PHYSICS, PHYSICS HONORS & PHYSICS RUNNING START

Course Abstract

Course Abstract: Physics	This is a first-year physics course which provides an extensive background in the basic concepts of physics, including motion, forces, energy, and waves. Laboratory work will be emphasized. Students will use skills from algebra II and trigonometry to analyze word problems.
Course Abstract: Physics H	This is a fast-paced, first year physics course which provides an extensive inquiry into all major physics topics including Newton's laws of motion, energy and momentum, mechanical waves and sound, electromagnetic waves and light, and electricity and magnetism. It also approaches some basic concepts of nuclear and modern physics. This is a challenging course that cultivates a deeper understanding of key foundational principles. The course is designed for students planning to major in science or engineering.
Course Abstract: Physics Early College	This is a fast-paced, first year physics course which provides an extensive inquiry into all major physics topics including Newton's laws of motion, energy and momentum, mechanical waves and sound, electromagnetic waves and light, and electricity and magnetism. It also approaches some basic concepts of nuclear and modern physics. This is a challenging course that cultivates a deeper understanding of key foundational principles. Due to the fact that this is a dual-enrollment course with the Community College System of New Hampshire, homework is a vital part of this course and will be counted toward the final grade. This course gives students the opportunity to earn college credit through Nashua Community College.

Primary Resources

Units

Units	Unit 1: Kinematics Unit 2: Dynamics Unit 3: Work and Energy Unit 4: Momentum Unit 5: Waves and Harmonic Motion Unit 6: Circular Motion (Honors and Running Start Only) Unit 7: Electricity and Magnetism (If time allows)

Unit 1: Kinematics

Unit Focus:	Introductory unit covers the basic principles of movement: position, velocity, and acceleration as well as the basics of graph analysis for accelerated motion. This unit covers only motion itself and not its causes.
Duration:	
Competencies & Standards:	**Competencies:** ● Motion & Forces A physics student who demonstrates proficiency in Motion & Forces will be able to evaluate and solve complex problems by applying models and mathematical expressions to kinematics, Newton's laws, gravitation, and uniform circular motion. **Standards:** ● HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. ● HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
Vision of a Learner	MHS 1. I am open to new possibilities and ask questions to help me understand. (Curious) MHS 2. I gather resources from diverse, relevant, and credible sources to solve problems or complete tasks. (Curious) MHS 3. I consider the impact of my actions on others. (Connected) MHS 4. I use interpersonal skills to build positive relationships and an inclusive environment. (Connected) MHS 5. I consider multiple perspectives from my school, local, national, global and digital communities and respect perspectives that differ from my own (Connected) MHS 6. I create and use a plan to guide my own academic, career, and social emotional development. (Prepared) MHS 7. I find or choose the most appropriate way to organize my thoughts and communicate my ideas based on the purpose and audience. (Prepared) MHS 8. I use my knowledge about myself to advocate for my needs and make responsible decisions. (Resilient) MHS 9. I develop and evaluate multiple ways to solve problems or complete tasks in order to persevere to meet goals and expectations. (Resilient) MHS 10. I actively invest my time and energy to benefit my communities (Dedicated)
Long-Term Transfer Goals	Students will be able to independently use their learning to… ● Use mathematics to represent physical variables and their relationships, to make quantitative predictions, and to solve problems. (T1) ● Design an investigation or model using appropriate scientific tools, resources, and methods. ● (T2) ● Develop a valid scientific conclusion, assess its validity and limitations, and determine future course of actions to inspire further questions. (T3)

Understandings & Essential Questions	Students will understand that… ● Position, velocity and acceleration of an object dictate its motion (U1) ● Graphs can be used to represent the motion of an object (U2) ● Two-dimensional motion can be broken down into one-dimensional components (U3)	Students will keep considering... ● What factors effect how an object moves? (Q1) ● How can an object's motion be represented visually? (Q2) ● How does moving in two directions vary from moving in just one? (Q3)
Acquisition of Knowledge & Skill	Students will know... ● The difference between scalar and vector quantities (K1) ● How to predict an object's position, velocity or acceleration based on it's initial conditions (K2) ● How to graphically represent the linear motion of an object (K3) ● Gravity affects all objects the same (K4)	Students will be skilled at… ● Differentiating between vectors and scalars (S1) ● Using kinematics equations to predict the motion of an object (S2) ● Creating and interpreting graphs of an object's position, velocity or acceleration vs time (S3) ● Using the principles of free fall to describe and predict the motion of a projectile (S4)
Assessment Evidence Performance Task(s)		
Learning Activities	**PT1: Kinematics Test** Performance Task 1D & 2D Motion Test. The test will focus on utilizing the kinematic equations to solve for position, velocity, time, & acceleration; motion graphs, and utilizing knowledge of 1D motion to solve 2D motion problems. **PT2: Finding the Acceleration Due to Gravity Formal Lab** Performance Task Students will utilize the kinematic equations to predict the acceleration of an object based on its initial position. **PT3: Catapult Project** Performance Task Students will utilize their knowledge and understanding of two-dimensional motion to design a catapult that will be able to hit targets at various distances with accuracy. **OE1: Kinematics Supplementary Evidence** Supplementary Evidence Practice Problems 1D Quiz 2D Quiz	

	Measurement Lab Constant Velocity Lab Constant Acceleration Lab

Unit 2: Dynamics

Unit Focus:	This unit covers motion and its causes. This includes applications of Newton's Laws of Motion, applied forces, friction, tension, gravitational, and normal forces and how they relate to an object's accelerated motion.
Duration:	
Competencies & Standards:	**Competencies:** ● Motion & Forces A physics student who demonstrates proficiency in Motion & Forces will be able to evaluate and solve complex problems by applying models and mathematical expressions to kinematics, Newton's laws, gravitation, and uniform circular motion. **Next Generation Science Standards (SE / DCI / CC): High School: 9-12:** ● HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. ● HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
Vision of a Learner	MHS 1. I am open to new possibilities and ask questions to help me understand. (Curious) MHS 2. I gather resources from diverse, relevant, and credible sources to solve problems or complete tasks. (Curious) MHS 3. I consider the impact of my actions on others. (Connected) MHS 4. I use interpersonal skills to build positive relationships and an inclusive environment. (Connected) MHS 5. I consider multiple perspectives from my school, local, national, global and digital communities and respect perspectives that differ from my own (Connected) MHS 6. I create and use a plan to guide my own academic, career, and social emotional development. (Prepared) MHS 7. I find or choose the most appropriate way to organize my thoughts and communicate my ideas based on the purpose and audience. (Prepared) MHS 8. I use my knowledge about myself to advocate for my needs and make responsible decisions. (Resilient) MHS 9. I develop and evaluate multiple ways to solve problems or complete tasks in order to persevere to meet goals and expectations. (Resilient)

	MHS 10. I actively invest my time and energy to benefit my communities (Dedicated)	
Long-Term Transfer Goals	Students will be able to independently use their learning to… ● Use mathematics to represent physical variables and their relationships, to make quantitative predictions, and to solve problems. (T1) ● Communicate scientific information clearly, thoroughly, and accurately. (T2) ● Collect, analyze, and evaluate the quality of evidence in relation to a question. (T3)	
Understandings & Essential Questions	Students will understand that… ● Interactions between objects and within systems (U1) ● Underlying forces explain a variety of interactions (U2)	Students will keep considering... ● What factors cause a change to an object's motion? (Q1) ● How do external factors effect the motion of an object in a system? (Q2)
Acquisition of Knowledge & Skill	Students will know... ● What forces are present in a given system (K1) ● How the forces in a system are related to each other (K2) ● How the forces in a system can be used to represent the motion of the objects in the system (K3)	Students will be skilled at… ● Identifying the forces present in a system (S1) ● Interpreting the relationship between the forces present in a system and the object's motion (S2) ● Using Newton's Laws of Motion to create a mathematical model of the motion of an object in a system (S3)
Assessment Evidence Performance Task(s)	**PT1: Forces Test** Performance Task The test will focus on identifying forces present in a system and predicting the motion of an object within that system. **PT2: Winter Tires Project** Performance Task Students will create an informational piece that demonstrates the importance of winter tires. Students will create and use a mathematical model to demonstrate the change in stopping distance under varying conditions. **OE1: Dynamics Supplementary Evidence** Supplementary Evidence Practice Problems Friction Lab Newton's Second Law Lab Dynamics Mini Labs Quiz	
Learning Activities		

Unit 3: Work and Energy

Unit Focus:	This unit covers types of energy, the Law of Conservation of Energy, work and power. This includes the conservation of energy in closed systems as well as work and energy in open systems, the rate at which work is done (power) and the effects of external forces on the energy present in a system.
Duration:	
Competencies & Standards:	**Competencies:** ● Energy A physics student who demonstrates proficiency in Energy will be able to evaluate and solve complex problems by applying models and mathematical expressions to various forms of energy, conservation of energy, momentum, and collisions. **Next Generation Science Standards (SE / DCI / CC): High School: 9-12:** ● HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. ● HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).
Vision of a Learner	MHS 1. I am open to new possibilities and ask questions to help me understand. (Curious) MHS 2. I gather resources from diverse, relevant, and credible sources to solve problems or complete tasks. (Curious) MHS 3. I consider the impact of my actions on others. (Connected) MHS 4. I use interpersonal skills to build positive relationships and an inclusive environment. (Connected) MHS 5. I consider multiple perspectives from my school, local, national, global and digital communities and respect perspectives that differ from my own (Connected) MHS 6. I create and use a plan to guide my own academic, career, and social emotional development. (Prepared) MHS 7. I find or choose the most appropriate way to organize my thoughts and communicate my ideas based on the purpose and audience. (Prepared) MHS 8. I use my knowledge about myself to advocate for my needs and make responsible decisions. (Resilient) MHS 9. I develop and evaluate multiple ways to solve problems or complete tasks in order to persevere to meet goals and expectations. (Resilient) MHS 10. I actively invest my time and energy to benefit my communities (Dedicated)

Long-Term Transfer Goals	Students will be able to independently use their learning to… ● Use mathematics to represent physical variables and their relationships, to make quantitative predictions, and to solve problems. (T1) ● Communicate scientific information clearly, thoroughly, and accurately. (T2) ● Design an investigation or model using appropriate scientific tools, resources, and methods. (T3) ● Develop a valid scientific conclusion, assess its validity and limitations, and determine future course of actions to inspire further questions. (T4)	
Understandings **&** **Essential Questions**	Students will understand that… ● Energy cannot be created or destroyed it can only change forms (U1) ● The conservation of energy can be used to predict the motion of objects in a closed system (U2) ● External forces can change the amount of energy in an open system (U3) ● The conservation of work and energy can be used to predict the motion of an object in an open system (U4)	Students will keep considering... ● What effects the amount of energy present in a closed system? (Q1) ● How can the energy in a system be related to the motion of the objects in the system? (Q2) ● How do external factors effect the amount of energy in an open system? (Q3) ● How can external forces be used to predict the motion of an object in an open system? (Q4)
Acquisition of Knowledge **& Skill**	Students will know... ● The relationship between position and gravitational potential energy and velocity and kinetic energy (K1) ● The transformation of energy from one form to another (K2) ● How energy is gained or lost to external forces in an open system (K3)	Students will be skilled at… ● Using a mathematical model to analyze the energy present in a closed system (S1) ● Using a transformation of energy to predict the motion of the objects in a closed system (S2) ● Creating and using a mathematical model to interpret how external forces effect the objects in an open system (S3)
Assessment Evidence **Performance Task(s)**	**PT1: Energy Test** Performance Task The test will focus on conservation of energy, using the conservation of energy to predict motion, the impact of force on energy in an open system, and the rate that work is added/removed from a system. **PT2: Conservation of Energy Formal Lab Report** Performance Task Students will utilize their understanding of the conservation of energy to create a mathematical model that demonstrates the concept. **OE1: Work & Energy Supplementary Evidence**	

	Supplementary Evidence Practice Problems Intro Conservation of Energy Lab Work & Energy Lab Quiz
Learning Activities	

Unit 4: Momentum

Unit Focus:	This unit covers momentum, the conservation of momentum and impulse. This includes analysis of collisions and which factors effect the safety of the object's in a collision.
Duration:	
Competencies & Standards:	**Competencies:** ● Energy A physics student who demonstrates proficiency in Energy will be able to evaluate and solve complex problems by applying models and mathematical expressions to various forms of energy, conservation of energy, momentum, and collisions. **Next Generation Science Standards (content standards): High School Physical Sciences: 9 - 12:** ● Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. (HS-PS2-2) ● Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. (HS-PS2-3)
Vision of a Learner	MHS 1. I am open to new possibilities and ask questions to help me understand. (Curious) MHS 2. I gather resources from diverse, relevant, and credible sources to solve problems or complete tasks. (Curious) MHS 3. I consider the impact of my actions on others. (Connected) MHS 4. I use interpersonal skills to build positive relationships and an inclusive environment. (Connected) MHS 5. I consider multiple perspectives from my school, local, national, global and digital communities and respect perspectives that differ from my own (Connected) MHS 6. I create and use a plan to guide my own academic, career, and social emotional development. (Prepared)

	MHS 7. I find or choose the most appropriate way to organize my thoughts and communicate my ideas based on the purpose and audience. (Prepared) MHS 8. I use my knowledge about myself to advocate for my needs and make responsible decisions. (Resilient) MHS 9. I develop and evaluate multiple ways to solve problems or complete tasks in order to persevere to meet goals and expectations. (Resilient) MHS 10. I actively invest my time and energy to benefit my communities (Dedicated)	
Long-Term Transfer Goals	Students will be able to independently use their learning to… ● Use mathematics to represent physical variables and their relationships, to make quantitative predictions, and to solve problems. (T1) ● Integrate knowledge from a variety of disciplines and apply it to new situations to make sense of information, formulate insightful questions, and/or solve problems. (T2)	
Understandings & Essential Questions	Students will understand that… ● Momentum is conserved in all collisions (U1) ● The relationship between impact forces and changes in momentum (U2)	Students will keep considering... ● What dictates the motion of an object after a collision? (Q1) ● How can changes in momentum be used to create safer collision? (Q2)
Acquisition of Knowledge & Skill	Students will know... ● How to differentiate between elastic and inelastic collisions (K1) ● How to relate impact forces to changes in momentum (K2)	Students will be skilled at… ● Creating and using a mathematical model to interpret elastic and inelastic collisions (S1) ● Creating and using a mathematical model to determine the impact of forces on changes in momentum (S2)
Assessment Evidence Performance Task(s)	**PT1: Momentum Test** Performance Task The test will focus on the conservation of momentum & the relationship between impact forces and changes in momentum Momentum is conserved in all collisions The relationship between impact forces and changes in momentum **PT2: Mouse Trap Car** Performance Task Students will build a mousetrap car to demonstrate their understanding of conservation of energy, momentum, and impulse. **OE1: Momentum Supplementary Evidence**	

	Supplementary Evidence Practice Problems Conservation of Momentum Lab
Learning Activities	

Unit 5: Waves and Harmonic Motion

Unit Focus:	This unit covers simple harmonic motion, oscillations and mechanical waves, sound, and the electromagnetic spectrum.
Duration:	
Competencies & Standards:	**Competencies:** ● Waves & Harmonic Motion A physics student who demonstrates proficiency in Waves & Harmonic Motion will be able to evaluate and solve complex problems by applying models and mathematical expressions to waves and the electromagnetic spectrum. **Next Generation Science Standards (content standards): High School Physical Sciences: 9 - 12:** ● Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. (HS-PS4-1) ● Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. (HS- PS4-3)
Vision of a Learner	MHS 1. I am open to new possibilities and ask questions to help me understand. (Curious) MHS 2. I gather resources from diverse, relevant, and credible sources to solve problems or complete tasks. (Curious) MHS 3. I consider the impact of my actions on others. (Connected) MHS 4. I use interpersonal skills to build positive relationships and an inclusive environment. (Connected) MHS 5. I consider multiple perspectives from my school, local, national, global and digital communities and respect perspectives that differ from my own (Connected) MHS 6. I create and use a plan to guide my own academic, career, and social emotional development. (Prepared) MHS 7. I find or choose the most appropriate way to organize my thoughts and communicate my ideas based on the purpose and audience. (Prepared) MHS 8. I use my knowledge about myself to advocate for my needs and make responsible decisions. (Resilient)

	MHS 9. I develop and evaluate multiple ways to solve problems or complete tasks in order to persevere to meet goals and expectations. (Resilient) MHS 10. I actively invest my time and energy to benefit my communities (Dedicated)	
Long-Term Transfer Goals	Students will be able to independently use their learning to… ● Use mathematics to represent physical variables and their relationships, to make quantitative predictions, and to solve problems. (T1) ● Collect, analyze, and evaluate the quality of evidence in relation to a question. (T2) ● Develop a valid scientific conclusion, assess its validity and limitations, and determine future course of actions to inspire further questions. (T3)	
Understandings & Essential Questions	Students will understand that… ● Oscillating and harmonic motion differ from constant acceleration linear motion (U1) ● Waves are the transfer of energy through the motion of a disturbance (U2) ● The properties of waves dictate how a wave will interact with matter (U3) ● Forms of electromagnetic radiation vary in wavelength and frequency (U4) ● Relative motion effects the frequency of a wave (U5)	Students will keep considering... ● How does harmonic motion differ from linear or projectile motion? (Q1) ● How does energy permeate through a vacuum? (Q2) ● How do different material properties cause the various ways that waves interact with matter? (Q3) ● Why does a variation in wavelength and frequency cause some waves to be harmful and others harmless? (Q4) ● Why does a sound you hear change if the source of the sound is moving? (Q5)
Acquisition of Knowledge & Skill	Students will know... ● The factors that effect the harmonic motion of a pendulum and an oscillating mass- spring system (K1) ● How to differentiate between longitudinal and transverse waves and pulse and standing waves (K2) ● The different forms of wave-boundary interactions (K3) ● How the speed of sound and a wave's wavelength effect the sound that they hear (K4)	Students will be skilled at… ● Using a wave function to predict the simple harmonic motion of a pendulum or an oscillating mass-spring system (S1) ● Creating a visual representation of standing wave patterns (S2) ● Identifying and predicting how waves will interact with boundaries (S3) ● Create and use a mathematical model to demonstrate the doppler effect (S4)
Assessment Evidence Performance Task(s)	**PT1: Simple Harmonic Motion Test** Performance Task The test will focus on using a mathematical model to demonstrate and predict simple harmonic motion.	

	PT2: Waves Test Performance Task The test will focus on using a mathematical model to predict how motion affects waves and understanding wave boundary interactions. **PT3: Musical Instrument Project** Performance Task Students will design and build a properly tuned musical instrument that can achieve multiple pitches. **OE1: Waves & Simple Harmonic Motion Supplementary Evidence** Supplementary Evidence Practice Problems Speed of Sound Lab Simple Harmonic Motion Lab
Learning Activities	

Unit 6: Circular Motion (Honors & Running Start Only)

Unit Focus:	This unit covers kinematics, dynamics, work and energy, and momentum for circular and rotational motion.

Duration:		
Competencies & Standards:	**Competencies:** ● Energy A physics student who demonstrates proficiency in Energy will be able to evaluate and solve complex problems by applying models and mathematical expressions to various forms of energy, conservation of energy, momentum, and collisions. **Next Generation Science Standards (content standards): High School Engineering Design: 9 - 12:** **High School Physical Sciences: 9 - 12** ● HS-PS2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. ● HS-PS2-1 Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.	
Vision of a Learner	MHS 1. I am open to new possibilities and ask questions to help me understand. (Curious) MHS 2. I gather resources from diverse, relevant, and credible sources to solve problems or complete tasks. (Curious) MHS 3. I consider the impact of my actions on others. (Connected) MHS 4. I use interpersonal skills to build positive relationships and an inclusive environment. (Connected) MHS 5. I consider multiple perspectives from my school, local, national, global and digital communities and respect perspectives that differ from my own (Connected) MHS 6. I create and use a plan to guide my own academic, career, and social emotional development. (Prepared) MHS 7. I find or choose the most appropriate way to organize my thoughts and communicate my ideas based on the purpose and audience. (Prepared) MHS 8. I use my knowledge about myself to advocate for my needs and make responsible decisions. (Resilient) MHS 9. I develop and evaluate multiple ways to solve problems or complete tasks in order to persevere to meet goals and expectations. (Resilient) MHS 10. I actively invest my time and energy to benefit my communities (Dedicated)	
Long-Term Transfer Goals	Students will be able to independently use their learning to… ● Use mathematics to represent physical variables and their relationships, to make quantitative predictions, and to solve problems. (T1) ● Integrate knowledge from a variety of disciplines and apply it to new situations to make sense of information, formulate insightful questions, and/or solve problems. (T2) ● Collect, analyze, and evaluate the quality of evidence in relation to a question. (T3)	
Understandings **&** **Essential Questions**	Students will understand that… ● Forces perpendicular to linear motion create circular motion (U1)	Students will keep considering... ● How can the direction of applied forces cause an object to turn? (Q1)

	• Objects will rotate differently depending on their distribution of mass (U2)	• How does an object's distribution of mass dictate the speed of its rotation? (Q2)
Acquisition of Knowledge & Skill	Students will know... • The effect of perpendicular applied forces on an object's velocity and turn radius (K1) • The relationship between mass and radius of curvature and its effects on an object's motion (K2)	Students will be skilled at… • Identifying forces present in a system and creating a mathematical model to represent an object's circular motion (S1) • Using an object's mass distribution to predict how it will rotate (S2)
Assessment Evidence Performance Task(s)	**PT1: Circular Motion Test** Performance Task The test will focus on forces that cause circular motion and understanding the distribution of mass on rotation. Forces perpendicular to linear motion create circular motion Objects will rotate differently depending on their distribution of mass **OE1: Circular Motion Supplementary Evidence** Supplementary Evidence Practice Problems Centripetal Acceleration Lab Torque Lab Truss Lab Conservation of Angular Momentum Activity Conservation of Rotational Energy Lab	
Learning Activities		