EDUCATION NEEDS

Classroom teachers are the key educators of students who have special education needs. They have a responsibility to help all students learn, and they work collaboratively with special education teachers, where appropriate, to achieve this goal. Special Education Transformation: The Report of the Co-Chairs with the Recommendations of the Working Table on Special Education, 2006 endorses a set of beliefs that should guide program planning for students with special education needs in all disciplines. Those beliefs are as follows: All students can succeed. Universal design and differentiated instruction are effective and interconnected means of meeting the learning or productivity needs of any group of students. Successful instructional practices are founded on evidence-based research, tempered by experience.

PROGRAM CONSIDERATIONS FOR ENGLISH LANGUAGE LEARNERS

Ontario schools have some of the most multilingual student populations in the world. The first language of approximately 20 percent of the students in Ontario's English language schools is a language other than English. Ontario's linguistic heritage includes several Aboriginal languages; many African, Asian, and European languages; and some varieties of English, such as Jamaican Creole. Many English language learners were born in Canada and raised in families and communities in which languages other than English were spoken, or in which the variety of English spoken differed significantly from the English of Ontario classrooms. Other English language learners arrive in Ontario as newcomers from other countries; they may have experience of highly sophisticated educational systems, or they may have come from regions where access to formal schooling was limited. When they start school in Ontario, many of these students are entering a new linguistic and cultural environment.

THE ROLE OF TECHNOLOGY IN THE PROGRAM

Information and communications technologies (ICT) provide a range of tools that can significantly extend and enrich teachers' instructional strategies and support students' language learning. ICT tools include multimedia resources, databases, Internet websites, digital cameras, and word-processing programs. Tools such as these can help students to collect, organize, and sort the data they gather and to write, edit, and present reports on their findings. Information and communications technologies can also be used to connect students to other schools, at home and abroad, and to bring the global community into the local classroom. Whenever appropriate, therefore, students should be encouraged to use ICT to support and communicate their learning.

ACCOMMODATIONS

Accommodations will be based on meeting with parents, teachers, administration and external educational assessment reports. The following three types of accommodations may be provided:

- ***Instructional accommodations:*** such as changes in teaching strategies, including styles of presentation, methods of organization, or use of technology and multimedia.
- ***Assessment accommodations:*** such as allowing additional time to complete tests or assignments or permitting oral responses to test questions.

Other examples of modifications and aids, which may be used in this course, are:

- Provide step-by-step instructions.
- Help students create organizers for planning writing tasks.
- Allow students to report verbally to a scribe (teacher/ student) who can help in note taking.
- Permit students a range of options for reading and writing tasks.
- Where an activity requires reading, provide it in advance.
- Provide opportunities for enrichment.