Board Approved October 2021

Wilson Area School District
Planned Course Guide

Title of planned course: Honors Physics

Subject Area: Science

Grade Level: 11, 12

Course Description: Physics is the study of matter and energy, which includes mechanics, energy, vibrations, light, electricity, magnetism, and atomic structure. Honors Physics is designed for the typical honors student. Problem-solving is emphasized, and students are expected to have mastered algebra, trigonometry, and geometry.

Time/Credit for this Course: One Full Academic Year / 1.0 Credit

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Board Approved October 2021

Wilson Area School District
Planned Course Materials

Course Title: Honors Physics

Textbook: Glencoe's "P*hysics: Principles and Problems*"
McGraw-Hill
2017

Teacher Resources: *Physics Principles and Problems Teacher Essentials*
Online Resources- My connectED

State Standards:

- 3.1.12.A* Apply concepts of systems, subsystems, feedback, and control to solve complex technical problems
- 3.1.12.B* Apply concepts of models as a method to predict and understand science and technology
- 3.1.12.C* Assess and apply patterns in science and technology
- 3.1.12.D* Analyze scale as a way of relating concepts and ideas to one another by some measure
- 3.1.12.E* Evaluate change in nature, physical systems, and man-made systems
- 3.2.12.A* Evaluate the nature of scientific and technical knowledge
- 3.2.12.B* Evaluate experimental information for appropriateness and adherence to relevant science processes
- 3.2.12.C* Apply the elements of scientific inquiry to solve multi-step problems
- 3.2.12.D* Analyze and use the technological design process to solve problems
- 3.4.12.C Apply the principles of motion and force
- 3.7.12.A* Apply advanced tools, materials, and techniques to answer complex questions
- 3.7.12.B* Evaluate appropriate instruments and apparatus to accurately measure materials and processes
- 3.4.10.C Distinguish among the principles of force and motion

* These standards are supported in each of the units.

Curriculum Map

August: Metrics and Measurement. Vectors and Scalars.

September: Kinematics: Position, Velocity, and Acceleration 1 dimensional, graphs.
Kinematics: Motion in 2-D: Projectile Motion, River Problems.

October: Kinematics: Motion in 2-D: Projectile Motion, River Problems.
Dynamics: Newton's Laws: Force, Mass, Acceleration interactions.

November: Dynamics: Force Diagrams, Friction, Inclined Planes, and Static Equilibrium.

December: Circular Motion. Planetary Motion, Universal Gravity.

January: Torque, Moment of Inertia, Rotational Motion,

February: Impulse-Momentum. Collisions

March: Work-Energy: Conservation of Energy, Simple Machines.

April: Thermal Energy, States of Matter, Specific Heat, Thermal Expansion.
Vibrations and Waves: Hooke's Law, Wave Optics.

May: Vibrations and Waves: Hooke's Law, Wave Optics.
Electricity and Magnetism.

June: Electricity and Magnetism.

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: Metrics and Measurement

Time frame: 2 weeks

Anchor(s) or adopted anchor: S 3.2.P.A6

Essential content/objectives: At the end of the unit, students will be able to:
- Measure and quantify the concepts of length, area, and volume using the Metric System
- Measure and quantify mass and weight using the Metric System
- Understand and calculate derived units such as density
- Evaluate answers using dimensional analysis
- Perform arithmetic operations using scientific notation
- Distinguish between accuracy and precision
- Categorize quantities as either vector or scalar quantities
- Add and subtract vectors appropriately

Core Activities: Students will complete/participate in the following:
- Activity: *Data Mining*
- Lab: *Weight of Air in Classroom*
- Lab: *Density of an Unknown Metal*

Extensions:
- Current events: https://www.sciencenews.org/
- Independent exploration: *Weight of Air in Your Kitchen*

Remediation:
- Online tutorials and resources:
  - https://www.youtube.com/watch?v=XKCZn5MLKvk
  - https://www.youtube.com/watch?v=pEDVddQvimI
  - https://www.khanacademy.org

Instructional Methods:
- Daily Warm-Up problem
- Explicit instruction
- Measurement worksheets: *Factor Labeling, Conversions, Scientific Notation*
- Measurement labs
- Demonstration: *Objects of Varying Volume and Density*

Materials & Resources:
- Textbook
- Chromebook with Vernier data acquisition probes and software
- Internet
- Lab equipment
- Worksheets

Assessments:

- Tests / quizzes
- Lab reports
- Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: Kinematics

Time frame: 6 weeks

Anchor(s) or adopted anchor: S11.A.1.1-3, S11.A.2.1-2, S11.A.3.1-3, S11.C.3.1

Essential content/objectives: At the end of the unit, students will be able to:

- Define coordinate systems for motion problems, displacement, velocity, acceleration, and acceleration due to gravity
- Develop position-time graphs for moving objects
- Use a position-time graph to interpret an object's position or displacement
- Calculate the slope of a position-time graph to determine an object's velocity
- Differentiate between speed and velocity
- Create velocity-time graphs
- Interpret position-time graphs for motion with constant acceleration
- Calculate the slope of a velocity-time graph to determine an object's acceleration
- Determine the mathematical relationships among position, velocity, acceleration, and time
- Apply graphical and mathematical relationships to solve uniform acceleration problems
- Measure and quantify (in magnitude and direction) the position, velocity, and acceleration of an object using appropriate tools and units within a reference frame
- Represent and analyze the motion of a projectile as two different motions; a vertical motion with constant acceleration and a horizontal motion with constant speed
- Relate the height, time in the air, and initial vertical velocity of a projectile using its vertical motion, and determine range using its horizontal motion
- Recognize that the vertical and horizontal motions of a projectile are independent
- Recognize vectors as quantities that: rely on both direction and magnitude; combine with other velocity and acceleration vectors according to specific mathematical rules; describe the motion of objects at every scale from the motion of subatomic particles to the motion of entire galaxies; and allow the formulation of physical laws independent of a particular coordinate system
- Classify position, velocity, and acceleration as examples of vectors

Core Activities: Students will complete/participate in the following:

- Lab: *Constant Velocity*
- Lab: *Graphing Motion*
- Activity: *Walk, Jog, Run*
- Lab: *Projectile Motion*
- Activity: *Projectile Motion - Horizontal Launched, Angle Launched, and Hit the Target* interactives
- Physics Interactives: *Match That Graph, Graph That Motion*
- Go Take a Hike- Students will take their recently learned knowledge of graphing, acceleration, velocity, and position to plan a hike on a topographical map. They will have to decide how long it will take, where the hike will lead, and estimate walking speeds based on terrain.
- Blast from the Past- Students will investigate, design, and create a medieval ranged siege weapon and test it out.

Extensions:

- Current events: https://www.sciencenews.org/
- Independent exploration: https://passionatelycurioussci.weebly.com/blog/kinematics-crime-scene

Remediation:

- Online tutorials and resources:
  - https://www.khanacademy.org,
  - https://www.physicsclassroom.com/
  - https://www.aplusphysics.com/courses/honors/honors_physics.html

Instructional Methods:

- Daily Warm-Up problem
- Explicit instruction
- Kinematics worksheets: *Constant Velocity, Accelerated Motion* series
- Kinematics labs
- Demonstration: *Ball Rolling Down Ramp*
- Physics Interactives

Materials & Resources:

- Textbook
- Chromebook with Vernier data acquisition probes and software
- Internet : *www.physicsclassroom.com*
- Lab equipment
- Worksheets

Assessments:

- Tests / quizzes
- Lab reports
- Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit Dynamics

Time frame: 6 weeks

Anchor(s) or adopted anchor: S11.C.3.1

Essential content/objectives: At the end of the unit, students will be able to:

- Define force, Newton's first law, Newton's second law, Newton's third law, and normal force
- Distinguish between contact forces (e.g., push/pull, friction) and field forces (e.g., gravitational, electrostatic, or magnetic fields)
- Use Newton's second law to solve problems numerically
- Describe how the weight and the mass of an object are related
- Apply Newton's Laws of Motion to empirically describe the motion of objects in terms of force interactions, mass, and acceleration in a non-accelerating, non-relativistic reference frame
- Use free body diagrams to represent and analyze the forces acting on an object
- Classify force as a vector and determine the single net force produced when multiple forces act upon an object
- Define the friction force
- Distinguish between static and kinetic friction
- Analyze the motion of an object on an inclined plane with and without friction

Core Activities: Students will complete/participate in the following:

- Activity: *Free Body Diagram* interactive
- Activity: *Elevator* interactive
- It's Raining… Eggs?!?!- Students will use their knowledge of Newton's Laws to create an apparatus that can protect an egg from damage when dropped from a set height. There will be no set "correct way", so they can draw upon any physics concept they have learned.

Extensions:

- Current events: https://www.sciencenews.org/
- Independent explorations: *Popsicle Stick Bridge*

Remediation:

- Online tutorials and resources:
  - https://www.khanacademy.org
  - https://www.physicsclassroom.com/
  - https://www.aplusphysics.com/courses/honors/honors_physics.html

Instructional Methods:

- Daily Warm-Up problem
- Demonstrations: *Newton's Laws*
- Explicit instruction
- Physics interactives
- Labs

Materials & Resources:

- Textbook
- Moments of Inertia reference chart
- Chromebooks
- Internet - *www.physicsclassroom.com*
- Lab equipment
- Worksheets

Assessments:

- Tests / quizzes
- Lab reports
- Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit Circular Motion

Time frame: 6 weeks

Anchor(s) or adopted anchor: S11.C.3.1

Essential content/objectives: At the end of the unit, students will be able to:

- Differentiate between actual weight and apparent weight
- Compute the force between two masses using Newton's Law of Universal Gravitation
- Explain why an object moving in a circle at a constant speed is accelerating
- Describe how centripetal acceleration depends upon the object's speed and the radius of the circle
- Identify the force that causes centripetal acceleration
- Recognize that a rotating reference frame can give the appearance of an object constrained to travel in a circular path which gives a centripetal acceleration directed from the object toward the center of the rotating reference frame
- Relate Kepler's laws to the law of universal gravitation
- Calculate orbital speeds and periods
- Relate weightlessness to objects in free fall
- Define and determine an object's moment of inertia, the rotational analogue of mass for translational motion, by its mass distribution around the axis of rotation
- Define and calculate torque, the rotational analogue of force for translational motion, as the product of an applied force and the perpendicular distance between the application and an object's axis of rotation that results in the rotation of an object
- Define center of mass
- Explain how the location of the center of mass affects the stability of an object
- Explain that an object in equilibrium has vector sums of forces and torques both equal to zero

Core Activities: Students will complete/participate in the following:

- Lab: *Centripetal Force*
- Activity: *Free Body Diagram* interactive
- Activity: *Elevator* interactive
- Activity: *Newton's Law of Gravitation* interactive
- Activity: *The Moons of Jupiter*
- Activity: *Torque* interactive
- Roller Coaster Tycoon- Students will design the perfect roller coaster. They will need to use the concepts learned about circular motion to ensure safe operating speed, proper loop design, and overall safety of their roller coaster.

Extensions:

- Current events: https://www.sciencenews.org/

Remediation:

- Online tutorials and resources:
  - https://www.khanacademy.org
  - https://www.physicsclassroom.com/
  - https://www.aplusphysics.com/courses/honors/honors_physics.html

Instructional Methods:

- Daily Warm-Up problem
- Demonstrations: *Loop-the-Loop Marble, Bucket of Water in Vertical Loop*
- Explicit instruction
- Physics interactives
- Labs

Materials & Resources:

- Textbook
- Moments of Inertia reference chart
- Chromebooks
- Internet - *www.physicsclassroom.com*
- Lab equipment
- Worksheets

Assessments:

- Tests / quizzes
- Lab reports
- Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: Momentum and Impulse (Collisions)

Time frame: 4 weeks

Anchor(s) or adopted anchor: S11.C.3.1

Essential content/objectives: At the end of the unit, students will be able to:

- Define the linear momentum and angular momentum of an object
- Determine the impulse given to an object
- Represent and quantify the position and velocity of an object or interacting objects in terms of linear momentum
- Represent and quantify rotational inertia and angular velocity of an object in terms of angular momentum
- Recognize that in a closed system, the total linear and angular momenta are conserved and use this fact when solving motion problems
- Relate Newton's third law to conservation of momentum in collisions and explosions
- Solve conservation of momentum problems in two dimensions
- Solve collision problems using both conservation of momentum and energy

Core Activities: Students will complete/participate in the following:

- Lab: *Conservation* of *Momentum I* (sphere collisions)
- Lab: *Conservation of Momentum II* (cart collisions)
- Activity: *Exploding Cart* interactive
- Activity: *Collision Cart* interactive
- Car Crash Investigation- The real world will be brought into the classroom. Students will use a mockup of a car accident and skills they have learned so far in physics to investigate the accident. Students will pretend to be insurance investigators trying to determine whether their client is at fault in this situation.

Extensions:

- Current events: https://www.sciencenews.org/
- Independent explorations: The Vicis High Tech Football Helmet (reduce concussion)

Remediation:

- Online tutorials and resources:
  - https://www.khanacademy.org
  - https://www.physicsclassroom.com/
  - https://www.aplusphysics.com/courses/honors/honors_physics.html

Instructional Methods:

- Daily Warm-Up problem
- Demonstration: *Tennis Ball/ Basketball Collision*
- Demonstrations: *Two-Body Linear Collisions*
- Demonstration: *Rotating Chair* (angular momentum)
- Explicit instruction
- Physics interactives
- Worksheets: *Momentum* series
- Labs

Materials & Resources:

- Textbook
- Chromebooks
- Internet
- Lab equipment
- Worksheets

Assessments:

- Tests / quizzes
- Lab reports
- Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: Energy and Work

Time frame: 4 weeks

Anchor(s) or adopted anchor: S11.C.2.1

Essential content/objectives: At the end of the unit, students will be able to:

- Describe the relationship between work and energy
- Calculate work, work done by a variable force and the power generated
- Calculate the total work performed by objects in a closed system by calculating the change in energy
- Represent and quantify the position and velocity of an object or interacting objects in terms of kinetic energy and potential energy
- Calculate kinetic and potential energy
- Recognize that potential energy is converted into kinetic energy, and vice versa
- Recognize that the total energy of a system remains constant while energy conversions occur
- Apply the knowledge that the total amount of energy in a closed system is conserved
- Identify elements of simple machines in compound machines
- Calculate the mechanical advantage of moving an object using a simple machine

Core Activities: Students will complete/participate in the following:

- Lab: *Simple Machines*
- Activity: *Horsepower on Stairs*
- Activity*: Sphere Rolling Down Ramp and Projecting Outward*
- Lab: *Specific Heat of an Unknown Metal*
- Lab: *Heat of Fusion of Melting Ice*
- Rube Goldberg Machine- Students will design a rube goldberg machine that uses a series of simple machines to accomplish a task like watering a plant or ringing a bell.

Extensions:

- Current events: https://www.sciencenews.org/

Remediation:

- Online tutorials and resources:
  - https://www.khanacademy.org
  - https://www.physicsclassroom.com/
  - https://www.aplusphysics.com/courses/honors/honors_physics.html

Instructional Methods:

- Daily Warm-Up problem
- Demonstration: *Thermal Expansion of Iron Wire*
- Explicit instruction
- Worksheets: *Work-Energy* series
- Labs

Materials & Resources:

- Textbook
- Chromebooks
- Internet
- Lab equipment
- Worksheets

Assessments:

- Tests / quizzes
- Lab reports
- Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: Thermodynamics

Time frame: 2 weeks

Anchor(s) or adopted anchor: S11.C.2.1

Essential content/objectives: At the end of the unit, students will be able to:
- Describe thermal energy and compare it to potential and kinetic energy
- Distinguish temperature from thermal energy
- Define specific heat, heats of fusion and vaporization
- Calculate heat transfer problems
- Distinguish between heat and work
- Calculate the expansion of solids

Core Activities: Students will complete/participate in the following:
- Activity: *Tuna Boat Float*
- What's the Fastest Way to Cool a Soda?- So you've just finished mowing the lawn on a hot summer day, and you'd like a cold, refreshing drink as a reward. You look in the fridge, and oops! it's empty. The sodas are still sitting in the cupboard, at room temperature. What's the fastest way to get that soda down to a cold, drinkable temperature with materials readily at hand?
- How Does Color Affect Heating by Absorption of Light?- Why is it more comfortable to wear light-colored clothes on a hot summer day? Why wear a dark-colored jacket for early-morning fishing on a cold lake? How much difference can it make? Here's a project where you can quantify how much difference color makes for absorbing heat.

Extensions:
- Current events: https://www.sciencenews.org/
- Activity: Build a boat out of insulation board and duct tape

Remediation:
- Online tutorials:
  - https://www.khanacademy.org
  - https://www.physicsclassroom.com/
  - https://www.aplusphysics.com/courses/honors/honors_physics.html

Instructional Methods:
- Daily Warm-Up problem
- Demonstrations: *Pressure, Pascal's Principle, and Bernoulli's Principle*
- Explicit instruction
- Worksheet: *Pressure Problems*
- Activities

Materials & Resources:

- Textbook
- Chromebooks
- Internet
- Lab equipment
- Worksheet

Assessments:

- Tests / quizzes
- Lab reports
- Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: Vibrations and Waves

Time frame: 3 weeks

Anchor(s) or adopted anchor: S11.C.2.1, S11.C.2.2

Essential content/objectives: At the end of the unit, students will be able to:

- Describe the force in an elastic spring
- Determine the energy stored in an elastic spring
- Recognize an object undergoing simple harmonic motion
- Diagram and quantify how potential energy, kinetic energy, displacement, velocity, acceleration, and the restoring force vary during simple harmonic motion
- Contrast transverse and longitudinal waves
- Measure the period, frequency, wavelength, and amplitude of a simple harmonic oscillator
- Relate wave speed, wavelength, and frequency
- Calculate the period of a pendulum
- Describe how waves transfer energy to distant objects that absorb or reflect the traveling waves
- Compare and contrast different types of waves in the electromagnetic spectrum (e.g., ultraviolet, infrared, visible light, x-rays, microwaves) as it relates to their properties, energy levels, and motion
- Describe the phenomena of wave superposition, interference, reflection, refraction, and resonance
- Relate the physical properties of sound waves to our perception of sound
- Calculate the speed of sound
- Identify some applications of the Doppler effect
- Demonstrate an understanding of resonance especially as applied to air columns and strings
- Predict the effect of mixing colors of light and pigments
- Explain the phenomena of polarization
- Locate the images formed by plane mirrors
- Explain how concave mirrors and convex mirrors form images
- Determine the locations and sizes of spherical mirror images using ray diagrams and mirror equations
- Solve problems involving refraction using Snell's Law
- Describe how real and virtual images are formed by single convex and concave lenses
- Determine the locations of images formed by lenses using ray diagrams and lense equations
- Explain nearsightedness and farsightedness and how eyeglass lenses correct these defects

Core Activities: Students will complete/participate in the following:

- Lab - *Hooke's Law*
- Lab - *Period of a Pendulum*
- Lab - *Speed of Sound*
- Activity - *Plane Mirror*
- Activity - *Refraction with Glass Square*
- Activity - *Ray Diagrams for Curved Mirrors*
- Activity - *Optics Bench* interactive
- Activity - *Ray Diagrams for Lenses*

- Lab - *Finding Images for Convex Lenses*
- Eye Spy- Students will complete a spy mission using the learned concepts of sound, mirrors, and lenses. There will be a series of scavenger hunt style challenges that focus on a different concept from this unit.

Extensions:

- Current events: https://www.sciencenews.org/
- Activity: Using the 3 meter bowling ball pendulum to measure Earth's gravity.
- Exploration: How Binoculars and Telescopes Function with Mirrors and Lenses.

Remediation:

- Online tutorials and resources:
  - https://www.khanacademy.org
  - https://www.physicsclassroom.com/
  - https://www.aplusphysics.com/courses/honors/honors_physics.html

Instructional Methods:

- Daily Warm-Up problem
- Explicit instruction
- Demonstrations: *Motion on a spring, Period of a Pendulum, Mechanical Wave, Standing Wave, Closed vs. Open Tubes, Doppler Effect, Octave, and Beats.*
- Worksheets: *Ray Diagrams*
- Lab
- Instructional Activities:
- Interactive

Materials & Resources:

- Textbook
- Chromebooks
- Internet: *www.physicsclassroom.com*
- Lab equipment
- Worksheets

Assessments:

- Tests / quizzes
- Lab reports
- Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: Electricity and Magnetism

Time frame: 3 weeks

Anchor(s) or adopted anchor: S11.C.3.1

Essential content/objectives: At the end of the unit, students will be able to:

- Demonstrate that charged objects exert forces, both attractive and repulsive
- Recognize that charging is separation, not the creation, of electric charges
- Describe the differences between conductors and insulators
- Explain how to charge objects by conduction and induction
- Compute the force between two electrically charged objects at a distance using Coulomb's Law
- Define electric field and electric potential difference
- Solve problems relating to charge, electric fields and forces
- Calculate the potential difference from the work required to move a charge
- Describe electricity and magnetism as two aspects of a single electromagnetic force and relate electricity and magnetism to the movement of charges
- Explain how Ohm's Law relates resistance, current, and electromotive forces
- Explain how a wire's composition and physical size determine its resistance
- Differentiate between power and energy in an electric circuit
- Explain how electric energy is converted into thermal energy
- Describe Series and Parallel Circuits
- Calculate currents, voltage drops, and equivalent resistances in series and parallel circuits
- Explain how fuses, circuit breakers, and ground-fault interrupters protect household wiring
- Explain how voltmeters and ammeters are used in circuits

Core Activities: Students will complete/participate in the following:

- Activity: *The Law of Electrostatic Force* interactive
- Lab: *Ohm's Law*
- Lab: *The Resistance of Nichrome Wire*
- Lab: *Series and Parallel Circuits*
- Lab: *Light Bulbs vs. LEDs*
- Architects corner- Students will design their dream house with a focus on the electrical wiring. They will need to calculate what amperage their main service will need to be and make sure that all individual circuits have the appropriate circuit breakers.

Extensions:

- Current events: https://www.sciencenews.org/
- Independent exploration: The Cost of LED Light vs. Incandescent Light
- Independent project: https://www.sciencebuddies.org/science-fair-projects/project-ideas/electricity-electronics

Remediation:

- Online tutorials and resources:
  - https://www.khanacademy.org
  - https://www.physicsclassroom.com/
  - https://www.aplusphysics.com/courses/honors/honors_physics.html

Instructional Methods:

- Daily Warm-Up Problem
- Explicit instruction
- Demonstration: *Charging by Induction and Conduction*, *Electroscope, Van de Graaff generator*
- Labs

Materials & Resources:

- Textbook
- Chromebooks
- Internet
- Lab equipment
- Worksheets

Assessments:

- Tests / quizzes
- Lab reports
- Problem sets
- In-class Q&A