Department of Education and Early Childhood Development

Physics 12

Prioritized Curriculum| Published May 2020

New Nouveau Brunswick CANADA

Acknowledgments

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The outcomes included in this document were exported from the original source document published by the Government of New Brunswick (2003). Physics 12 Atlantic Canada Science Curriculum. Access curriculum document here.

Table of Contents

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: Dynamics Extension

Topic: Vectors to Analyze: Force and Motion

- Use vector analysis in two dimensions for systems involving two or more masses, relative motions, static equilibrium, and static torques. (ACP-1)
- Use vectors to represent forces. (325-5)
- Select and use appropriate numeric, symbolic, graphical, and linguistic modes of representations to communicate ideas, plans, and results. (215-2)
- Design an experiment identifying and controlling major variables. (212-3)
- Evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring and decision making. (212-8)
- Carry out procedures controlling major variables and adapting or extending procedures where required. (213-2)
- Compile and display evidence, by hand or computer, in a variety of formats, including diagrams, charts, tables, graphs and scatter plots. (214-3)
- Prepare a written report of your experiment about static equilibrium. (ACP-1, 212-3, 212-8, 213-3, 214-3) (level 1 only)

Topic: Conservation of Momentum

- Apply quantitatively the law of conservation of momentum to one dimensional collisions and explosions. (326-3)
- Design an experiment identifying and controlling major variables. (212-3)
- Evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring and decision making (212-8)
- Carry out procedures controlling major variables and adapting or extending procedures where required. (213-2)
- Compile and display evidence, by hand or computer, in a variety of formats, including diagrams, charts, tables, graphs and scatter plots. (214-3)

Topic: Technological Implications

- Analyse and describe examples where energy- and momentum-related technologies were developed and improved over time. (115-5, 116-4)
- Describe and evaluate the design of technological solutions and the way they function using principles of energy and momentum. (116-6)
- Explain the importance of using appropriate language and conventions when describing events related to momentum and energy. (114-9)
- Identify multiple perspectives that influence a science related decision or issue. (215-4)

Topic: Collisions in Two Dimensions

- Apply quantitatively the laws of conservation of momentum to one and two-dimensional collisions and explosions. (326-3)
- Determine in which real-life situations involving elastic and inelastic interactions the laws of conservation of momentum and energy are best used. (326-4)
- Design an experiment identifying and controlling major variables. (212-3)
- Evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring and decision making. (212-8)
- Carry out procedures controlling major variables and adapting or extending procedures where required. (213-2)
- Compile and display evidence, by hand or computer, in a variety of formats, including diagrams, charts, tables, graphs and scatter plots. (214-3)
- Work cooperatively with team members to develop and carry out a plan and troubleshoot problems as they arise. (215-6)

Unit 2: Projectiles, Circular Motion, and Universal Gravitation

Topic: Projectiles

- Analyse and describe examples where technologies were developed based on scientific understanding. (116-4)
- Describe and evaluate the design of technological solutions and the way they function, using scientific principles. (116-6)
- Construct, test and evaluate a device or system on the basis of developed criteria. (214-14, 214-16)
- Analyse qualitatively and quantitatively the horizontal and vertical motion of a projectile. (325-6)
- Derive a formula for the range of a level to level projective. (325-6) (level 1 only)
- Use your formula to prove that the maximum range for a given muzzle velocity (325-6) (level 1 only)

Topic: Circular Motion

- Describe uniform circular motion using algebraic and vector analysis. (325-12)
- Explain quantitatively circular motion using Newton's laws. (325-13)

Topic: Universal Gravitation

- Explain qualitatively Kepler's first and second laws and apply quantitatively Kepler's third law. (ACP-2)
- Use appropriate numeric and graphic analysis to explain and apply the law of universal gravitation to orbital rotations. (215-2)
- Distinguish between scientific questions and technological problems. (115-1)

Unit 3: Fields

Topic: Magnetic, Electric, and Gravitational Fields

- Explain the roles of evidence, theories and paradigms, and peer review in the development of the scientific knowledge associated with a major scientific milestone. (114-2, 114-5, 115-3)
- Communicate questions, ideas and intentions, and receive, interpret, understand, support and respond to the ideas of others. (215-1)
- Describe magnetic, electric and gravitational fields as regions of space that affect mass and charge. (328-1)
- Describe magnetic, electric, and gravitational fields by illustrating the source and direction of the lines of force. (328-2)
- Describe electric fields in terms of like and unlike charges, and magnetic fields in terms of poles. (328-3)

Topic: Coulomb's Law

- Define and delimit problems, estimate quantities, interpret patterns and trends in data, and infer or calculate the relationship among variables. (212-2, 213-4, 214- 5)
- Compare Newton's Law of universal gravitation with Coulomb's Law and apply both laws quantitatively. (328-4)

Appendix A – Remaining Outcomes

Remaining outcomes can be set aside for future learning.

UNIT: Projectiles, Circular Motion, and Universal Gravitation

Topic: Simple Harmonic Motion (SHM)

- Identify questions, analyse, compile, and display evidence and information to investigate the development over time of a practical problem, issue, or technology. (212-3, 214-3, 115-5)
- Explain qualitatively the relationship between displacement, velocity, time, and acceleration for simple harmonic motion. (327-2)
- Explain quantitatively the relationship between potential and kinetic energies of a mass in simple harmonic motion. (327-4)
- Compile and organize data, using data tables and graphs, to facilitate interpretation of the data. (213-5)

UNIT: Magnetic, Electric, and Gravitational Fields

Topic: Electric Circuits

- Apply Ohm's Law to series, parallel, and combination circuits. (ACP-3)
- Carry out procedures controlling the major variables, selecting and using instruments effectively, accurately, and safely, and adapting or extending procedures where required. (213-2, 213-3, 213-8)
- State a prediction and a hypothesis based on available evidence and background information. (212-4)
- Design an experiment and identify specific variables. (212-6)

Topic: Electromagnetism and Electromagnetic Induction

- Describe the magnetic field produced by a current in a long, straight conductor, and in a solenoid. (328-6)
- Analyse qualitatively the forces acting on a moving charge in a uniform magnetic field. (328-5)
- Analyse qualitatively electromagnetic induction by both a changing magnetic flux and a moving conductor. (328-7)

Topic: Generators and Motors (for level 1 only)

- Compare and contrast the ways a motor and generator function, using the principles of electromagnetism. (328-9)
- Describe and compare direct current and alternating current. (ACP-4)
- Describe the historical development of a technology. (115-4)
- Describe the functioning of domestic and industrial technologies, using scientific principles. (116-5)
- Analyse natural and technological systems to interpret and explain their structure and dynamics. (116- 7)
- Select and integrate information from various print and electronic sources or from several parts of the same source. (213-7)

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
- Quadratics
- Trigonometry
- Inverse square relationships
- Graphing of functions

Science concepts

- Difference between accuracy and precision
- Precision Rule when adding/subtracting measurements
- Certainty Rule when multiplying/dividing measurements
- Unit conversions and 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

Subject specific

The following theory-related Physics 11 concepts support student learning for Physics 12:

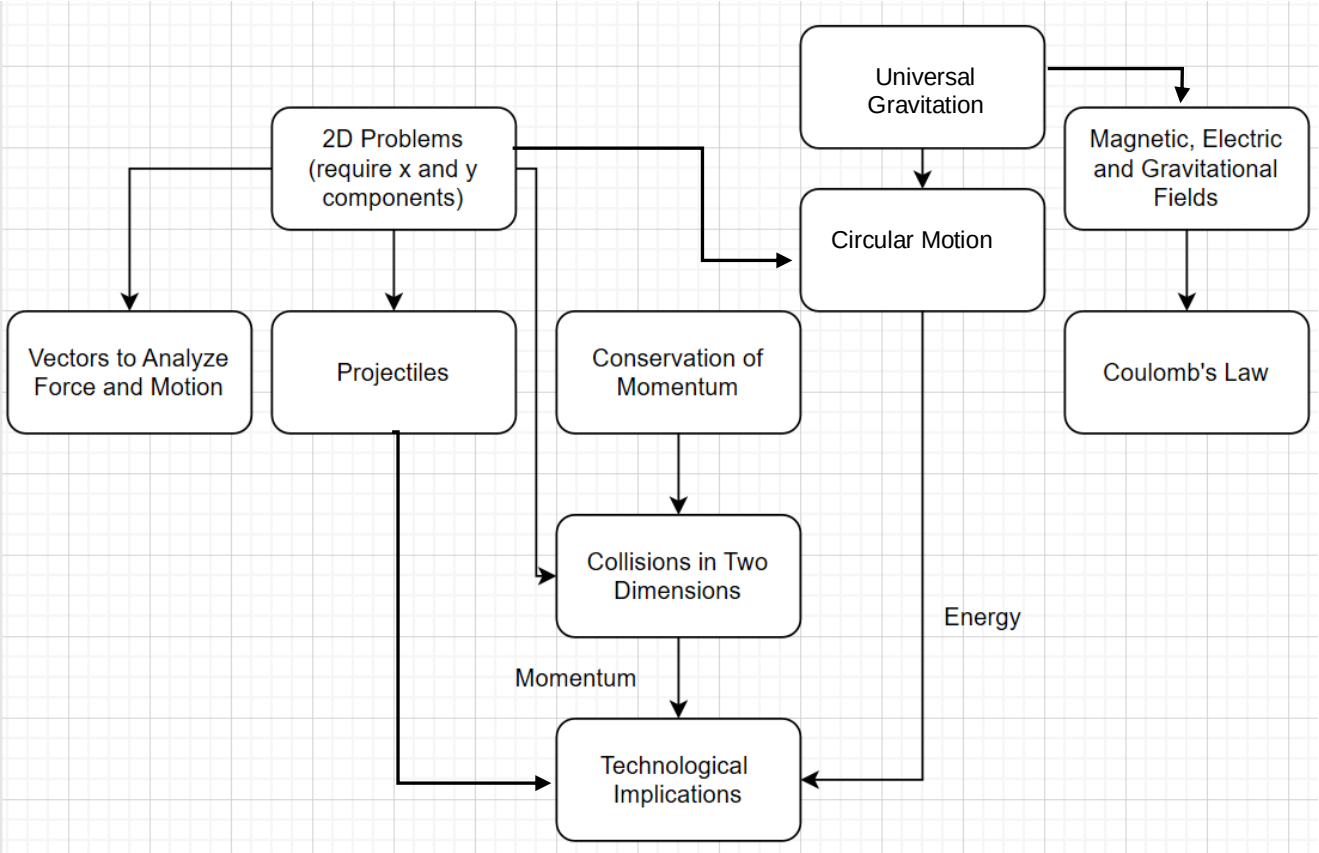
- a solid foundation of force and dynamics, motion, and energy from Physics 11
- momentum will need to be introduced in Physics 12 before exploring the conservation of momentum

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