**Unit 5: Revolutions in Modern Physics: Quantum Mechanics and Special Relativity**

**Chapter 11: Relativity & Chapter 12: Quantum Mechanics**

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| **Day / Topic** | **Topic & Details** | **Curriculum Expectations** | **Assessment/Evaluation** | **Materials Needed**  |
| **Day 1**The Special Theory of Relativity (11.1)  | * Make students choose one definition each, and create a word wall with images for the definitions in this unit
* 03 – Perimeter Inspirations – Revolutions in Science (Based on: Alice & Bob in Wonderland Animations)

Activity and Worksheet: Scientific Revolution: Special Relativity (pg. 35-37) 1. Head-on Collision
2. A Glancing Collision
3. All Forms of Energy have Inertia
4. E=mc2
* Homework questions 1,3,4,6 (Nelson Physics 12 pg. 579)
 | **F2.1** use appropriate terminology related to quantum mechanics and special relativity, but not limited to: *quantum theory, photoelectric effect, matter waves, time dilation, and mass-energy transformation***F3.3** identify Einstein’s two postulates for the theory of special relativity, and describe the evidence supporting the theory | * Communication marks for correct definition and image

Group work on worksheets* Observation and conversation
 | * Reserve computer lab for definitions
* Worksheets from Perimeter Inspirations booklet (pg. 35-37)
 |
| **Day 2**Time Dilation (11.2) | * Take up homework questions
* 03 – Perimeter Inspirations – Revolutions in Science (Based on: Alice & Bob in Wonderland Animations)

Activity and Worksheet:Scientific Models: Time (pg. 32-34)* Homework questions 3, 4, 7 (Nelson Physics 12 pg. 587)
 | **F2.3** solve problems related to Einstein’s theory of special relativity in order to calculate the effects of relativistic motion on time, length, and mass | * Group work on worksheets
* Observation and conversation
 | * Worksheets from Perimeter Inspirations booklet (pg. 35-37)
 |
| **Day 3**Length Contraction, Simultaneity, and Relativistic Momentum (11.3) | * Take up homework questions
* Class discussion with clicker questions for the following topics:
* *Length Contraction*
* *Relativity of Simultaneity*
* *The Twin Paradox*
* *Relativistic Momentum*
* Homework questions (4, and 5)
 | **F2.3** solve problems related to Einstein’s theory of special relativity in order to calculate the effects of relativistic motion on time, length, and mass | * Observation and conversation with clickers
 | * SMART Board
* Clickers
* Notes for students

(<http://schools.hwdsb.on.ca/highland/files/2011/01/special_relativity3.pdf>) |
| **Day 4**Mass-Energy Equivalence (11.4) | * Take up homework questions
* *Mass-Energy Equivalence*
* *Nuclear fusion*

*(* <http://youtu.be/qe7mbv7v9Zg>*)* | **F2.3** solve problems related to Einstein’s theory of special relativity in order to calculate the effects of relativistic motion on time, length, and mass | * Observation and conversation with clickers
 | * SMART Board
* Clickers
* PowerPoint (<http://bit.ly/Z2zTnN>)
 |
| **Day 5**Introducing Quantum Theory (12.1) | * Quiz on Chapter 11
* *Particles and Waves*

Wave/Particle Duality – minutephysics(<http://youtu.be/Q_h4IoPJXZw>)* *Interference experiment with electrons*

Dr. Quantum – Double Slit Experiment (<http://youtu.be/DfPeprQ7oGc>)* Homework questions 1, 2, 3, 8 (Nelson Physics 12 pg. 619)
 | **F3.2** describe the experimental evidence that supports a wave model of matter  | * Quiz marked for all 4 categories of achievement chart (K/U, A, C, T/I)
 | * Laptop
* Projector
* Quiz

(<http://bit.ly/10Od3DS>) |
| **Day 6**Photons and the Quantum Theory of Light (12.2) | * Take up homework questions
* *The Work Function*
* *The Photoelectric Effect*
	+ Perimeter Institute - Measuring Plank’s Constant Student Worksheet
* *Photons Possess Energy and Momentum*
* *Photon Interaction*
 | **F1.1** analyse the development of the two major revolutions in modern physics, and assess how they changed scientific thought**F2.4** conduct a laboratory inquiry or computer simulation to analyse data that support a scientific theory related to relativity or quantum mechanics | * Plank’ Constant Laboratory Experiment and Report (marked on K/U, A, C, T/I)
 | Equipment needed:* 6 V battery
* 1kΩ
* 330Ω resistor
* Voltmeter
* Five connecting leads
* Set of LED’s producing five different colours
* Worksheets from Perimeter Institute booklet for measuring Plank’s constant
 |
| **Day 7**Wave Properties of Classical Particles (12.3) | * Collect Lab Reports
* *Wave-like Properites of Classical Particles*
* *The Electron Double-Slit Experiment*
* *The Wave Function: A mathematical Description of Wave-Particle Duality*
* *The Heisenberg Uncertainty Principle*
* 02 – Perimeter Explorations – The Challenge of Quantum Reality

Wave-Particle Duality with Electrons & Light (pg. 20-23)* PhET simulation for Quantum wave interference

(<http://phet.colorado.edu/en/simulation/quantum-wave-interference>)* Homework questions 1-3, 5, 8 (Nelson Physics 12, pg.639)
 | **F2.2** solve problems related to the photoelectric effect, the Compton effect, and de Broglie’s matter waves**F3.1** describe the experimental evidence that supports a particle model of light**F3.2** describe the experimental evidence that supports a wave model of matter  | * Group work on worksheets
* Observation and conversation
 | * Worksheets from Perimeter Explorations booklet (pg. 20-23)
 |
|  **Day 8**The Standard Model of Elementary Particles(12.6) | * *Take up homework questions*
* *Understanding the Atom*
* *21st Century Physics and Antimatter*
* *The Standard Model*
1. The standard model of particle physics (<http://youtu.be/V0KjXsGRvoA>)
* Homework questions 1 and 3 (Nelson Physics 12, pg. 653)
 | **F3.4** describe the standard model of elementary particles in terms of the characteristics of quarks, hadrons, and field particles | * Observation and conversation with clickers
 | * SMART Board
* Clickers
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| **Day 9\*** Preparation for Presentations  | Students will use the internet and other sources to create a multimedia presentation on their topic (includes its history/development, its application, and the core science of the technology)Presentation on Modern Physics Topics: 1. Global Positioning Systems (GPS) and Satellites (Section 11.2)
2. Large Hadron Collider (LHC) (Section 11.3)
3. Electron microscopy (Section 12.4)
4. Superconducting Quantum Interference Device (SQUID) (Section 12.4)
5. Lasik eye surgery (Section 12.4)
6. Positron Emission Tomography (PET) (Section 12.4)
7. Computed Tomography (CT) (Section 12.4)
8. UV light sterilizers (Section 12.4)
9. Quantum dots in cancer therapy (Section 12.4)
10. Quantum Information and Developments in Quantum Cryptography (Section 12.5)
11. The Mystery of Dark Matter
12. Linear Accelerators
13. Fission and Fusion
 | **F1.2** assess the importance of relativity and quantum mechanics to the development of various technologies | Students presentation will be marked for content, layout, multimedia, and APA referencesGroup/partner work will also be evaluated | * Reserve computer lab
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| **Day 10****and** **Day 11\***Presentations | Students will present their research to the classEach group will get approximately 8-10 minutes to present their topic, with 2-4 minutes for questions. | Same as above | Students presentation will be marked for eye contact, posture, and voice  | * Laptop
* SMART Board
* Projector
* Speakers if needed
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| **Day 12**Review | Review of both chapters |  | Assessment as Learning (Peer and Self-Assessment) | * Summary of both chapters and review questions (<http://bit.ly/WrmSHR>)
 |
| **Day 13**Unit Test | Review of both chapters |  | Test will be marked for all 4 categories of the achievement chart (K/U, A, C, T/I) | Copies of the test |

**\***Day 9-11 covers sections:

* 12.4 Explore an Application in Quantum Mechanics
* 12.5 Raymond Laflamme and Quantum Information Theory