Department of Education and Early Childhood Development

Physics 11

Prioritized Curriculum | Published May 2020

New Nouveau Brunswick
CANADA

Acknowledgments

The Department of Education and Early Childhood Development of New Brunswick (EECD) gratefully acknowledges the contributions of the following groups and individuals toward the development of the Physics 11 prioritized curriculum:

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- Jason Melendy, Teacher, ASD-East
- Sarah Morgan-Lee, Teacher, ASD-South
- Mike Finnamore, Teacher, ASD-West
- Jennifer Matheson, Online Teacher, ASD-North
- Darren White, Science Coordinator, ASD-South
- Kevin Doiron, Instructor, New Brunswick Community College (Saint John)
- Dennis Tokaryk, Senior Teaching Associate, University of New Brunswick (Fredericton)
- Julie Lizotte, Learning Specialist, Science Assessment, EECD
- Janice Williams, Learning Specialist, Science K-12, EECD

The outcomes included in this document were exported from the original source document published by the Government of New Brunswick (2003). Physics 11 Atlantic Canada Science Curriculum. Access curriculum document here.

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Background and Rationale

Due to the reduced learning time presented by school closures for COVID-19 and the uncertainty of what the 2020-2021 year will bring, the Department of Education and Early Childhood Development (EECD) is releasing a prioritized curriculum for select high school courses. This document provides a list of required outcomes that will frame the learning expectations for students and offer time for effective teaching practices.

A team of New Brunswick chemistry, mathematics and physics educators – high school teachers, post-secondary instructors from New Brunswick Community College and University of New Brunswick, and Learning Specialists from EECD worked together to identify and curate a list of **Required Outcomes** for the 2020-2021 school year. Any outcomes that were not identified as being *required* were categorised as **Remaining Outcomes** and can be set aside for future learning.

The *Required Outcomes* outlined in this document have been identified as the best representation of instructional outcomes to engage learners and contribute to student readiness for post-secondary mathematics and science studies and/or future life pursuits.

Identification of the *Required Outcomes* is but one of the necessary elements which will support learners in the province. Teachers will also consider how to engage students in deep and meaningful ways within the framework of the new learning environments (online, blended, and/or face-to-face).

Required Outcomes

The outcomes presented in Units 1, 2 and 3 frame the learning expectations for students for the 2020-2021 academic year.

Unit 1: Kinematics

Topic: Vector Analysis

- Identify the frame of reference for a given motion to distinguish fixed and moving frames. (325-7)
- Use vectors to represent position, displacement, velocity, and acceleration: define scalar and vector quantities; distinguish between scalar and vector quantities, using distance and displacement, respectively, as examples. (325-5)
- Identify and investigate questions that arise from practical problems/issues involving motion. (212-1)

Topic: Graphical Analysis

- Analyze graphically and mathematically the relationship among displacement, velocity, and time. (325-2)

Topic: Mathematical Analysis

- Analyze graphically and mathematically the relationship among displacement, velocity and time. (325-2)
- Analyse and describe examples where scientific understanding was enhanced as a result of the invention of a technological device. (116-2)
- Identify questions to investigate that arise from practical problems and issues. (212-1)
- Carry out an experiment to investigate the motion of an object falling vertically near Earth. (212-3, 213-2)
- Compile and display evidence and information in a variety of formats. (214-3)
- Evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring, and decision making. (212-8, 213-3)
- Interpret trends in data and infer or calculate relationships among variables. (214-5)
- Compare theoretical and empirical values and account for discrepancies. (214-7)
- Describe and evaluate the design of technological solutions and the way they function, using scientific principles. (116-6)

Unit 2: Dynamics

Topic: Dynamics Introduction

- Analyse the influence of society on scientific and technological endeavours in dynamics. (117-2)
- Describe and evaluate the design of technological solutions and the way they function, using scientific principles. (116-6)
- Analyse natural and technological systems to interpret and explain their structure and dynamics. (116-7)
- Use vectors to represent forces: draw free-body diagrams; explain what is meant by net force and apply it to several situations. (325-5)

Topic: Newton's Laws

- Apply Newton's laws of motion to explain inertia; the relationships among force, mass, and acceleration; and the interaction of forces between two objects. (325-8)
- Investigate the relationship between acceleration and net force. (212-3)
- Evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring, and decision making. (212-8)
- Compile and display evidence and information in a variety of formats. (214-3)
- Interpret patterns and trends in data and infer or calculate linear and nonlinear relationships among variables. (214-5)
- Provide a statement that addresses the problem or answers the question investigated in light of the link between data and the conclusion. (214-11)

Unit 3: Work and Energy

Topic: Work, Power, and Efficiency

- Analyse quantitatively the relationships among force, distance, and work. (325-9)
- Analyse quantitatively the relationships among work, time, and power. (325-10)
- Design and carry out an experiment to determine the efficiency of simple machines. (212-3, 213-2, 213-3, 214-7) (level 1 only)

Topic: Transformation, Total Energy, and Conservation

- Analyse quantitatively the relationships among mass, speed, kinetic energy, and thermal energy, using the law of conservation of energy. (326-1)
- Describe quantitatively mechanical energy as the sum of kinetic and potential energies. (326-5)
- Compare empirical and theoretical values of total energy and account for discrepancies. (214-7)
- Analyse quantitatively problems related to kinematics and dynamics using the mechanical energy concept. (326-6)
- Analyse common energy transformation situations using the closed system work-energy theorem. (326-7)
- Analyse and describe examples where technological solutions were developed based on scientific understanding. (116-4)
- Determine the percent efficiency of energy transformation. (326-8)
- Design an experiment, select and use appropriate tools, carry out procedures, compile and organize data, and interpret patterns in the data to answer a question posed regarding the conservation of energy. (212-3, 212-8, 213-2, 214-3, 214-5, 214-11, 326-4)
- Distinguish between problems that can be solved by the application of physics-related technologies and those that cannot. (118-8)

Appendix A – Remaining Outcomes

Remaining outcomes can be set aside for future learning.

UNIT: Dynamics

Topic: Momentum Introduction

- Use Newton's second law to show how impulse is related to change in momentum. (326-3)
- Describe the functioning of technological devices based on principles of momentum. (116-5)

UNIT: Waves

Topic: Fundamental Properties

- Describe the production, characteristics, and behaviours of longitudinal and transverse mechanical waves. (327-1)
- Formulate operational definition of major variables. (212-7)
- Select and integrate information from various print and electronic sources. (213-7)
- Analyse, from a variety of perspectives, the risks and benefits to society and to the environment when applying scientific knowledge or introducing a technology. (118- 2)
- Analyse natural and technological systems to interpret their structure and dynamics. (116-7)
- Analyse society's influence on scientific and technological endeavours. (117-2)
- Construct and test a prototype of a device and troubleshoot problems as they arise. (214-14)
- Analyse why and how a technology was developed and improved over time. (115-5)
- Apply the universal wave equation to explain and predict the behaviour of waves (327-2)
- Implement appropriate sampling procedures and evaluate the relevance, reliability, and adequacy of data and data collection methods in wave experiments. (213-1, 214-8)
- Apply the laws of reflection and the laws of refraction to predict wave behaviour. (327-7)
- State a prediction and a hypothesis about wave behaviour based on available evidence and background information. (212-4)

Topic: Sound Waves and Electromagnetic Radiation

- Apply the laws of reflection and the laws of refraction to predict wave behaviour. (327-7)
- Explain qualitatively and quantitatively the phenomena of wave interference, diffraction, reflection, and refraction, and the Doppler effect. (327-8)
- Compare and describe the properties of electromagnetic radiation and sound. (327-5)
- Describe how sound and electromagnetic radiation, as forms of energy transfer, are produced and transmitted. (327-6)
- Analyse and describe examples where scientific understanding was enhanced as a result of the invention of a technological device. (116-2)

Appendix B - Enablers

Pre-requisite knowledge, skills, and experiences required by learners which facilitate learning of the discipline (subject) at the next level. Awareness of enablers allows teachers to optimise pedagogy and students their learning.

General

Math concepts

- Basic arithmetic and rearranging equations.
- Units and their "behavior" in calculations (ex. 2 m x 2 m = 4 m^2)
- Calculating percentages
- Working with exponents
- Graphical representation of data
- Significant digits
- Scientific notation
- Slope as a rate of change

Science concepts

- Difference between accuracy and precision
- Precision Rule when adding/subtracting measurements
- Certainty Rule when multiplying/dividing measurements
- Converting measurements from one unit to another (including compound units)
- Theory-based calculations using dimensional analysis for unit conversions.
- familiarization of the 7 base units of the SI system of units
- familiarization of common SI prefixes (milli, centi, kilo).

Competencies

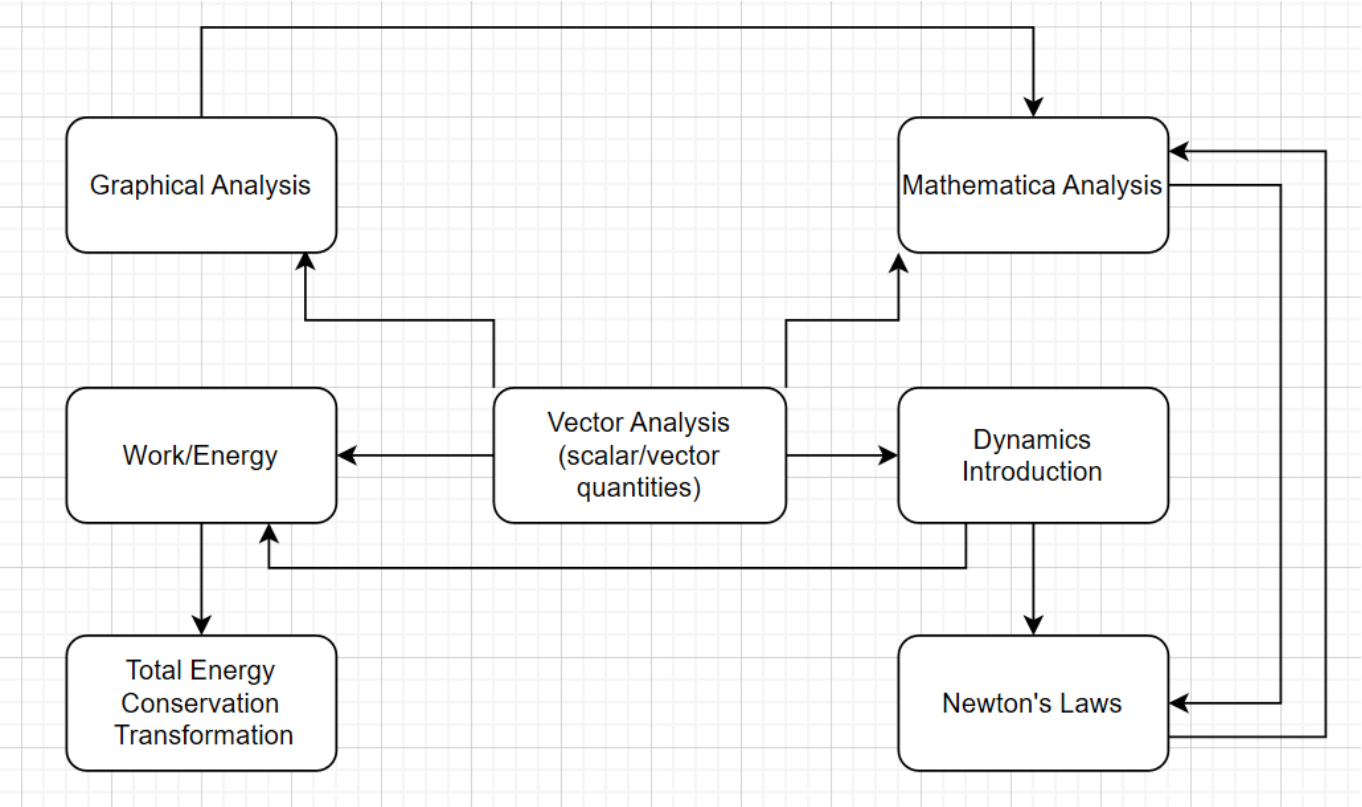
- Higher order thinking skills; synthesizing, analyzing, application and problem-solving
- Developing scientific reasoning

Appendix C – Insights from Post-Secondary

Students should be able to:

- develop strategies for solving practical and conceptual problems about the physical world.
- communicate solutions to problems using the 4 languages of physics:
    - descriptive
    - pictorial
    - graphical
    - computational
- justify solutions to problems using reasoning and argumentation.

Appendix D - Exemplar of Instructional Flow



Nancy Sherrard, Science Teacher, Miramichi Valley High School, ASD-N

Appendix E – Online Learning Resources

Bozeman Physics
Description: *Bozeman Physics* was created by educator, Paul Andersen. Paul was the 2011 Montana Teacher of the Year and was also one of four finalists for the 2011 National Teacher of the Year. In addition to teaching Paul has created hundreds of YouTube science tutorials that have been viewed millions of times by students around the world.
Website: http://www.bozemanscience.com/physics

Khan Academy's Preparing to Study Physics
Description: Physics is the study of the basic principles that govern the physical world around us. You'll learn about forces, momentum, energy, and other concepts in lots of different physical situations.
Website: https://www.khanacademy.org/science/physics
Available in multiple languages.

PhET Interactive Simulations
Description: Founded in 2002 by Nobel Laureate Carl Wieman, *the PhET Interactive Simulations* project at the University of Colorado Boulder creates free interactive math and science simulations. PhET sims engage students through an intuitive, game-like environment where students learn through exploration and discovery.
Website: https://phet.colorado.edu/en/simulations/category/physics
Available in multiple languages.

The Sourcebook for Teaching Science
Description: Resources for Teaching Physics. Hands-On physics activities with real-life applications contains over 300 intriguing investigations designed to engage students in a genuine pursuit of science.
Website: http://www.csun.edu/science/physics/index.html

Perimeter Institute
Description: Resources that are designed to help teachers explain a range of important physics and science topics. Each compilation includes a set of lesson plans, hands-on activities and demos, modifiable worksheets, background information for teachers, and original PI videos.
Website: https://resources.perimeterinstitute.ca/
Available in multiple languages.

TED Ed Physics
Description: TED-Ed's mission is to capture and amplify the voices of great educators around the world. We do this by pairing extraordinary educators with talented animators to produce a new library of curiosity-igniting videos. Searchable by topic.
Website: https://ed.ted.com/search?qs=physics

Physlet® Physics 3E
Description: Interactive Illustrations, Explorations, and Problems for Introductory Physics.
Website: https://www.compadre.org/Physlets/

The Wonder of Science

A phenomenon is simply an observable event. In the science classroom a carefully chosen phenomenon can drive student inquiry. Phenomena add relevance to the science classroom showing students science in their own world. The Master List of Phenomenon is an open Google doc that lists all phenomenon we have aggregated. These phenomena will be tagged and added to the website (with relevant links, videos, and images) over time. This website is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.
Website: https://thewonderofscience.com/phenomenal

Student Companion Site for Physics, 6th Edition

Description: Rich tools and resources available introductory physics.
Website: http://bcs.wiley.com

The Physics Classroom

Description: Resources for physics teachers, including; tutorials, interactives, concept builders, videos, and much more.
Website: https://www.physicsclassroom.com/

myPhysicsLab.com

Description: Interactive physics simulations that animate in real time.
Website: https://www.myphysicslab.com/

College Physics

Description: Interactive introductory physics applets.
Website: http://highered.mheducation.com