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

Curriculum Writing Committee: Isaac Ruhf

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
Phet.colorado.com
TIPERs / Ranking Tasks
Physicsclassroom.com

Curriculum Map

August: Graphs, Vectors, and Scalars

September: 1-D Kinematics: Position, Velocity, and Acceleration
2-D Kinematics: Motion in 2-D: Projectile Motion, Relative Motion and Riverboat Problems.

October: 2-D Kinematics: Motion in 2-D: Projectile Motion, Relative Motion and Riverboat Problems.
Dynamics: Newton's First Law (N1L): Force Diagrams and Free-Body Diagrams, Force of Friction, Hooke's Law, Force of Gravity, Normal Force, Tension. Static and Dynamic Equilibrium

November: Dynamics - Newton's Laws: Newton's First Law (N1L): Force Diagrams and Free-Body Diagrams, Force of Friction, Hooke's Law, Force of Gravity, Normal Force, Tension. Static and Dynamic Equilibrium

December: Dynamics - Newton's Laws: Newton's Second Law (N2L): Mass, Acceleration interactions.
Dynamics - Newton's Laws: Newton's Third Law (N3L): Force Interaction Pairs

January: Dynamics - Newton's Laws: Newton's Third Law (N3L): Force Interaction Pairs
Dynamics - Additional Topics: Circular Motion and Centripetal Forces, Planetary Motion, Universal Gravitation

February: Dynamics - Additional Topics: Circular Motion and Centripetal Forces, Planetary Motion, Universal Gravitation

March: Work/Power/Energy: Work, Power, Mechanical Energy, Work - Energy Theorem
Work/Power/Energy: Conservation of Energy

April: Momentum/Impulse: Momentum, Impulse - Momentum Theorem
Momentum/Impulse: Conservation of Momentum: explosions, elastic collisions, inelastic collisions

May: Electricity: Ohm's Law
Electricity: Parallel and Series Circuits

June: Final Exam Review

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: 1-D Kinematics

Time frame: 4 weeks

State Standards: 3.2.3.A, 3.2.6-8.H, 3.2.9-12.I

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
- Graphically model the motion of an object using position v. time, velocity v. time, and acceleration v. time graphs for both constant velocity motion (CVM) cases and constant accelerated motion (CAM) cases
- 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 scalar quantities (distance, speed) and vector quantities(displacement, velocity)
- 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
- 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: *Graph the Classroom*
- Lab: *Graphing Motion*
- Activity: *Walk, Jog, Run*
- Physics Interactives: *Match That Graph, Graph That Motion*

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
- Explicit instruction
- Independent practice through problem sets
- Kinematics labs
- Physics Interactives

Materials & Resources:

- Textbook
- Chromebook with Vernier data acquisition probes and software
- Internet
- TIPERs
- physicsclassroom.com
- phet.colorado.edu
- Lab equipment
- Worksheets

Assessments:

- Constant Velocity Motion (CVM) Quiz
- Constant Accelerated Motion (CAM) Quiz
- Kinematics Unit Test
- Routine Exit Tickets
- Lab reports
- CVM Math, CAM Math, CVM graphs, and CAM graphs Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: 2-D Kinematics

Time frame: 4 weeks

State Standards: 3.2.3.A, 3.2.6-8.H, 3.2.9-12.I

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

- Continue to apply all objectives and essential content learned from the 1-D Kinematics Unit here
- Measure and quantify (in magnitude and direction) the position, velocity, and acceleration of an object using appropriate tools and units within a reference frame.
- Apply the principles of Constant Velocity Motion to an object moving with both horizontal and vertical components to its motion.
- Resolve a vector with some known magnitude and direction into its horizontal and vertical parts.
- Resolve the horizontal and vertical components into one vector to determine its resultant magnitude and direction.
- Apply the principles of 2-D motion to analyze and solve relative motion problems in two dimensions (classically called “riverboat problems”).
- Represent and analyze the motion of a projectile as two different motions: a vertical freefall motion with constant acceleration and a horizontal constant velocity motion
- 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

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

- Lab: *Relative Motion / Riverboat Problem*
- Lab: *Projectile Motion*
- Activity: *Projectile Motion - Horizontal Launched, Angle Launched, and Hit the Target* interactives
- Physics Interactives: *Projectile Motion Lab*

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
- Explicit instruction
- Independent practice through problem sets
- 2-D Kinematics labs
- Physics Interactives

Materials & Resources:

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

Assessments:

- Relative Velocity Motion Quiz
- Projectile Motion Quiz
- 2-D Kinematics Unit Test
- Routine Exit Tickets
- Lab reports
- Riverboat, Horizontal Projectile Motion, and Angled Projectile Motion Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit Dynamics - Newton's Laws

Time frame: 8 weeks

State Standards: 3.2.6-8.G, 3.2.6-8.H, 3.2.9-12.I

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

- Define what a force is
- Distinguish between contact forces (e.g., push/pull, friction) and field forces (e.g., gravitational, electrostatic, or magnetic fields)
- Model the forces applied to an object at any given instant using both Free Body Diagrams and Force Diagrams to represent and analyze the forces acting on an object
- Correctly identify the various common forces that can be found in physical scenarios
    - Force of Gravity
    - Spring Force
    - Normal Force
    - Force of Tension
    - Force of Friction (both static and kinetic)
- Mathematically relate the factors that affect the force of gravity acting on an object
- Mathematically relate the factors that affect the spring force acting on an object
- Mathematically relate the factors that affect the force of friction (both static and kinetic) acting on an object
- Define Newton's first law and apply it to model various physical scenarios
- Define Newton's second law and apply it to model various physical scenarios
- Define Newton's third law and apply it to model various physical scenarios
- Classify force as a vector and mathematically relate the individual forces acting on an object to the net force acting on that object
- Use Newton's second law to solve problems numerically
- Differentiate between the weight of an object to the mass of an object
- Define the property of inertia and describe how it applies to Newton's Laws of Motion
- 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
- Apply all of the above in a 2-D context with forces applied at angles, continuing to use all the skills and essential knowledge gained from the 2-D kinematics unit prior to this one such as resolving vectors and determining magnitude and direction of resultants, etc.
- Analyze the motion of an object on an inclined plane with and without friction

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

- Lab: *Factors that Affect Force*
- Lab: *Newton's Second Law Lab*
- Activity: Newton's Third Law Exploration
- Activity: Property of Inertia Project
- Lab: *Forces on an Incline*

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
- Explicit instruction
- Independent Practice through problem sets
- Physics interactives
- Forces and Newton's Laws Labs

Materials & Resources:

- Textbook
- Chromebooks
- Internet
- www.physicsclassroom.com
- phet.colorado.edu
- TIPERs
- Lab equipment
- Worksheets

Assessments:

- Newton's First Law Quiz
- Newton's Second Law Quiz
- Newton's Laws Unit Test
- Routine Exit Tickets
- Lab reports
- Free Body Diagram, Net Force, Balanced Forces, Force of Gravity, Spring Force, Force of Friction, 2-D forces, and Forces on Inclines Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit Dynamics - Additional Topics (Circular Motion, Planetary Motion, Universal Gravitation)

Time frame: 6 weeks

State Standards: 3.2.3.A, 3.2.6-8.G, 3.2.6-8.H, 3.2.9-12.I, 3.2.9-12.L

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 in any given physical scenario
- 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
- Differentiate between centripetal and centrifugal forces
- Fully model and analyze an object experiencing uniform circular motion with forces applied at angles (ex. a car going around a banked turn, a conical pendulum, etc.)

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

- In depth investigation: *The perfect Racetrack*

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
- Demonstrations
- Explicit instruction
- Independent practice through problem sets
- Physics interactives
- Forces / Circular Motion Labs

Materials & Resources:

- Textbook
- Chromebooks
- Internet
- www.physicsclassroom.com
- phet.colorado.edu
- TIPERs
- Lab equipment
- Worksheets

Assessments:

- Unit Test
- Routine Exit Tickets
- Uniform Circular Motion, Newton's Law of Universal Gravitation, Kepler's Law and Orbital Periods, and Apparent Weight Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: Work/Power/Energy

Time frame: 3 weeks

State Standards: 3.2.9-12.O, 3.2.9-12.P, 3.2.9-12.Q, 3.2.9-12.R, 3.2.9-12.S

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
- Analyze the work done, or energy transferred, graphically by using an f-x graph
- Represent and quantify the position and velocity of an object or interacting objects in terms of kinetic energy and potential energy
- Relate the net work done to or by an object to the change in that object's kinetic energy
- Calculate kinetic, gravitational potential energy, and spring potential energy
- Analyze the transformation of energies within a system as well as the transfer of energy to or from that system conceptually using energy bar charts
- 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

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

- Lab: *Calculate your power on stairs*
- Activity*: The Ramp PhET*

Extensions:

- Current events: https://www.sciencenews.org/
- Independent explorations: Rube Goldberg device

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
- Demonstration: *What is work?*
- Explicit instruction
- Independent practice through problem sets
- Work / Power / Energy Lab/Activity

Materials & Resources:

- Textbook
- Chromebooks
- Internet
- www.physicsclassroom.com
- phet.colorado.edu
- TIPERs
- Lab equipment
- Worksheets

Assessments:

- Work / Power Quiz
- Energy Quiz
- Work / Power / Energy Unit Test
- Lab reports
- Work, Power, Individual Energies, Work - Energy Theorem, and Conservation of Energy Problem Sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: Momentum and Impulse

Time frame: 5 weeks

State Standards: 3.2.9-12.J, 3.2.9-12.K

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

- Define the linear momentum of an object
- Calculate the momentum of an object
- Determine the impulse given to an object
- Relate the impulse applied to an object to the change in that object's momentum
- Graphically analyze the impulse applied to an object through a force-time graph
- Represent and quantify the position and velocity of an object or interacting objects in terms of linear momentum
- Recognize that in a closed system, the total linear momentum is 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
- Define a perfectly elastic collision vs. a perfectly inelastic collision and use conservation of kinetic energy to determine how elastic a collision is
- Solve both elastic and inelastic collision problems using both conservation of momentum and kinetic energy
- Conceptually analyze the momentum transfers into, out of, and within a system using momentum bar charts

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

- Lab: *Impulse - Momentum theorem*
- Lab: *Collisions*
- Activity: *Exploding Cart* interactive
- Activity: *Collision Cart* interactive

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
- Demonstration: *Tennis Ball/ Basketball Collision*
- Demonstrations: *Two-Body Linear Collisions*
- Explicit instruction
- Physics interactives
- Independent practice through problem sets
- Impulse / Momentum Labs

Materials & Resources:

- Textbook
- Chromebooks
- Internet
- www.physicsclassroom.com
- phet.colorado.edu
- TIPERs
- Lab equipment
- Worksheets

Assessments:

- Momentum / Impulse-Momentum Theorem Quiz
- Conservation of Momentum Quiz
- Momentum Unit Test
- Routine Exit Tickets
- Lab reports
- Individual Momentum, Impulse - Momentum Theorem, Explosion, Inelastic Collision, and Elastic Collision Problem sets
- In-class Q&A

Curriculum Scope & Sequence

Planned Course: Honors Physics

Unit: Electricity

Time frame: 3 weeks

State Standards: 3.2.9-12.L, 3.2.9-12.M

Essential content/objectives: At the end of the unit, students will be able to:
- Explain the basics of electrical generation.
- Explain how Ohm's Law relates resistance, current, and electromotive forces.
- Explain how a wire's composition and physical size determine its resistance
- 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:
- Lab: *Series and Parallel Circuits*
- Lab: *Light Bulbs vs. LEDs*
- Architects' Corner - Students will design their dream house, focusing on electrical wiring.

Extensions:
- Current events: https://www.sciencenews.org/
- Independent exploration: The Cost of LED Light vs. Incandescent Light

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

Instructional Methods:
- Daily Warm-Up
- Explicit instruction
- Demonstration: *Circuits*
- Labs
- Independent practice through problem sets

Materials & Resources:
- Textbook
- Chromebooks
- Internet
- Lab equipment
- Worksheets

Assessments:
- Circuits Quiz
- Routine Exit Tickets
- Lab reports
- Problem sets
- In-class Q&A