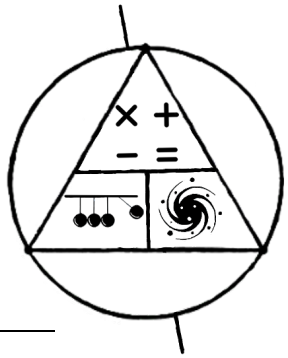
Unit 3 Plan

Course: SPH4U
Unit: Gravitational, Electric, and Magnetic Fields
Teacher: Roger Wilkinson



Unit 3 - Gravitational, Electric, and Magnetic Fields	
Overall Expectations Evaluated	**Evidence of achievement/Assessment of learning**
D1: analyse the operation of technologies that use gravitational, electric, or magnetic fields, and assess the technologies' social and environmental impact **D2:** investigate, in qualitative and quantitative terms, gravitational, electric, and magnetic fields, and solve related problems **D3:** demonstrate an understanding of the concepts, properties, principles, and laws related to gravitational, electric, and magnetic fields and their interactions with matter.	1. Assignment #3 (3%) 2. Test #3 (11%) **Student Success Criteria:** I can; • describe various physical phenomena caused by gravitational, electric, and magnetic fields • quantitatively solve various real world problems concerning orbits and orbital velocities • quantitatively solve various real world problems concerning electric and magnet fields and the forces that they apply on various charges and magnets in both static and non-static situations • describe the effects of the scientific study of fields on science and industry and explain various examples of applications • perform lab experiments in a safe manner • predict the results of various laboratory experiments concerning gravitational, electric, and magnetic field given the setup • describe and explain the feature and properties of fields as physical and mathematical objects • evaluate the social and environmental impacts of various technologies related to the fields studied in this unit • state and apply the various physical laws related to gravitational, electric, and magnetic fields
Approximate weighting for each category in the unit	**K** - 25% **T** - 25% **C** - 25% **A** - 25%
Specific Expectations Taught and Assessed in Unit	
A1.1, 1.3, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 01.13, 2.1, 2.2, D1., 1.2, 2.1. 2.2, 2.3, 2.4, 2.5, 3.1, 3.2, 3.3	

Lesson	Description
1. Newtonian Gravitation Specific Expectation: A1.12, D2.1, 3.3	**Objectives:** 1. To identify and use Newton's Law of universal gravitation in qualitative as well as quantitative terms. 2. To understand and explain the physical concept of a field and how it applies to gravitation. 3. To solve various quantitative problems involving gravitating bodies using the concept of a field and vector algebra. **Materials/Resources:** • textbook and notes • computer and projector with internet access **Activities/Lesson Body:** • Short video introduction of Newton and his theory of gravitation. https://www.youtube.com/watch?v=7gf6YpdvtE0 • Introduce the concept of gravity as being represented or thought of as a field. • Introduce the mathematical representation of Newton's law of universal gravitation. • Give explanation of why gravity is an inverse square law, think light in an expanding sphere and how the flux dies off as an inverse square • Newton's universal constant: value and how it was measured • Review solving some problems with vector algebra to determine the force of gravity in various situations. **Assignments/Homework:** • Textbook: pg 296, 1- 13 **Evaluation/Assessment:** • FOR: yes/no concept checking questions • AS: Kahoot! Review, Chap. 6 Self-quiz (pg. 311) • OF: A3, T3

2. Orbits and Satellites Specific Expectation: A1.12, D2.1, 2.2	**Objective:** 1. Understand and explain the basic idea that to be in orbit means to be in continuous free fall, but always missing the earth. 2. Make the connection between parabolic flight and elliptical orbits. 3. Calculate various orbital velocities and periods for planets and satellites. **Materials/Resources:** • computer and projector with internet access • textbook and notes • Whiteboard markers and/or markers and large pieces of paper **Activities/Lesson Body:** • Indigenous Story from *Lessons from the Earth and Beyond:* Wilfred Buck- The Story of The Great Bear And The Seven Birds ‘ • connect story to the quote “There is an art to flying, or rather a knack. The knack lies in learning how to throw yourself at the ground and miss. ... Clearly, it is this second part, the missing, that presents the difficulties.” by Douglas Adams. • Connect with conic sections; parabolas and ellipses • Quantitative analysis of using gravitational field strength to determine orbital velocity and period • Discuss different types of orbits for satellites; elliptical, circular, geosynchronous orbits, etc. • Review solving some problems from the textbook, then have students work in small groups to solve problems **Assignments/Homework:** • Textbook: pg 303, 1-14 **Evaluation/Assessment:** • FOR: yes/no concept checking questions • AS: Kahoot! Review, Chap. 6 Self-quiz (pg. 311) • OF: A3, T3

3. Project Based Learning - Explore the Solar System Specific Expectation: A1.1, A1.7, 1.9, 1.10, 1.11, 2.1, 2.2, D1.1, 1.2	**Objective:** 1. To research topics related to gravitation using one of the guiding questions below. 2. To summarize and present findings in an impromptu presentation **Materials/Resources:** • Students will be asked to bring an electronic device with internet access to class. If this is not possible, then book out computer lab time for this lesson. **Activities/Lesson Body:** • Split students into groups and give them one of the guiding questions below to explore and present on. The students will be given 50 min. to research with their groups, then give a brief presentation on what they found and what questions they have. • Driving Questions: – How does GPS work? – What is the New Horizons space probe? – Is space junk a problem? What can we do about it? – What are the environmental benefits of using technology involving gravitational fields to search for mineral deposits? – How could zero-gravity experiments on agricultural products benefit society and the environment? – What careers are there related to orbital mechanics? – How have Canadians contributed to space exploration? **Assignments/Homework:** • Write up a 1 page summary of what your group found in your own words. What further questions do you have concerning the research topic? **Evaluation/Assessment:** • FOR: give quick feedback on 1 page summaries • AS: 1 page summary • OF: N/A

4. Guest Speaker Specific Expectation: A2.1, D1.1, 1.2, 3.1	**Objective:** 1. To introduce students to the concepts of General Relativity. 2. To introduce students to a GR researcher. **Materials/Resources:** • Setup guest speaker. Richard Epp would be ideal, but graduate students working in GR would also be a good fit. **Activities/Lesson Body:** • Have guest speaker present, then leave time for questions about the content as well as their career and educational pathway. **Assignments/Homework:** • N/A **Evaluation/Assessment:** • N/A

5. Properties of Electric Charge Specific Expectation: D2.1, D2.3, 2.5, 3.2, 3.3	**Objective:** 1. To understand the basic concept of charge and recognize related physical phenomena. 2. To grasp the law of electric charges; like charges repel, unlike charges attract. 3. To understand the conservation of charge as a conservation law. 4. To understand the difference between an insulator and a conductor. 5. To understand how to charge objects by friction and induction in practice and in theory. **Materials/Resources:** • Look for a few small experiments you can use to show how objects can be charged by friction and induction. If possible deflect a thin stream of water with charged object. **Activities/Lesson Body:** • Use small experiments to demonstrate some phenomena related to electric charges • Have students try to generate similar effects themselves with various classroom objects • Short period of formal instruction on the theory behind the physical phenomena demonstrated in class. **Assignments/Homework:** • Textbook problems: pg 326, 1 - 11 **Evaluation/Assessment:** • FOR: yes/no concept checking questions • AS: having the students try to generate similar effects using different objects, Kahoot! Review, Chap. 7 Self-quiz (pg. 369) • OF: A3, T3

6. Coulomb's law & Electric fields Specific Expectation: D2.1, D2.3, 2.5, 3.2, 3.3	**Objective:** 1. To understand and apply Coulomb's Law in various situations. 2. To use the principle of superposition to calculate the net electric force on a charge. 3. To make connections between the gravitational force/field and the electric force/field. 4. To draw field lines for various charge distributions. **Materials/Resources:** • Whiteboard markers and/or markers and large pieces of paper **Activities/Lesson Body:** • Review the quantitative formulas for calculating the force of gravity and why the force is represented by an inverse square law. • Have students work in pairs to discuss and predict whether or not the electric force will also follow an inverse square law and explain their reasoning. • Give students Coulomb's law and have them try to solve a problem in small groups on white boards or large pieces of paper to determine the net force on a charge in 1D • After reviewing the solution, try to let students solve a problem in 2D, then review solution. • Give examples of how to draw field lines for basic charges, then have students try to draw field lines in small groups. **Assignments/Homework:** • Textbook: pg 333, 1-10, pg. 345, 1-8 **Evaluation/Assessment:** • FOR: yes/no concept checking questions, walking around while students are working through problems and seeing how they are doing and how much help they need • AS: solving new problems actively in small groups Kahoot! Review, Chap. 7 Self-quiz (pg. 369) • OF: A3, T3

7. Potential difference and electric potential Specific Expectation: D2.1, D2.3, 2.5, 3.2, 3.3	**Objective:** 1. To calculate various quantities around work and electric potential energy 2. To develop skills to solve more quantitative problems centred around various physical situations involving charges and electric fields. **Materials/Resources:** • Textbook • Whiteboard markers and/or markers and large pieces of paper **Activities/Lesson Body:** • Period of formal instruction about the definition of electric potential • Class example of solving a quantitative problem • Give problems sheet to students and have them solve problems together in small groups. **Assignments/Homework:** • Textbook: pg 354, 1-10 **Evaluation/Assessment:** • FOR: yes/no concept checking questions, walking around while students are working through problems and seeing how they are doing and how much help they need • AS: solving new problems actively in small groups Kahoot! Review, Chap. 7 Self-quiz (pg. 369) • OF: A3, T3

8. Electric potential and electric potential energy due to point charges Specific Expectation: D2.1, D2.3, 2.5, 3.2, 3.3	**Objective:** 1. To calculate the change in electric potential and electric potential energy for various physical situations using point charges. **Materials/Resources:** • Textbook • Whiteboard markers and/or markers and large pieces of paper **Activities/Lesson Body:** • Period of formal instruction about the definition of electric potential • Class example of solving a quantitative problem • Give problems sheet to students and have them solve problems together in small groups. **Assignments/Homework:** • Textbook: pg 361, 1-8 **Evaluation/Assessment:** • FOR: yes/no concept checking questions, walking around while students are working through problems and seeing how they are doing and how much help they need • AS: solving new problems actively in small groups Kahoot! Review, Chap. 7 Self-quiz (pg. 369) • OF: A3, T3

9. The Millikan oil drop experiment Specific Expectation: D2.1, D2.3, 2.5, 3.2, 3.3	**Objective:** 1. To understand the importance of the result of the Millikan oil drop experiment. 2. To connect the result to other physics by recognizing the charge of the electron as a fundamental physical constant **Materials/Resources:** • computer and projector • have students bring electronic devices if possible or book out computer lab time **Activities/Lesson Body:** • Review the basic idea of Millikan's experiment • Have students go to the web app: https://ophysics.com/em2.html , and try to determine the charge on an electron themselves. • Consolidate lesson by determining the charge on an electron using the web app. • Have students discuss why they think this result is important and fundamental **Assignments/Homework:** • Textbook: pg 365, 1-8 **Evaluation/Assessment:** • FOR: yes/no concept checking questions • AS: having students try to find the charge on the electron will test their comprehension of the basic idea behind the Millikan experiment Kahoot! Review, Chap. 7 Self-quiz (pg. 369) • OF: A3, T3

10. Laboratory Day Specific Expectation: D1.1, 1.2, 2.5,	**Objective:** 1. To gain a better conceptual understanding of what a field is and how it is used to describe gravitational, electric, and magnetic phenomena. **Materials/Resources:** • The Perimeter Institute's (PI) activity sheets on "What is a field?" • Magnets and iron fillings **Activities/Lesson Body:** • Follow the PI lesson plan and worksheets, but supplement the material by letting students explore fields using magnets, iron fillings, and metallic objects. The exploration here should be mostly unstructured, but students must nonetheless complete the worksheets before the end of class. **Assignments/Homework:** • 1 page write up, in their own words, describing what they learned about fields and what questions they still have. **Evaluation/Assessment:** • FOR: quick feedback on 1 page summary of learning • AS: working through the handouts with the activity will allow students to evaluate what they do and don't understand about fields • OF: A3, T3

11. Magnets and Electromagnets Specific Expectation: D2.1, 2.4, 2.5, 3.2, 3.3	**Objective:** 1. To gain a basic understanding of permanent and electro-magnets. 2. To identify magnetic phenomena in the physical world and students' everyday life. 3. To understand that moving charges create magnetic fields. 4. To understand and apply the right hand rule for straight conductors and solenoids. **Materials/Resources:** • Magnets and iron fillings • collection of magnetic and none magnetic objects, devices, and toys **Activities/Lesson Body:** • Have a class discuss about bar magnets and compare them to electric dipoles • Have students explore some magnets in an unstructured way to see what they can do with them in class. Have students share what they did with the class and explain their results in terms of fields and field strength • Formal instruction on the principle of electromagnetism and the right hand rules **Assignments/Homework:** • Textbook: pg 385, 1-7 **Evaluation/Assessment:** • FOR: yes/no concept checking questions • AS: when students are exploring in class, ask them if they can make something specific happen with the magnets and objects and explain why or why not Kahoot! Review, Chap. 8 Self-quiz (pg. 415) • OF: A3, T3

12. Magnetic force on moving charges Specific Expectation: D2.1, 2.4, 2.5, 3.2, 3.3	**Objective:** 1. To understand the magnetic forces on charges only occurs when the charge (or the magnet) is in motion. 2. To calculate the magnet force on various moving charges. 3. To apply the right hand rule for a moving charge in a magnetic field. **Materials/Resources:** • Textbook • Whiteboard markers and/or markers and large pieces of paper **Activities/Lesson Body:** • Formal instruction • have students solve problems in groups on large sheets of paper or white-board • Videos about magnets and special relativity: https://www.youtube.com/watch?v=1TKSfAkWWN0 https://www.youtube.com/watch?v=hFAOXdXZ5TM **Assignments/Homework:** • Textbook: pg 391, 1-10 **Evaluation/Assessment:** • FOR: yes/no concept checking questions • AS: working in groups to see how well they understood the material Kahoot! Review, Chap. 8 Self-quiz (pg. 415) • OF: A3, T3

13. Magnetic force on a current carrying conductor Specific Expectation: D2.1, 2.4, 2.5, 3.2, 3.3	**Objective:** 1. To calculate the magnetic force on a current carrying conductor under various circumstances. 2. To apply the right hand rule for magnetic forces on conductors **Materials/Resources:** • Textbook • Whiteboard markers and/or markers and large pieces of paper • computer and projector **Activities/Lesson Body:** • Formal instruction with demo of magnetic force on conductor: https://www.youtube.com/watch?v=F1PWnu01IQg • have students solve problems in groups on large sheets of paper or whiteboard **Assignments/Homework:** • Textbook: pg 396, 1-5 **Evaluation/Assessment:** • FOR: yes/no concept checking questions • AS: working in groups to see how well they understood the material Kahoot! Review, Chap. 8 Self-quiz (pg. 415) • OF: A3, T3

14. Motion of charged particles in magnetic fields Specific Expectation: D1.1, 1.2, 2.1, 2.4, 2.5, 3.2, 3.3	**Objective:** 1. To calculate and describe the motion of charged particles in magnetic fields. 2. To understand various phenomena and applications of magnetic fields in research and industry. **Materials/Resources:** • Textbook • Whiteboard markers and/or markers and large pieces of paper • computer and projector **Activities/Lesson Body:** • Video about the aurora borealis: https://www.youtube.com/watch?v=czMh3BnHFHQ • Formal Instruction on phenomena and equations • Watch video about mass spectrometer: https://www.youtube.com/watch?v=0ma-0d4iDVE • have students work in groups to solve problems **Assignments/Homework:** • Textbook: pg 404, 1-6 **Evaluation/Assessment:** • FOR: yes/no concept checking questions • AS: working in groups to see how well they understood the material Kahoot! Review, Chap. 8 Self-quiz (pg. 415) • OF: A3, T3

15. Applications of electric and magnetic fields Specific Expectation: D1.1, 1.2, 2.1, 2.4, 2.5, 3.2, 3.3	**Objective:** 1. To explore different applications of electric and magnetic fields in science and industry. 2. To connect what students have learned in class to various examples of applications in the real world. **Materials/Resources:** • have students bring electronic devices or book computer lab time **Activities/Lesson Body:** • Brief introduction to a few applications of electric and magnetic fields • Have students work in small groups to research interesting applications of electric and magnetic fields, and find one video or website to share with the class • have groups share their findings and explain how it connects to what the class has been learning about **Assignments/Homework:** • 1 page reflection about what they learned in their research and from the presentations of the other students **Evaluation/Assessment:** • FOR: quick feedback on 1 page reflection • AS: writing 1 page reflection • OF: N/A

16. Laboratory Day Specific Expectation: D1.1, 1.2, 2.1, 2.4, 2.5, 3.2, 3.3	**Objective:** 1. To explore magnetic phenomena with ferrofluids. **Materials/Resources:** • computer and projector • see list of handouts and material for lab at: https://www.nationalgeographic.org/activity/magnetic-fields-lab/ **Activities/Lesson Body:** • Watch videos together as a class from link above. • Have students follow instructions on handouts with material from the lab. • Consolidation period at the end for students to share what they found. **Assignments/Homework:** • N/A **Evaluation/Assessment:** • FOR: yes/no concept checking questions • AS: filling out the lab sheet and making predictions • OF: N/A

17. Review Day Specific Expectation: All of Strand D	**Objective:** 1. To review qualitative and quantitative material from unit 3. **Materials/Resources:** • Feedback data from student replies to "Muddiest Point," so that I can target the review to the concepts and problems that students find most challenging. • Computer of projector for use in playing Kahoot! review game. • Students must be told to bring an electric device which they can use to play Kahoot! **Activities/Lesson Body:** • Start with Kahoot! review as an assessment FOR learning to get an extra feel for how students are doing after review of the Muddiest point responses. • Review select questions and ideas based on student feedback. Ensure to review questions that are similar in nature to test questions. **Assignments/Homework:** • Review and student for test. • Select questions from Unit 3 Self-quiz and Review from textbook (pgs. 424 - 433) **Evaluation:** • FOR: Kahoot!Review and Muddiest Point feedback • AS: Kahoot! Review • OF: N/A

18. Test Day Specific Expectation: All of Strand D	**Main Components of Test:** • Gravitational Fields – True/False concept checking questions – Quantitative questions about orbital speeds and periods • Electric and Magnetic Fields – True/False concept checking questions – Quantitative questions about: properties of electric charges, Coulomb's law, electric potential, electric potential difference, magnetic forces on moving charges and current carrying conductors – Qualitative communication questions about: physical fields, electromagnetic induction, applications of gravitational & electromagnetic fields