The reference digital text ***Openstax: Physics High School*** will be used throughout the course (grade 12 will also require the *College Physics* digital text for outcome 6.3). Readings can be found within the outcome description and the page reference is for the PDF file, not a printed version. Within the first few days of school, go through ***Chapter 1*** to add to your understanding of what physics is all about.

1 Kinematic Motion in One Dimension: Kinematics is the study of *how* objects move.

- 1.1 Define and identify scalars and vectors. Classify each of the quantities listed in outcome 1.2 as a scalar or vector. ***Chapter 2, Pg. 67 – 80***
- 1.2 Recognize and define position, displacement, distance, velocity, speed, acceleration, force, and their units. ***Course Concept Guide***
- 1.3 Graphically analyze one-dimensional relationships among position, velocity, acceleration, and time. ***Chapter 2, Pg. 81 – 96***
- 1.4 Mathematically analyze the relationship among position, velocity, acceleration, and time in 1D. ***Chapter 3. Pg. 107 – 127***

2 Kinematic Motion in Two Dimensions: Much of physics relies on being able to solve problems in 1, 2 or 3 dimensions. In high school, we study 1 and 2 dimensional problems. Outcomes 2.1 – 2.3 are about the mathematics behind analyzing 2D problems. Outcomes 2.4 and 2.5 apply the 2D analysis to kinematic concepts from Unit 1. ***Chapter 5.1 & 5.2, Pg. 157-175***

- 2.1 Measuring vectors and the resultant position for 2D vectors using a scale diagram.
- 2.2 Calculating perpendicular components of vectors.
- 2.3 Calculating vectors (magnitude and direction) given the components.
- 2.4 Mathematically analyze the relationship among displacement (position), velocity, acceleration, and time in 2D.
- 2.5 Vector addition and solving for missing vectors.

3 Dynamics: The study of *why* objects move. This unit describes the types of forces and Newton's Laws of motion. ***Chapter 4, Pg. 129 – 156***

- 3.1 Explain, describe, and analyze the forces of gravity and friction. Including the types and causes of friction, the coefficient of friction, and determining normal force given the situation in one dimension.
- 3.2 Describe and apply Newton's 3 Laws of motion within inertial and non-inertial frames of reference in one dimension.
- 3.3 Qualitatively and quantitatively analyze the various types of forces including friction, normal, gravitational, applied, tension, and the concept of net force in two dimensions.

4 Conservation of Mechanical Energy: Understanding changes that take place in a system is often aided by considering energy exchanges. Students will learn the concept of work, relative to physics, identify forms of energy and that energy for a system is a constant. ***Chapter 9, Pg. 293-313***

- 4.1 Define and apply the concept of work incorporating the following: kinetic, gravitational potential, and elastic potential energy.
- 4.2 Qualitatively and quantitatively analyze the conservation of mechanical energy with conservative and non-conservative forces.

5 Electromagnetic Radiation: The following outcomes relates foundational information of the types of EM radiation (radio waves, light, x-rays, etc.). ***Chapters 13 - 17***

- 5.1 Waves
- 5.2 Doppler Shift*
- 5.3 Electromagnetic Spectrum*
- 5.4 Refraction
- 5.5 Lenses*
- 5.6 Diffraction*

6 Kinematics & Dynamics in 2D: The study of why objects move in two-dimensional space. This unit applies the concept of perpendicular components to solve problems. Problems, or systems, involve:

- 6.1 In depth quantitative analysis of a projectile motion. ***Chapter 5.3, Pg. 176-185***
- 6.2 Applying Newton's Laws of motion for objects on an incline plane. ***Chapter 5.4, Pg. 185-192***
- 6.3 Learn and apply the concept of net torque to solve static equilibrium problems. ***OpenStax College Physics: Chapter 9, Pg. 329-354***
- 6.4 Collisions and explosions in one and two dimensions. ***Chapter 8, Pg. 267-287***

7 Circular Motion & Universal Gravitation: This explores how and why an object travels in a circular path (be it a ball on a string, an amusement park ride, or the Moon about the Earth, for example). Universal gravitation is a deeper analysis of the force of gravity between two masses and is further analyzed with Kepler's Laws of planetary motion.

- 7.1 Qualitatively and quantitatively analyze circular motion using vectors and Newton's laws. ***Chapter 6, Pg. 211-236***
- 7.2 Quantitatively apply Newton's law of gravitation and Kepler's third law of planetary motion to solve problems. Identify and explain Kepler's three laws of planetary motion. **Chapter 7, Pg. 243-260**

8 Fields & Electromagnetic Forces: Forces can affect objects over a distance and through space without physical contact. The analysis of that affect requires the physics concept of fields. When a current is made to pass through a wire, it creates a magnetic field, and vice-verse. Coulomb's Law allows for the mathematical analysis of the interaction of charged objects.

- 8.1 Qualitatively and quantitatively analyze electric charge and electric fields, including Coulomb's Law. **Chapter 18, Pg. 563-606**
- *8.2* Qualitatively analyze magnetism including magnetic poles, fields, and moving charges. ***Chapter 20, Pg. 663-69***

Strong Work Ethic and Skills for Success

- On task during class
  - This is the only time I can help you learn. Use it.
- Proper use of technology
  - Turn off your notifications, like completely. This is the main reason student work suffers.
- Time/task management
- Problem solving skills
  - Not just math, but the approach to any problem.
- Reflection
  - No big write up necessary. "Did I work to my best today?"
- Take initiative with your learning.
  - You have the course materials for the entire semester. Use them.
- Personal workspace (outside of class)
- Goal setting
- Ask questions during class lessons.
  - Seek your own answers before asking the teacher during work time.
- Ask for feedback
- Use of course resources
  - It is all there. Everything. Go forth, learn.
- Embrace mistakes
  - Learn from them.

Classifying Mistakes

For any type of assessment, determine the type of mistake and the learning opportunity, that is, how to prevent the mistake from happening again. The purpose is to give us information on any learning barriers you are experiencing, and work towards removing them. Use the guide, below, to determine the type of mistake(s) and the learning opportunity.

Type	Type Definition and Examples of Learning Opportunities
Minor	An abnormal mistake, hard to catch, not made often, and not part of the problem solving. • Forgetting to divide by a number that is written down • A number or sign is not carried down to the next math step • Calculator buttons miss-hit • No units in final answers
Background	Usually in the form of mathematical mistakes. • Equation solving • Order of operations • Algebra rules (like and unlike terms)
Conceptual	These mistakes link to gaps in understanding the concepts of physics. • Vector signs • Incorrect formula • Incorrect setup or analysis • Concepts and definitions not fully understood

Course Project

A physics project may be assigned that runs the full length of the course. If so, it falls under outcome 10. It will break down into two grading components, each scored out of 6. You will be responsible for demonstrating course concepts connected to the project through qualitative and quantitative means. It is possible for this project to help you meet the course content outcomes, but outcomes will not be double-graded.

1. **Science and Engineering Practices**: There are eight practices to work towards mastering and can be found on the next page. Throughout the semester your team will journal how you met these practices.

2. **Overall Project**: Using information from self and peer assessments, goal and task setting, public feedback, conferencing, observations, etc. Specific details will be given to you later in the course.
   - Self-assessment will have you evaluate your role in the team by thinking about collaboration, communication both vocally and listening (considering ideas of) others, contribution, punctuality of tasks, problem solving, and critical thinking.
   - Tasks/Goals are to be made (bi)weekly followed by a short reflection on if the task was met or what prevented the task from being completed.
   - Teacher observations, conversations, conferencing, public feedback.

The Eight Science and Engineering Practices (NGSS)

Learning Target	Description
SEP1: Asking Questions and Defining Problems	A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas.
SEP2: Developing and Using Models	A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions, and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.
SEP3: Planning and Carrying Out Investigations	Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters. Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.
SEP4: Analyzing and Interpreting Data	Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis. Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.
SEP5: Using Mathematics and Computational Thinking	In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions.
SEP6: Constructing Explanations and Designing Solutions	The end-products of science are explanations, and the end-products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.
SEP7: Engaging in Argument from Evidence	Argumentation is the process by which evidence-based conclusions and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims.
SEP8: Obtaining, Evaluating, and Communicating Information	Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to obtain information that is used to evaluate the merit and validity of claims, methods, and designs.

Assessment and Evaluation

Outcomes will be graded from 1 to 6. That grade will be based on evidence from multiple sources including all or some of the following: observations, conversations, formative, and summative assessments.

<table>
<tr><td rowspan="2">Expert: Demonstration of a deep/thorough understanding of the concept</td><td>6</td><td>• Chose an appropriate strategy.
• Successfully applied the necessary background skills and proper concepts to complete solutions.
• Solutions contained no minor mistakes, or a summative contains at most two.
• Clearly and concisely explained how to solve the problem using appropriate vocabulary, diagrams, and a coordinate system. “Did I show my work?”
• Evaluated the reasonableness of my answer. “Does this make sense for the situation?”
• Concept understood to a high degree to teach it to someone else.
• Concept can be applied to new problems.</td></tr>
<tr><td>5</td><td>• Chose an appropriate strategy.
• Solution(s) contained an error(s) related to a background skill.
• The concept can be explained using appropriate vocabulary.
• The concept can be applied successfully in known problems.</td></tr>
<tr><td rowspan="2">Apprentice: Good/Satisfactory understanding of the concept</td><td>4</td><td>• Chose an appropriate strategy.
• A solution contained a concept error. A summative contained at most two such errors.
• Minor mistakes and background skill errors are common.
• Explanations of a problem contained mostly appropriate terminology.
• Mistakes were identified and corrected after referring to a key.
• More practice is needed solving this type of problem.</td></tr>
<tr><td>3</td><td>• Chose an appropriate strategy.
• Solution(s) contained a combination of concept errors, errors related to background skills and minor mistakes.
• A lack of necessary background skills to solve problems.
• Notes, examples, or help was needed to solve problems.
• Explanations did not contain proper terminology.
• Help from an expert is required solving this type of problem.</td></tr>
<tr><td rowspan="2">Novice: Minimal-to-no understanding of the concept</td><td>2</td><td>• Incorrect strategy(ies) chosen for a problem(s).
• Step-by-step instructions are required to solve problems.
• Tasks could not be performed to an acceptable standard.
• Consistent extra help from an expert is required.</td></tr>
<tr><td>1</td><td>• Basics of what was needed to solve the problem was not known.
• Solution left blank; first step not known.
• Teaching by an expert is required.</td></tr>
</table>

<table>
<tr><th>Learning Category</th><th>Classification Level</th><th colspan="3">Only shortly before report cards will a percentage mark be determined</th></tr>
<tr><td rowspan="2">Expert</td><td>6</td><td colspan="3">95 – 100</td></tr>
<tr><td>5</td><td>86</td><td>90</td><td>94</td></tr>
<tr><td rowspan="2">Apprentice</td><td>4</td><td>73</td><td>80</td><td>85</td></tr>
<tr><td>3</td><td>60</td><td>66</td><td>72</td></tr>
<tr><td rowspan="2">Novice</td><td>2</td><td>50</td><td>56</td><td>59</td></tr>
<tr><td>1</td><td>0</td><td>25</td><td>49</td></tr>
</table>

Students will log their grades in their Physics Book. The overall grade is guided with the calculation of the *median* and *mean* of all grades.

*Reassessing outcomes is encouraged, and times will be made available during the semester.
*No traditional final exam. Reassessment is possible.

Course Outcome Tracking

Physics 112 Outcome	Description	Grade	Physics 122 Outcome	Description	Grade
1.1 & 1.2	Define and identify scalars and vectors. Classify each of quantity listed in outcome 1.2 as a scalar or vector. Recognize and define position, displacement, distance, velocity, speed, acceleration, force, and their units.		**6.1**	In depth quantitative analysis of a projectile motion.	
1.3	Graphically analyze one-dimensional relationships among position, velocity, acceleration, and time.		**6.2**	Applying Newton's Laws of motion for objects on an incline plane.	
1.4	Mathematically analyze the relationship among position, velocity, acceleration, and time in 1D.		**6.3**	Learn and apply the concept of net torque to solve static equilibrium problems.	
2.1	Measuring vectors and the resultant position for 2D vectors using a scale diagram.		**6.4**	Collisions and explosions in one and two dimensions.	
2.2	Calculating perpendicular components of vectors.		**7.1**	Qualitatively and quantitatively analyze circular motion using vectors and Newton's laws.	
2.3	Calculating vectors (magnitude and direction) given the components.		**7.2**	Quantitatively apply Newton's law of gravitation and Kepler's third law of planetary motion to solve problems. Identify and explain Kepler's three laws of planetary motion.	
2.4	Mathematically analyze the relationship among displacement (position), velocity, acceleration, and time in 2D.		**8.1**	Qualitatively and quantitatively analyze electric charge and electric fields, including Coulomb's Law.	
2.5	Vector addition and solving for missing vectors.		**8.2**	Qualitatively analyze magnetism including magnetic poles, fields, and moving charges.	
3.1	Explain, describe, and analyze the forces of gravity and friction. Including the types and causes of friction, the coefficient of friction, and determining normal force given the situation in one dimension.		**9.1**	Climate Literacy and Science	N/A
3.2	Describe and apply Newton's 3 Laws of motion within inertial and non-inertial frames of reference in one dimension.		**10.1**	Science and Engineering Practices	
3.3	Qualitatively and quantitatively analyze the various types of forces including friction, normal, gravitational, applied, tension, and the concept of net force in two dimensions.		**10.2**	Project Grade (using information from self and peer assessments, goal and task setting, public feedback, conferencing, observations, etc.)	
4.1	Define and apply the concept of work incorporating the following: kinetic, gravitational potential, and elastic potential energy.				
4.2	Qualitatively and quantitatively analyze the conservation of mechanical energy with conservative and non-conservative forces.				
5.1 – 5.6	The following outcomes relate foundational information of the types of EM radiation (radio waves, light, x-rays, etc.).	N/A			

Overall Course Grade

- Calculate your *median* by arranging your grades from lowest to highest. The grade in the middle is *likely* your overall grade. If there is no exact middle number, average the two middle numbers.
- Calculate your mean by adding all the grades up and divide by how many there are.
- Use a pencil, if you are writing your grades here because grades will fluctuate over the semester.

Median = _______ Mean = _______

Example Percent Determinations

Median	Mean	Percent	Reason
4	3.8 – 4.2	80 %	Median and mean match or are close
4	4.3 or higher	85 %	Mean is much higher than median
4	3.7 or lower	73 %	Mean is much lower than median