

Erindale College

Assessment Period:	2021 S2
Course:	PHYSICS
Unit:	Unit 4: Revolutions in Modern Physics (1.0)
Accreditation:	T
Year:	12

Unit Goals

- understand the consequences for space and time of the equivalence principle for inertial frames of reference
- understand how the quantum theory of light and matter explains blackbody radiation, the photoelectric effect, and atomic emission and absorption spectra
- understand how the Standard Model explains the nature of and interaction between the fundamental particles that form the building blocks of matter
- understand how models and theories have developed over time, and the ways in which physical science knowledge and associated technologies interact with social, economic, cultural and ethical considerations
- use science inquiry skills to design, conduct, analyse and evaluate investigations into frames of reference, diffraction, black body and atomic emission spectra, the photoelectric effect, and photonic devices, and to communicate methods and findings
- use algebraic and graphical models to solve problems and make predictions related to the theory and applications of special relativity, quantum theory and the Standard Model
- evaluate the experimental evidence that supports the theory of relativity, wave-particle duality, the Bohr model of the atom, the Standard Model, and the Big Bang theory
- communicate physics understanding using qualitative and quantitative representations in appropriate modes and genres

Content Description

Science Inquiry Skills

- identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes
- design investigations, including the procedure to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics
- conduct investigations, including use of simulations and manipulation of spectral devices, safely, competently and methodically for the collection of valid and reliable data
- represent data in meaningful and useful ways, including using appropriate SI units, symbols and significant figures; organise and analyse data to identify trends, patterns and relationships; identify sources of uncertainty and techniques to minimise these uncertainties; utilise uncertainty and percentage uncertainty to determine the cumulative uncertainty resulting from calculations, and evaluate the impact of measurement uncertainty on experimental results; and select, synthesise and use evidence to make and justify conclusions
- interpret a range of scientific and media texts, and evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments
- select, construct and use appropriate representations, including text and graphic representations of

empirical and theoretical relationships, simulations, simple reaction diagrams and atomic energy level diagrams, to communicate conceptual understanding, solve problems and make predictions

- select, use and interpret appropriate mathematical representations, including linear and non-linear graphs and algebraic relationships representing physical systems, to solve problems and make predictions
- communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports (PHYT08)

Science as a Human Endeavour

- ICT and other technologies have dramatically increased the size, accuracy and geographic and temporal scope of datasets with which scientists work
- models and theories are contested and refined or replaced when new evidence challenges them, or when a new model or theory has greater explanatory power
- the acceptance of science understanding can be influenced by the social, economic and cultural context in which it is considered
- people can use scientific knowledge to inform the monitoring, assessment and evaluation of risk
- science can be limited in its ability to provide definitive answers to public debate; there may be insufficient reliable data available, or interpretation of the data may be open to question
- international collaboration is often required when investing in large-scale science projects or addressing issues for the Asia-Pacific region
- scientific knowledge can be used to develop and evaluate projected economic, social and environmental impacts and to design action for sustainability

Science Understanding - Special relativity

- observations of objects travelling at very high speeds cannot be explained by Newtonian physics (for example, the dilated half-life of high-speed muons created in the upper atmosphere, and the momentum of high speed particles in particle accelerators)
- Einstein's special theory of relativity predicts significantly different results to those of Newtonian physics for velocities approaching the speed of light
- the special theory of relativity is based on two postulates: that the speed of light in a vacuum is an absolute constant, and that all inertial reference frames are equivalent
- motion can only be measured relative to an observer; length and time are relative quantities that depend on the observer's frame of reference
- relativistic momentum increases at high relative speed and prevents an object from reaching the speed of light
- the concept of mass-energy equivalence emerged from the special theory of relativity and explains the source of the energy produced in nuclear reactions

Mathematical representations and relationships - Special relativity

$$t = \frac{t_o}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

$$l = l_o \sqrt{\left(1 - \frac{v^2}{c^2}\right)}$$

$$p_v = \frac{mv}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

$$\Delta E = \Delta mc^2$$

View Definitions - Quantum theory

- atomic phenomena and the interaction of light with matter indicate that states of matter and energy

are quantised into discrete values

- on the atomic level, electromagnetic radiation is emitted or absorbed in discrete packets called photons; the energy of a photon is proportional to its frequency; and the constant of proportionality, Planck's constant, can be determined experimentally (for example, from the photoelectric effect or the threshold voltage of coloured LEDs)
- a wide range of phenomena, including black body radiation and the photoelectric effect, are explained using the concept of light quanta
- atoms of an element emit and absorb specific wavelengths of light that are unique to that element; this is the basis of spectral analysis
- the Bohr model of the hydrogen atom integrates light quanta and atomic energy states to explain the specific wavelengths in the hydrogen spectrum and in the spectra of other simple atoms; the Bohr model enables line spectra to be correlated with atomic energy-level diagrams
- on the atomic level, energy and matter exhibit the characteristics of both waves and particles (for example, young's double slit experiment is explained with a wave model but produces the same interference pattern when one photon at a time is passed through the slits)

Mathematical representations and relationships - Quantum theory

- $E = hf$

$$\lambda_{max} = \frac{b}{T}$$

$$E_k = hf - W$$

$$\lambda = \frac{h}{p}$$

$$n\lambda = 2\pi r$$

$$mvr = \frac{nh}{2\pi}$$

$$\frac{1}{\lambda} = R \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

View Definitions - The Standard Model

- the standard model is based on the premise that all matter in the universe is made up from elementary matter particles called quarks and leptons; quarks experience the strong nuclear force, leptons do not
- the standard model explains three of the four fundamental forces in terms of an exchange of force-carrying particles called gauge bosons; each force is mediated by a different type of gauge boson
- interactions between particles, including nuclei and nuclear components, can be represented by simple reaction diagrams
- lepton number and baryon number are conserved in all reactions between particles; these conservation laws can be used to support or invalidate proposed reactions
- new reactions between particles can be predicted by applying time-reversal symmetry or charge-reversal symmetry to all the particles that participate in a reaction, or by applying crossing symmetry to an individual particle in a reaction (for example, applying symmetry to beta-minus decay enables reactions in which a proton is converted into a neutron to be predicted)
- high-energy particle accelerators are used to test theories of particle physics including the standard model
- the standard model is used to describe and explain the evolution of the four fundamental forces and the creation of matter in the Big Bang theory

Assessment Tasks

Name	Due Date	Weighting
Assignment 1	17 August - 24 August	20%
Test 1	7 September	30%
Assignment 2	19 October - 2 November	20%
Test 2	9 November	30%

Specific Unit Information

Students are expected to bring a scientific calculator to every class.

Assignment 1 will include a practical on the 24th August.

Assignment 2 will include a practical on 26th October.

If you are absent on the day of the practical, you must have appropriate documentation (e.g. a medical note) and must arrange an alternative time to complete the task.

Tests will be conducted during the doubles on the dates indicated.

School Assessment Information

For penalties for late and non-submission of work

See [BSSS Policy and Procedure Manual 4.3.10](#) for further information.

For academic integrity

See [BSSS Policy and Procedure Manual 4.3.12](#) for further information.

For appeals processes

See [BSSS Policy and Procedure Manual 7.2](#) for further information.

For moderation procedures (internal and external)

See [BSSS Policy and Procedure Manual 5](#) for further information.

For meshing procedures

See [BSSS Policy and Procedure Manual 5.4.1](#) for further information.

For method of unit score calculation

See [BSSS Policy and Procedure Manual 4.3.6.2](#) for further information.

For procedures for calculating course scores

See [BSSS Policy and Procedure Manual 4.3.13.2](#) for further information.

Achievement Standards for PHYSICS T - Year 12

	<i>A student who achieves an A grade typically</i>	<i>A student who achieves a B grade typically</i>	<i>A student who achieves a C grade typically</i>	<i>A student who achieves a D grade typically</i>	<i>A student who achieves an E grade typically</i>
Concepts, Models & Applications	<ul style="list-style-type: none"> critically analyses the properties and functions of system components, processes and interactions, and the interplay and effects of factors across a range of scales evaluates applications, limitations, and predictions of theories and models to explain systems and create solutions, with evidence, in unfamiliar contexts evaluates evidence with reference to critical analysis of models and/or theories, and develops evidence-based conclusions and evaluates limitations 	<ul style="list-style-type: none"> analyses the properties and functions of system components, processes and interactions, and the interplay and effects of factors across a range of scales analyses applications, limitations, and predictions of theories and models to explain systems and create plausible solutions, with evidence in familiar contexts analyses evidence with reference to models and/or theories, and develops evidence-based conclusions and discusses limitations 	<ul style="list-style-type: none"> explains the fundamental properties and functions of system components, processes and interactions, and the effects of factors across a range of scales explains applications, limitations, and predictions of theories and models to explain systems and create plausible solutions in familiar contexts describes evidence with reference to models and/or theories, and develops evidence-based conclusions and identifies limitations 	<ul style="list-style-type: none"> describes the fundamental properties and functions of system components, processes and interactions, and the effects of one or more factors describes the nature, functions, limitations and applications of theories and models to create solutions to problems with supporting evidence describes evidence, and develops conclusions with some reference to models and/or theories 	<ul style="list-style-type: none"> identifies the fundamental properties and functions of system components, processes and interactions, and some affective factors identifies the nature, functions, limitations and applications of theories and models, and suggest solutions to problems with supporting evidence identifies evidence, and asserts conclusions with little or no reference to models and/or theories
Contexts	<ul style="list-style-type: none"> critically analyses epistemology, role of peer review, collaboration, and technology in developing knowledge critically analyses the influence of social, economic, ethical and cultural factors on Science 	<ul style="list-style-type: none"> analyses epistemology, role of peer review and technology in developing knowledge analyses the influence of social, economic, ethical and cultural factors on Science 	<ul style="list-style-type: none"> explains epistemology, role of peer review and technology in developing knowledge explains the influence of social, economic, ethical and cultural factors on Science 	<ul style="list-style-type: none"> describes role of peer review and technology in developing knowledge describes the influence of social, economic, ethical and cultural factors on Science 	<ul style="list-style-type: none"> identifies that scientific knowledge has changed over time identifies the influence of social, economic, ethical and cultural factors on Science
Inquiry Skills	<ul style="list-style-type: none"> designs, conducts and improves safe, ethical and original inquiries individually and collaboratively, that collect valid, reliable data in response to a complex question critically analyses cause and correlation, anomalies, reliability and validity of data and representations, and critically analyses errors evaluates processes and claims, and provides a critique based on evidence, and critically analyses alternatives reflects on own thinking and evaluates planning, time management, use of appropriate work strategies communicates concisely, effectively and accurately, with scientific literacy in a range of modes, representations, and genres for specific audiences and purposes, and accurate referencing 	<ul style="list-style-type: none"> designs, conducts and improves safe, ethical inquiries individually and collaboratively, that collect valid, reliable data in response to a question analyses cause and correlation, anomalies, reliability and validity of data and representations, and analyses errors explains processes and claims, and provides a critique with reference to evidence, and analyses alternatives reflects on their own thinking and analyses planning, time management, use of appropriate work strategies communicates clearly and accurately, with scientific literacy in a range of modes, representations and genres for specific audiences and purposes, and accurate referencing 	<ul style="list-style-type: none"> plans and conducts safe, ethical inquiries individually and collaboratively, that collect valid data in response to a familiar question describes causal and correlational relationships, anomalies, reliability and validity of data and representations, and discusses common errors describes processes and claims, and identifies alternatives with reference to reliable evidence reflects on their own thinking and explains planning, time management, use of appropriate work strategies communicates accurately demonstrating scientific literacy, in a range of modes, representations, and genres for specific purposes, and mostly consistent referencing 	<ul style="list-style-type: none"> follows a procedure to conduct safe, ethical inquiries individually and collaboratively, to collect data in response to a simple question with varying success describes trends, relationships and anomalies in data, identifies anomalies, and cites sources of error describes processes and claims, and identifies the need for improvements with some reference to evidence reflects on their own thinking, with reference to planning and the use of appropriate work strategies communicates demonstrating some scientific literacy, in a range of modes, representations, and genres with some evidence and inconsistent referencing 	<ul style="list-style-type: none"> follows a procedure to conduct safe, ethical inquiries individually and collaboratively, to collect data with little or no connection to a question identifies trends and relationships in data with reference to sources of error identifies processes and the need for some improvements, with little or no reference to evidence reflects on their own thinking with little or no reference to planning, time management, and use of work strategies communicates demonstrating limited scientific literacy, in a range of modes and representations, with inconsistent and inaccurate referencing