

## DEPARTMENT OF ACADEMIC UPGRADING COURSE OUTLINE WINTER 2025

### PC0130(A3): Physics Grade 12 Equivalent 5 (6-0-2) HS

120 hours for 15 weeks

Northwestern Polytechnic acknowledges that our campuses are located on Treaty 8 territory, the ancestral and present-day home to many diverse First Nations, Metis, and Inuit people. We are grateful to work, live and learn on the traditional territory of Duncan's First Nation, Horse Lake First Nation and Sturgeon Lake Cree Nation, who are the original caretakers of this land.

We acknowledge the history of this land and we are thankful for the opportunity to walk together in friendship, where we will encourage and promote positive change for present and future generations.

<b>INSTRUCTOR:</b>	Sheryl Heikel	<b>PHONE:</b>	Office: 780-539-2059
<b>OFFICE:</b>	C417	<b>E-MAIL:</b>	sheikel@nwpolytech.ca

**OFFICE HOURS:** (location TBA) Tuesday, Thursday 11:45-12:45pm or by appointment

#### CALENDAR DESCRIPTION:

##### PC0130 - Physics Grade 12 Equivalent 5 (6-0-2) HS

The major concepts to be covered in this course include: momentum and impulse; electric forces and fields; current electricity; magnetic forces and fields; electromagnetic radiation (light); and atomic physics. Problem solving is highly emphasized throughout the course

#### PREREQUISITE(S):

- Complete All of the following:
  - [PC0120](#) (or Physics 20)
  - MA0122 (Math 20-2) or MA0120 (Math 20-1) or [MA0130](#) placement.
- Note: If MA0123 (Math 20-3) was used as the prerequisite for PC0120, then the student cannot take PC0130

## REQUIRED TEXT/RESOURCE MATERIALS:

- Pearson Physics text
- Scientific calculator (if you need to purchase, TI-30X IIS is recommended)
- graph paper (fine lined *10 lines/cm* - may be printed from D2L)
- Clear 30 cm ruler, protractor

## DELIVERY MODE(S):

- On-campus (attend on-campus, in-person) – This type of course will be delivered on campus in a specific location which will be indicated on the student timetable. Students are expected to fully attend in person.
- Use of D2L (myClass) is required.

## LEARNING OUTCOMES:

### *Students will:*

#### **Momentum and Impulse**

- Explain how momentum is conserved when objects interact in an isolated system.

#### **Forces and Fields**

- explain the behavior of electric charges, using the laws that govern electrical interactions
  - describe electrical phenomena, using the electric field theory
  - explain how the properties of electric + magnetic fields are applied in technologies.
- Electromagnetic Radiation • explain the nature and behavior of EMR, using the wave model

#### **Atomic Physics** • explain describe the electrical nature of the atom

- describe the photoelectric effect, using the quantum model.
- describe the quantization of energy in atoms and nuclei
- describe nuclear fission and fusion as powerful energy sources in nature

#### **Lab Skill objectives** (focus on scientific inquiry)

- Initiate, Plan, Perform, Record, Analyze, Interpret, Communicate and work in a Team

Please see pages 5-8 following.

## TRANSFERABILITY:

Please consult the Alberta Transfer Guide for more information. You may check to ensure the transferability of this course at the Alberta Transfer Guide main page <http://www.transferalberta.alberta.ca>.

\*\* Grade of D or D+ may not be acceptable for transfer to other post-secondary institutions. **Students are cautioned that it is their responsibility to contact the receiving institutions to ensure transferability.**

This course is listed in the Alberta Transfer Guide as equivalent to Physics 30. Although 50% (D) is considered a pass for this course, it is strongly recommend that you achieve a mark of 65% (C) to be successful at the next level.

**EVALUATIONS:** Course final grade will be based on the following components.

4 Unit Tests (equally weighted)	40%	
Labs, Assignments, Quizzes	10%	<b>Late penalty 20% per day for 2 days.</b>
Midterm Exam	20%	
Final Exam (Cumulative)	30%	

All tests and exams **MUST** be written at the scheduled times unless **PRIOR** arrangements have been made with the instructor. A missed test (exam) will result in a score of ZERO on that test (exam). Only in very specific cases may student be given an opportunity to make up a missed exam (student will be presented with a different version of the exam). Doctor, lawyer or police documentation may be required. The final exam is 3 hours long and is scheduled by the registrars' office during NWPolytechnic Exam weeks. **Please make your self familiar with the NWPolytechnic exam policy.**

**GRADING CRITERIA:** Final Grades will be assigned on the Letter Grading System.

Alpha Grade	4-point Equivalent	Percentage Guidelines	Alpha Grade	4-point Equivalent	Percentage Guidelines
A+	4.0	95-100	C+	2.3	67-69
A	4.0	85-94	C	2.0	63-66
A-	3.7	80-84	C-	1.7	60-62
B+	3.3	77-79	D+	1.3	55-59
B	3.0	73-76	D	1.0	50-54
B-	2.7	70-72	F	0.0	00-49

### COURSE SCHEDULE / TENTATIVE TIMELINE:

**Physics 0130** consists of four units (approx. 3 weeks each)

- A. Momentum and Impulse (text ch9)
- B. Forces and Fields (text ch10-12)  
Midterm Exam 20%
- C. Electromagnetic Radiation (text ch13)
- D. Atomic Physics (text ch14-16, ch17 as time permits)

**Labs:** Lectures are held on on lab days when there is no lab. See course schedule.

- Attendance is compulsory in all labs.
- Missed labs result in a score of zero. **There are NO make-up labs.**

- If you are late and have missed the lab safety discussion, you MAY be excluded from participating in the lab and will receive a mark of zero.
- Late lab reports will result in a penalty of 20% per day. Labs over two days late will not be graded without PRIOR approval.
- Download the lab sheets and complete the Pre-lab assignment before the lab period, data tables are completed during the lab and analysis and questions after the lab.

## STUDENT RESPONSIBILITIES:

Refer to the NWPolytechnic Policy on Student Rights and Responsibilities at

<https://nwpolytech.ca/about/administration/policies/fetch.php?ID=69>

The Academic Upgrading Department is an adult education environment. Students are expected to show respect for each other as well as faculty and staff. Students are expected to participate fully in achieving their educational goals.

Certain activities are disruptive and not conducive to an atmosphere of learning. In addition to the *Student Rights and Responsibilities* as set out in the Polytechnic calendar, the following guidelines will maintain an effective learning environment for everyone. We ask the cooperation of all students in the following areas of classroom environment.

1. Check **D2L** as well as **NWPolytechnic email** on a regular basis.
2. **Attendance:** Regular attendance and class participation is expected of all students and is crucial to good performance in the course. Class interruption due to habitual late arrival or leaving early will not be permitted.
3. **Once in class** – remain in class. Leaving to get a coffee is disruptive for others. Any behavior that interferes with the learning of others is not acceptable.
4. Assignments must be submitted on time.
5. Exams must be written on the days announced in class.
6. If an emergency prevents attendance on an exam day, students must contact me before the end of the exam (as soon as possible) via phone or email, and may be asked to provide documentation to justify their absence.
7. No unspecified electronic devices will be permitted during exams.
8. Complete daily homework.  
**At least 1.5** hours of study per day outside of class time is required.
9. Take responsibility for your learning.
10. **Please communicate all requests regarding appointments, etc via NWPolytechnic email.** I am not always in my office and will often not receive a message in time.

## STATEMENT ON ACADEMIC MISCONDUCT:

Academic Misconduct will not be tolerated. For a more precise definition of academic misconduct and its consequences, refer to the Student Rights and Responsibilities policy available at <https://www.nwpolytech.ca/about/administration/policies/index.html>.

\*\*Note: all Academic and Administrative policies are available on the same page.

## PC0130 Learning Outcomes (adapted from Alberta Learning Physics 30 curriculum [http://education.alberta.ca/media/654853/phy2030\\_07.pdf](http://education.alberta.ca/media/654853/phy2030_07.pdf))

### Review from Physics 20: Conservation of Energy

#### Key Concepts:

- conservation of mechanical energy
- work-energy theorem
- isolated systems
- mechanical energy
- power

Conservation of Mechanical energy in conservative and non-conservative systems.

Work is a transfer of energy.

Conservation of energy in an isolated system is a fundamental physical concept.

- define mechanical energy as the sum of kinetic and potential energy
- determine, quantitatively, the relationships among the kinetic, gravitational potential and total mechanical energies of a mass at any point between maximum potential energy and maximum kinetic energy
- analyze, quantitatively, kinematics and dynamics problems that relate to the conservation of mechanical energy in an isolated system
- recall work as a measure of the mechanical energy transferred and power as the rate of doing work
- describe power qualitatively and quantitatively
- describe, qualitatively, the change in mechanical energy in a system that is not isolated.

### Unit A: Momentum and Impulse

#### Key Concepts:

- impulse
- momentum
- Newton's laws of motion
- elastic collisions
- inelastic collisions

#### General Outcomes: Students will:

Explain how momentum is conserved when objects interact in an isolated system.

- define momentum as a vector quantity equal to the product of the mass and the velocity of an object
- explain, quantitatively, the concepts of impulse and change in momentum, using Newton's laws of motion
- explain, qualitatively, that momentum is conserved in an isolated system
- explain, quantitatively, that momentum is conserved in one- and two-dimensional interactions in an isolated system
- define, compare and contrast elastic and inelastic collisions, using quantitative examples, in terms of conservation of kinetic energy.

## Unit B: Forces and Fields

### Key Concepts:

- electric charge
- conservation of charge
- Coulomb's law
- vector fields
- electric field
- magnetic field
- electric potential difference
- interaction of charges with electric and magnetic fields
- electromagnetic induction

### General Outcomes: Students will:

1. explain the behavior of electric charges, using the laws that govern electrical interactions
  - explain electrical interactions in terms of the law of conservation of charge
  - explain electrical interactions in terms of the repulsion and attraction of charges
  - compare the methods of transferring charge (conduction and induction)
  - explain, qualitatively, the distribution of charge on the surfaces of conductors and insulators
  - explain, qualitatively, the principles pertinent to Coulomb's torsion balance experiment
  - apply Coulomb's law, quantitatively, to analyze the interaction of two point charges
  - determine, quantitatively, the magnitude and direction of the electric force on a point charge due to two or more other point charges in a plane
  - compare, qualitatively and quantitatively, the inverse square relationship as it is expressed by Coulomb's law and by Newton's universal law of gravitation.
  - Basic circuits, Ohm's Law and resistors in series and parallel
2. describe electrical phenomena, using the electric field theory
  - define vector fields
  - compare forces and fields
  - compare, qualitatively, gravitational potential energy and electric potential energy
  - define electric potential difference as a change in electric potential energy per unit of charge
  - calculate the electric potential difference between two points in a uniform electric field
  - explain, quantitatively, electric fields in terms of intensity (strength) and direction, relative to the source of the field and to the effect on an electric charge
  - define electric current as the amount of charge passing a reference point per unit of time
  - describe, quantitatively, the motion of an electric charge in a uniform electric field
  - explain, quantitatively, electrical interactions using the law of conservation of energy
3. explain how the properties of electric + magnetic fields are applied in technologies.
  - describe magnetic interactions in terms of forces and fields
  - compare gravitational, electric and magnetic fields (caused by permanent magnets and moving charges) in terms of their sources and directions
  - describe how the discoveries of Oersted and Faraday form the foundation of the theory relating electricity to magnetism
  - describe, qualitatively, a moving charge as the source of a magnetic field and predict the orientation of the magnetic field from the direction of motion
  - explain, qualitatively and quantitatively, how a uniform magnetic field affects a moving electric charge, using the relationships among charge, motion, field direction and strength, when motion and field directions are mutually perpendicular
  - explain, quantitatively, how uniform magnetic and electric fields affect a moving electric charge, using the relationships among charge, motion, field direction and strength, when motion and field directions are mutually perpendicular

- describe and explain, qualitatively, the interaction between a magnetic field and a moving charge and between a magnetic field and a current-carrying conductor
- explain, quantitatively, the effect of an external magnetic field on a current-carrying conductor
- describe, qualitatively, the effects of moving a conductor in an external magnetic field, in terms of moving charges in a magnetic field.

## Unit C: Electromagnetic Radiation

### Key Concepts:

- |                      |                             |
|----------------------|-----------------------------|
| • speed of EMR       | • diffraction               |
| • propagation of EMR | • interference              |
| • reflection         | • total internal reflection |
| • refraction         | • Snell's law               |

### General Outcomes: Students will:

1. explain the nature and behavior of EMR, using the wave model
  - describe, qualitatively, how all accelerating charges produce EMR
  - compare and contrast the constituents of the electromagnetic spectrum on the basis of frequency and wavelength
  - explain the propagation of EMR in terms of perpendicular electric and magnetic fields that are varying with time and travelling away from their source at the speed of light
  - explain, qualitatively, various methods of measuring the speed of EMR
  - calculate the speed of EMR, given data from a Michelson-type experiment
  - describe, quantitatively, the phenomena of reflection and refraction, including total internal reflection
  - describe, quantitatively, simple optical systems, consisting of only one component, for both lenses and curved mirrors
  - describe, qualitatively, diffraction, interference and polarization
  - describe, qualitatively, how the results of Young's double-slit experiment support the wave model of light
  - solve double-slit and diffraction grating problems using

$$\lambda = \frac{xd}{nl} \quad \lambda = \frac{d \sin \theta}{n}$$

- describe, qualitatively and quantitatively, how refraction
- supports the wave model of EMR, using

$$\frac{\sin \theta_1}{\sin \theta_2} = \frac{n_2}{n_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$$

- compare and contrast the visible spectra produced by diffraction gratings and triangular prisms.

## Unit D: Atomic Physics

### Key Concepts:

- charge-to-mass ratio (Thomson's experiment)
- charge quantization—Millikan's experiment
- models of the atom (Dalton, Thomson, Rutherford, Bohr, de Broglie)
- spectra: continuous, line emission and line absorption
- Balmer formula for hydrogen
- energy levels (states)
- de Broglie hypothesis
- quantum mechanical model
- half-life
- nuclear decay
- nuclear reactions
- Standard Model of matter
- photoelectric effect
- Compton effect
- Uncertainty Principle

### General Outcomes: *Students will:*

1. describe the electrical nature of the atom
  - describe matter as containing discrete positive and negative charges
  - explain how the discovery of cathode rays contributed to the development of atomic models
  - explain Millikan's oil-drop experiment and its significance relative to charge quantization.
  - explain J. J. Thomson's experiment and the significance of the results for both science and technology
  - explain, qualitatively, the significance of the results of Rutherford's scattering experiment, in terms of scientists' understanding of the relative size and mass of the nucleus and the atom.
2. describe the photoelectric effect, using the quantum model.
  - define the photon as a quantum of EMR and calculate its energy
  - classify the regions of the electromagnetic spectrum by photon energy
  - describe the photoelectric effect in terms of the intensity and wavelength or frequency of the incident light and surface material
  - describe, quantitatively, photoelectric emission, using concepts related to the conservation of energy
  - describe the photoelectric effect as a phenomenon that supports the notion of the wave-particle duality of EMR
  - explain, qualitatively and quantitatively, the Compton effect as another example of wave-particle duality, applying the laws of mechanics and of conservation of momentum and energy to photons.
3. describe the quantization of energy in atoms and nuclei
  - explain, qualitatively, how emission of EMR by an accelerating charged particle invalidates the classical model of the atom
  - describe that each element has a unique line spectrum
  - explain, qualitatively, the characteristics of, and the conditions necessary to produce, continuous line-emission and line-absorption spectra
  - Quantitatively predict the wavelength for the photon emitted by hydrogen during a specific energy level change.
  - calculate the energy difference between states, using the law of conservation of energy and the observed characteristics of an emitted photon
  - explain, qualitatively, the concept of stationary states and how they explain the observed spectra of atoms and molecules
  - explain, qualitatively, how electron diffraction provides experimental support for the de Broglie hypothesis

- describe, qualitatively, how the two-slit electron interference experiment shows that quantum systems, like photons and electrons, may be modeled as particles or waves, contrary to intuition.
- describe, qualitatively, how the Compton effect contributed to the acceptance of the wave particle duality for light.
- Calculate the change in wavelength in Compton scattering.

4. describe nuclear fission and fusion as powerful energy sources in nature

- describe the nature and properties, including the biological effects, of alpha, beta and gamma radiation
- write nuclear equations, using isotope notation, for alpha, beta-negative and beta-positive decays, including the appropriate neutrino and antineutrino
- perform simple, nonlogarithmic half-life calculations
- use the law of conservation of charge and mass number to predict the particles emitted by a nucleus
- compare and contrast the characteristics of fission and fusion reactions
- relate, qualitatively and quantitatively, the mass defect of the nucleus to the energy released in nuclear reactions, using Einstein's concept of mass-energy equivalence.

Lab Skills and objectives are included in labs and assignments in each unit of the course.

## Specific Outcomes for Skills (focus on scientific inquiry)

### Initiating and Planning

*Students will :*

- identify, define and delimit questions to investigate
- design an experiment, identifying and controlling major variables
- state a prediction and a hypothesis based on available evidence or background information or on a theory
- evaluate and select appropriate procedures, including appropriate sampling procedures, and instruments for collecting evidence and information

### Performing and Recording

*Students will :*

- research, integrate and synthesize information from various print and electronic sources regarding a scientific question
- select and use appropriate instruments for collecting data effectively, safely and accurately
- carry out procedures, controlling the major variables, and adapt or extend procedures where required
- compile and organize findings and data by hand or computer, using appropriate formats such as diagrams, flowcharts, tables and graphs
- apply Workplace Hazardous Materials Information System (WHMIS) standards to handle and dispose of materials

### Analyzing and Interpreting

*Students will :*

- apply appropriate terminology, classification systems and nomenclature used in the sciences
- interpret patterns and trends in data and predict the value of a variable by interpolating or extrapolating from graphical data or from a line of best fit
- estimate and calculate the value of variables, compare theoretical and empirical values, and account for discrepancies
- identify limitations of data or measurements; explain sources of error; and evaluate the relevance, reliability and adequacy of data and data collection methods
- identify new questions or problems that arise from what was learned
- state a conclusion, based on data obtained from investigations, and explain how evidence gathered supports or refutes a hypothesis, prediction or theory

### Communication and Teamwork

*Students will :*

- work collaboratively to develop and carry out investigations
- select and use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate findings and conclusions
- evaluate individual and group processes used in planning and carrying out investigative tasks