COURSE INFORMATION
Physics

Grade Level:	11th & 12th (10th with approval)
Length:	1 Year
Period(s) Per Day:	1

ESSENTIAL UNDERSTANDING
Physics is a fundamental science whose concepts and principles are drawn upon by Chemistry, Biology, Geology, and Astronomy in their exploration of the universe. The course is intended primarily for students who will require some competence in Physics for subsequent college work. Emphasis will be placed on Mechanical Physics to include an understanding of the rules of motion in our Universe. The course will balance the conceptual understanding of physical laws as well as the numerical application of these laws. Students will also have several engineering opportunities to enhance their STEM experiences.

THEME SAMPLES
1. Motion
2. Force
3. Energy

COURSE OBJECTIVES AND EXPECTATIONS
1. Stability and Change
2. Systems
3. Patterns
4. Scale, Proportion, & Quantity
5. Energy & Matter
6. Cause & Effect

STUDENT OBJECTIVES
1. Students will use correct measuring techniques.
2. Students will express quantities to appropriate levels of precision.
3. Students will identify appropriate units for various measurements.
4. Students will identify all variables relevant in motion analysis.

5. Students will understand basic relationships between kinematic variables.
6. Students will differentiate uniform and accelerated motion.
7. Students will apply vector mathematics to kinematics.
8. Students will analyze the motion of an object traveling in two dimensions.
9. Students will compare Newton's Laws of motion.
10. Students will construct quality free-body diagrams.
11. Students will identify a net force and how it acts to accelerate an object.
12. Students will analyze tension, friction, gravity, and normal force.
13. Students will apply vector mathematics to free-body diagrams.
14. Students will quantify the rate change in velocity for an object moving in a circle.
15. Students will apply Newton's 2^{nd} Law to centripetal force.
16. Students will identify variables associated with the Universal Law of Gravitation.
17. Students will use Newton's 2^{nd} Law and ULG to analyze orbital motion.
18. Students will analyze Kepler's Laws of Planetary Motion.
19. Students will show an equality between Work and Energy.
20. Students will compare Kinetic and Potential Energy.
21. Students will apply Conservation Law to Work and Energy Transformations.
22. Students will demonstrate the difference between conservative and non-conservative energy.
23. Students will analyze momentum as a form of inertia.
24. Students will numerically demonstrate that impulse causes a change in momentum.
25. Students will establish impulse is a product of force and time.
26. Students will numerically compare elastic and inelastic collisions.
27. Students will demonstrate conservation of momentum and energy in a collision.
28. Students will establish a relationship between heat, temperature, and kinetic energy of molecules.
29. Students will compare different scales of temperature.
30. Students will numerically isolate absolute zero temperature.
31. Students will identify a relationship between heat and expansion of material.
32. Students will analyze the variables effecting the R-Value of a material.
33. Students will compare fluid statics and fluid dynamics.
34. Students will numerically define conservation of energy in fluids in several applications.

PACING/TIMELINE AND STANDARDS

Semester 1	
Unit 1- Scientific Numeracy	HS-PS1-7; HS-PS2-2,4; HS-PS4-1
Unit 2- 1-D Kinematics	HS-PS2-1,2,3
Unit 3- 2-D Kinematics	HS-PS2-1,2,3
Unit 4- Dynamics (Newton's Laws)	HS-PS2-1,3,4
Unit 5- Circular Motion	HS-PS2-1,4
Unit 6- Work & Energy	HS-PS3-1,2,3,4
Unit 7- Momentum & Impulse	HS-PS2-2,3
Unit 8- Thermal Energy	HS-PS2-6; HS-PS3-1,2,3,4
Unit 9- Fluids Mechanics	HS-PS3-1,3

CONTENT

1st Semester

Scientific Numeracy

1. Measurement
2. Scientific Notation
3. Significant Figures
4. Basic Trigonometry

1-D Kinematics

5. States of Motion
6. Graphical Analysis of Kinematics
7. Kinematics Formulas

2-D Kinematics

8. Graphical Vectors
9. Trigonometric Vectors
10. Horizontal Kinematics
11. Vertical Kinematics
12. Projectile Motion
13. Relative Motion

Dynamics

14. Law of Inertia
15. Newton's 2nd Law
16. Newton's 3rd Law
17. Free-Body Diagrams

Circular Motion

18. Kinematics of Uniform Circular Motion
19. Dynamics of Uniform Circular Motion
20. Universal Law of Gravitation

21. Satellite Motion
22. Kepler's Laws

Work & Energy

23. Work-Energy Principle
24. Kinetic Energy
25. Potential Energy
26. Conservation of Energy

Momentum & Impulse

27. Collisions & Impulse
28. Elastic & Inelastic Collisions
29. Conservation of Momentum & Energy
30. 1-D Collisions
31. 2-D Collisions

Thermal Energy

32. Temperature & Absolute Zero
33. Thermal Expansion
34. Heat Transfer
35. Conductivity & R-Value

Fluids

36. Pressure
37. Fluid Statics
38. Fluid Dynamics

TIMELINE

1st Semester

Scientific Numeracy	(2 Weeks)
1-D Kinematics	(3 Weeks)
2-D Kinematics	(4 weeks)
Dynamics	(4 Weeks)
Circular Motion	(3 Weeks)
Work & Energy	(4 Weeks)
Momentum & Impulse	(3 Weeks)
Thermal Energy	(3 Weeks)
Fluids	(3 Weeks)

STANDARDS

PS1: Matter and Its Interactions

- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HSPS1-3),(secondary to HS-PS2-6)

PS2: Motion and Stability: Forces and Interactions

- Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)
- Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved. (HS-PS2-2)
- If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum
- Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)

PS3: Energy

- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2 -5) Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1),(HS -PS3-2)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HSPS3-2) (HS-PS3-3)
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as either motions of particles or energy stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HSPS3-2)
- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HSPS3-4)
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)
- The availability of energy limits what can occur in any system. (HS-PS3-1)

- Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3- 4)
- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4)

RESOURCES

Next Generation Science Standards, Disciplinary Core Ideas, and Crosscutting Concepts: Science Standards

Montana Office of Public Instruction Montana Science Model Curriculum Guide: 9-12 Earth and Space Science OPI Science Model Curriculum Guide