BIG IDEAS

1D Kinematics	**1D Dynamics**	**1D Momentum**	**Energy**	**Electric Circuits**
Kinematics allows us to predict, describe, and analyze an object's motion.	Forces influence the motion of an object.	Momentum is conserved in a closed system.	Energy is found in different forms, is conserved, and has the ability to do work.	The application of conservation laws explains the flow of electricity within a circuit.

CHOOSE TWO MODULES

Waves and Optics	**Quantum**	**Special Relativity**	**Nuclear Physics**
Light can be modelled as a wave or a particle.	Quantum mechanics can be used to describe the behaviour of very small particles.	Special relativity helps explain the relationship between space and time.	Nuclear reactions involve changes in the atomic nucleus.

Learning Standards

Curricular Competencies	Content
Students are expected to be able to do the following:	**This course comprises seven modules — all students take five modules which are core to the course and teachers choose an additional two modules to complete the course.**
Questioning and predicting	*Students are expected to know the following:*
• Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal, local, or global interest	**The following five modules are core to the course:**
• Make observations aimed at identifying their own questions, including increasingly abstract ones, about the natural world	**1D Kinematics**
• Formulate multiple hypotheses and predict multiple outcomes	• **vector** and scalar quantities
Planning and conducting	• uniform motion
• Collaboratively and individually plan, select, and use appropriate investigation methods, including field work and lab experiments, to collect reliable data (qualitative and quantitative)	• accelerated motion
• Assess risks and address ethical, cultural, and/or environmental issues associated with their proposed methods	• **projectile motion**
• Use appropriate SI units and appropriate equipment, including digital technologies, to systematically and accurately collect and record data	• **the relationship between variables**

Learning Standards (continued)

Curricular Competencies	Content
• Apply the concepts of accuracy and precision to experimental procedures and data: 　－ significant figures 　－ uncertainty 　－ scientific notation **Processing and analyzing data and information** • Experience and interpret the local environment • Apply First Peoples perspectives and knowledge, other ways of knowing, and local knowledge as sources of information • Seek and analyze patterns, trends, and connections in data, including describing relationships between variables, performing calculations, and identifying inconsistencies • Construct, analyze, and interpret graphs, models, and/or diagrams • Use knowledge of scientific concepts to draw conclusions that are consistent with evidence • Analyze cause-and-effect relationships **Evaluating** • Evaluate their methods and experimental conditions, including identifying sources of error or uncertainty, confounding variables, and possible alternative explanations and conclusions • Describe specific ways to improve their investigation methods and the quality of the data • Evaluate the validity and limitations of a model or analogy in relation to the phenomenon modelled • Demonstrate an awareness of assumptions, question information given, and identify bias in their own work and in primary and secondary sources • Consider the changes in knowledge over time as tools and technologies have developed • Connect scientific explorations to careers in science • Exercise a healthy, informed skepticism and use scientific knowledge and findings to form their own investigations to evaluate claims in primary and secondary sources • Consider social, ethical, and environmental implications of the findings from their own and others' investigations • Critically analyze the validity of information in primary and secondary sources and evaluate the approaches used to solve problems • Assess risks in the context of personal safety and social responsibility	**1D Dynamics** • the fundamental nature of forces • **gravitational force** • **spring force** • normal force • tension force • **frictional force** • **Newton's laws of motion** • **the relationship between variables** • **First Peoples knowledge** **1D Momentum** • momentum • **impulse** • **law of conservation of momentum** • **the relationship between variables** **Energy** • **potential and kinetic energy** • thermal energy • law of conservation of energy • **work** • **power and efficiency** • **the relationship between variables** **Electric Circuits** • **Ohm's law** • **Kirchoff's laws** • **power and efficiency** • **the relationship between variables**

Learning Standards (continued)

Curricular Competencies	Content
Applying and innovating • Contribute to care for self, others, community, and world through individual or collaborative approaches • Co-operatively design projects with local and/or global connections and applications • Contribute to finding solutions to problems at a local and/or global level through inquiry • Implement multiple strategies to solve problems in real-life, applied, and conceptual situations • Consider the role of scientists in innovation **Communicating** • Formulate physical or mental theoretical models to describe a phenomenon • Communicate scientific ideas, information, and perhaps a suggested course of action, for a specific purpose and audience, constructing evidence-based arguments and using appropriate scientific language, conventions, and representations • Express and reflect on a variety of experiences, perspectives, and worldviews through place	**Choose any two of the modules below to complete the course:** **Waves and Optics** • **types of waves** • **properties of waves** • **wave behaviours** • light behaviours • law of reflection • **refraction** • image formation • **mirrors** • **lenses** • ray diagrams • **applications of geometric optics** • **the relationship between variables** **Quantum** • **evidence** that led to the development of quantum theory • the wave-particle duality of light • photoelectric effect • **Heisenberg's uncertainty principle** • **de Broglie** and the wave nature of light • **applications of quantum theory**

Learning Standards (continued)

Curricular Competencies	Content

Applying and innovating
 	
• Contribute to care for self, others, community, and world through individual or collaborative approaches
• Co-operatively design projects with local and/or global connections and applications
• Contribute to finding solutions to problems at a local and/or global level through inquiry
• Implement multiple strategies to solve problems in real-life, applied, and conceptual situations
• Consider the role of scientists in innovation
 	
Communicating
 	
• Formulate physical or mental theoretical models to describe a phenomenon
• Communicate scientific ideas, information, and perhaps a suggested course of action, for a specific purpose and audience, constructing evidence-based arguments and using appropriate scientific language, conventions, and representations
• Express and reflect on a variety of experiences, perspectives, and worldviews through place
	Special Relativity
	
	• development of the special relativity theory:
	  − Michelson-Morley experiment
	  − **postulates of special relativity**
	• **relative motion** and effects:
	  − time dilation
	  − length contraction
	  − mass increase
	• equivalence of energy and mass
	• **the relationship between variables**
	
	Nuclear Physics
	
	• radioactivity:
	  − **radioisotopes**
	  − **radioactive decay**
	• **nuclear reactions:**
	  − fission
	  − fusion
	• **applications of nuclear processes**
	• **the relationship between variables**

1D Kinematics

Sample opportunities to support student inquiry:

- How is uniform motion different from uniform acceleration?
- What factors affect projectile motion?

1D Dynamics

Sample opportunities to support student inquiry:

- How can forces change the motion of an object?
- What influences the force of gravity felt by an object?
- How can Newton's laws be used to explain changes in motion?

1D Momentum

Sample opportunities to support student inquiry:

- What changes the momentum of an object?
- How does momentum affect the results of a car crash?

Energy

Sample opportunities to support student inquiry:

- What is the relationship between work, energy, and power in a system?
- Why can a machine not be 100% efficient?

Electric Circuits

Sample opportunities to support student inquiry:

- Why is a circuit breaker important in your home?
- What is the impact of different placement of resistors in a circuit?

CHOOSE TWO MODULES:

Waves and Optics

Sample opportunities to support student inquiry:

- How does light behave as a particle?
- How does light behave as a wave?
- What does the principle of complementarity tell us about the behaviour of light?

Big Ideas – Elaborations

Quantum

Sample opportunities to support student inquiry:

- Where did the term "quantum" come from and what experiments gave rise to it?
- How does the photoelectric effect support quantum theory?
- What are the implications of the de Broglie hypothesis?

Special Relativity

Sample opportunities to support student inquiry:

- What is relative motion?
- What is the principle of special relativity?
- What are the implications of the theory of special relativity?

Nuclear Physics

Sample opportunities to support student inquiry:

- What is in the nucleus and how does it hold together?
- What happens when the nucleus falls apart?
- What happens in a nuclear reaction?

Curricular Competencies – Elaborations

Questioning and predicting:

Sample prediction activities may include:

- **1D Kinematics:** an object's future motion based on its current state of motion
- **1D Dynamics:**
  - predicting the motion of an object under the conditions of Newton's first law
  - predicting the motion of an object under the conditions of Newton's second law
- **1D Momentum and Energy:**
  - predicting the factors that can change an object's momentum or an object's final momentum after a collision
  - predicting the velocity of pendulum bob released from a given height
- **Electric Circuits:**
  - predicting whether a given circuit will light a bulb when a switch is closed
  - observing the similarities and differences between series and parallel circuits

Planning and conducting:

Sample lab experiments may include:

- **1D Kinematics:**
    - determining the velocity of an object in uniform motion
    - determining acceleration due to gravity experimentally
    - determining the range of a horizontally fired projectile
- **1D Dynamics:**
    - using Hooke's law to determine the spring constant of an unknown spring
    - designing an experiment to determine the factors that affect the force of friction
    - designing an experiment to verify Newton's second law
- **1D Momentum and Energy:**
    - designing an experiment to test for the factors that change an objects momentum and using this explain/design the safety features in a real/toy car with a fake passenger
    - determining the work done by friction of a toboggan released from a given height at the top of a hill
    - determining the efficiency of a motor that lifts a known mass to a known height
- **Electric Circuits:**
    - gathering voltage and current data to experimentally determine the resistance of an ohmic resistor
    - gathering voltage and current data to experimentally verify Kirchoff's law

Processing and analyzing data and information:

Sample ways to construct graphs and diagrams may include:

- **1D Kinematics:**
    - p-t graphs, v-t graphs, or other motion graphs of objects in uniform motion and undergoing uniform acceleration
- **1D Dynamics:**
    - spring force versus weight graph
    - force of friction versus weight graph
    - unbalanced force versus acceleration graphs
- **1D Momentum and Energy:**
    - net force versus time graphs
    - force versus displacement graphs
- **Electric Circuits:**
    - voltage versus current graphs for a given resistor

Sample ways to analyze and interpret graphs and diagrams may include:

- **Calculating and interpreting slopes:**
  - graphing a linear relationship given any physical model
  - determining the slope of best fitting lines, including units
  - using the experimentally determined slope to determine values of unknown quantities (e.g., use a position versus time graph to determine displacement, distance, average velocity, average speed, instantaneous velocity and instantaneous speed; use velocity versus time graphs to determine velocity, displacement, average velocity, acceleration)
  - using *y*-intercepts to determine values of unknown quantities (e.g., use velocity versus time graphs to determine initial velocity of an object)

- **Calculating and interpreting area under the curve:**
  - determining the displacement of an object given velocity and time data
  - using a graph's appearance to verify or refute relationships between variables in an experimental hypothesis

Sample ways to construct, analyze, and interpret diagrams may include:

- **Vector diagrams, equations, and operations:**
  - deriving equations and constructing diagrams that use graphical vector addition or subtraction to determine a resultant for a physical phenomenon (e.g., displacement of an object, change in velocity or acceleration of an object, F net equations)
  - using vector components to analyze a physical phenomenon (e.g., determining horizontal and vertical components of a projectile launched horizontally (v_{oy} = 0 m/s), the idea of orthogonal components of a force)

- **Free-body diagrams**
  - drawing a free-body diagram that includes a representation of the object and the external forces acting on it, with the correct magnitude and direction
  - using free-body diagrams to analyze forces acting on a body in a 1D system
  - interpreting free-body diagrams to develop an equation that describes the motion of an object

- **Circuit diagrams:**
  - drawing and interpreting circuit diagrams

Evaluating:

Sample ways to evaluate methods and experimental conditions may include:

- comparing an experimental result with a theoretical result and calculating % error or difference
- identifying sources of random and systematic error

Applying and innovating:

Sample ways to use physics phenomena to design may include:

- airbags, elevator, Rube Goldberg machine

1D Kinematics

- **vector:** solve for vector components and vector addition
- **projectile motion:** vertical projectiles and simple 2D projectiles (e.g., cannon being fired off cliff)
- **the relationship between variables:** Refer to the formula sheet.

1D Dynamics

- **gravitational force:** gravitational force, including gravitational field
- **spring force:** Hooke's law
- **frictional force:** static and kinetic friction
- **Newton's laws of motion:**
  - First: consider the concept of mass as a measure of inertia
  - Second: free-body diagrams; the net force from two or more forces
  - Third: demonstrate that actions happen at the same time and in pairs
- **the relationship between variables:** Refer to the formula sheet.
- **First Peoples knowledge:** the application of Newton's laws in various First Peoples technologies

1D Momentum

- **impulse:** impulse as related to Newton's second law; a change in momentum
- **law of conservation of momentum:** collisions and explosions in one dimension
- **the relationship between variables:** Refer to the formula sheet.

Energy

- **potential and kinetic energy:** Consider mechanical energy of an object as its total potential and kinetic energy.
- **work:** Relate energy change to work done.
- **power and efficiency:** power and efficiency of a machine (e.g., car engine)
- **the relationship between variables:** Refer to the formula sheet.

Electric circuits

- **Ohm's law:**
  - current: conventional versus actual current flow; AC versus DC current
  - voltage: voltage drops and voltage sources
  - resistance: different kinds of resistance (e.g., variable); equivalent resistance
- **Kirchoff's laws:** applications of current (junction rule) and voltage (loop rule) laws
- **power and efficiency:**
  - power and efficiency of an electrical device (e.g., incandescent lightbulb)
  - the difference between a power source and power dissipated across a resistor or a load
- **the relationship between variables:** Refer to the formula sheet.

Waves and Optics

- **types of waves:** mechanical, electromagnetic, and matter waves
- **properties of waves:** Consider the differences between the properties of the wave and the properties of the medium.
- **wave behaviours:** reflection, refraction, diffraction, interference, Doppler shift, polarization
- **refraction:** index of refraction, Snell's Law, total internal reflection, critical angle
- **mirrors:** plane, concave and convex
- **lenses:** concave and convex
- **applications of geometric optics:** magnifying glass, telescope, periscope, microscope, pinhole camera, fibre optics
- **the relationship between variables:** Refer to the formula sheet.

Quantum

- **evidence:**
  - black body radiation
  - Max Plank's quantum hypothesis
  - photon theory
  - double-slit experiment
- **Heisenberg's uncertainty principle:** Heisenberg's uncertainty principle as it applies to position, velocity, momentum, and energy
- **de Broglie:** Consider why the wavelike nature of matter can only be observed at a subatomic level.
- **applications of quantum theory:** quantum computing

Special Relativity

- **postulates of special relativity:**
  - the relativity principle
  - invariance of the speed of light
- **relative motion:** inertial reference frame; the principle of simultaneity
- **the relationship between variables:** Refer to the formula sheet.

Nuclear Physics

- **radioisotopes:** properties, standard atomic notations, natural and artificial
- **radioactive decay:** changes to the nucleus (e.g., Alpha beta, gamma decay); half-life
- **nuclear reactions:** consider connections to mass-energy equivalence; mass defect and binding energy
- **applications of nuclear processes:**
  - radioisotopes (e.g., medical use)
  - nuclear reactors
  - irradiation (e.g., sterilization)
  - radioactive dating
- **the relationship between variables:** Refer to the formula sheet.