Pequea Valley School District
Science

Unit 1: Introduction to Physics **Course: Physics I** **Grade: 9-12**

Planning the Focus Based on the Desired Result
What do you want all students to know, understand and do by the end of the unit?

Unit Essential Question(s):
How can I use measurement units and graphing techniques to design and perform a laboratory experiment?

Keystone Eligible Content/PA Core Standard
3.1.12.B - Apply concepts of models as a method to predict and understand 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.A - 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.

Pacing: Approximate number of class sessions per unit
- 10 days

Tier 3 Vocabulary (Content specific vocabulary)
- Physics
- Science
- Dependent variable
- Independent variable
- Hypothesis
- Data
- Experimental design
- Line of best fit
- Parabola
- Hyperbola
- Linear relationship
- Inverse relationship
- Qualitative
- Quantitative
- Fundamental unit
- Derived unit

- Measurement system
- Prefix
- Factor-label method

Know - What do learners need to **know** in order to be able to do and understand? ***List concepts, such as facts, formulas, key vocabulary and knowledge "nuggets".***

- Base units of measurement
- Metric prefixes
- Elements of experimental design
- Scientific notation
- Pythagorean theorem
- Science is based on facts, data, and evidence
- Scientists use tools such as graphs and tables to explain their findings.

Understand - What do learners need to **understand**? What is the **big idea**? ***List broad concepts or "big ideas" in a statement of enduring understanding.***

- The difference between fundamental and derived units
- How to use the factor-label method to convert units
- Why numbers are written in scientific notation
- How and why graphs are used to represent data.

Learning Outcome - What do learners need to be able to **accomplish** by the unit's end? ***List skills and competencies.***

- The student will demonstrate the ability to carry out effective scientific investigations, analyze data, communicate results, and apply results to explain phenomena occurring outside the laboratory.

Literature:

Software/Resources:

Schoology

Pequea Valley School District
Department

Unit 2: Linear Motion **Course: Physics I** **Grade: 9-12**

Planning the Focus Based on the Desired Result
What do you want all students to know, understand and do by the end of the unit?

Unit Essential Question(s):
How can verbal, graphical and mathematical descriptions of motion be used to evaluate reaction time and stopping distance of a vehicle?

Keystone Eligible Content/PA Core Standard
3.1.10.D - Apply scale as a way of relating concepts and ideas to one another by some measure.
3.4.10.C - Distinguish among the principles of force and motion.
Describe and measure the motion of sound, light, and other objects.
3.4.12.C - Apply the principles of force and motion.
Analyze the principles of translational motion, velocity, and acceleration as they relate to free-fall and projectile motion.

Pacing: Approximate number of class sessions per unit
- 27 days

Tier 3 Vocabulary (Content specific vocabulary)
- Position
- Distance
- Displacement
- Speed
- Velocity
- Average velocity
- Instantaneous speed
- Acceleration
- Parabola
- Slope
- Area under a curve
- Scalar
- Vector
- Magnitude
- Free-fall

- Gravity
- Projectile
- Constant acceleration

Know - What do learners need to **know** in order to be able to do and understand? ***List concepts, such as facts, formulas, key vocabulary and knowledge "nuggets".***

- Difference between speed, velocity, and acceleration.
- Equations for linear motion
- Units for each motion parameter
- The meaning of positive and negative velocities and accelerations
- The meaning of slope and y-intercept on position, velocity, and acceleration graphs
- The meaning of area under the curve for velocity and acceleration graphs
- The difference between vectors and scalars
- The difference between average and instantaneous speed.
- Free-fall

Understand - What do learners need to **understand**? What is the **big idea**? ***List broad concepts or "big ideas" in a statement of enduring understanding.***

- How to use graphs to analyze the motion of an object.
- Motion can be described using words, graphs, and equations.
- Which characteristics of an object's motion can be described as either vector or scalar quantities.
- How to add and subtract vector quantities.

Learning Outcome - What do learners need to be able to **accomplish** by the unit's end? ***List skills and competencies.***

- The learner will demonstrate the ability to apply appropriate mathematical processes to solving problems.
- The learner will demonstrate the ability to define, describe, calculate, and differentiate among position, displacement, speed, velocity, and acceleration.

Literature:

Software/Resources:

Explore Learning, Schoology, Physics Classroom Tutorial (online)

Pequea Valley School District
Science

Unit 3: Projectile Motion **Course: Physics I** **Grade: 9-12**

Planning the Focus Based on the Desired Result
What do you want all students to know, understand and do by the end of the unit?

Unit Essential Question(s):
How can kinematic equations and trigonometric functions be used to describe and predict the motion of a projectile?

Keystone Eligible Content/PA Core Standard
3.2.10.C - Apply the elements of scientific inquiry to solve problems.
3.4.10.C - Distinguish among the principles of force and motion.
3.4.12.C - Apply the principles of motion and force.
Analyze the principles of translational motion, velocity, and acceleration as they relate to free-fall and projectile motion.

Pacing: Approximate number of class sessions per unit
- 13 days

Tier 3 Vocabulary (Content specific vocabulary)
- Projectile
- Trajectory
- Horizontal component
- Vertical component
- Sine
- Cosine
- Tangent
- Hypotenuse
- Adjacent
- Range
- altitude

Know - What do learners need to **know** in order to be able to do and understand? ***List concepts, such as facts, formulas, key vocabulary and knowledge "nuggets".***
- Trigonometric functions

- Kinematics equations
- Examples of projectile motion

Understand - What do learners need to **understand**? What is the **big idea**? ***List broad concepts or "big ideas" in a statement of enduring understanding.***

- How vectors can be added graphically and analytically.
- Factors that affect projectile motion
- Motion of a projectile is symmetric.

Learning Outcome - What do learners need to be able to **accomplish** by the unit's end? ***List skills and competencies.***

- Use kinematic equations and trigonometric functions to describe and predict the motion of a projectile.

Literature:

Software/Resources:

Physics classroom Tutorial (online), Angry Birds Video clip, Straw-Rocket launcher, Explore Learning Gizmos

Pequea Valley School District
Science

Unit 4: Newton's Laws **Course: Physics I** **Grade: 9-12**

Planning the Focus Based on the Desired Result
What do you want all students to know, understand and do by the end of the unit?

Unit Essential Question(s):
How do the forces on an object affect its motion?

Keystone Eligible Content/PA Core Standard
3.4.10.C Distinguish among the principles of force and motion.
Know Newton's Laws of motion (including inertia, action and reaction) and gravity and apply them to solve problems related to forces and mass.

3.4.12.C Apply the principles of motion and force.
Describe inertia, motion, equilibrium and action/reaction concepts through words, models, and mathematical symbols.

Pacing: Approximate number of class sessions per unit
- 25

Tier 3 Vocabulary (Content specific vocabulary)
- Mass
- Inertia
- Net force
- Action
- Reaction
- Free-body diagram (FBD)
- Tension
- Equilibrium
- Air resistance
- Gravity
- Friction
- Coefficient of friction
- System
- Apparent weight

- Force
- Newton
- Kilogram

Know - What do learners need to **know** in order to be able to do and understand? ***List concepts, such as facts, formulas, key vocabulary and knowledge "nuggets".***

- Mass does not change due to location
- Weight depends on both mass and location of an object
- Inertia is related to mass
- Mass is measured in kilograms
- There are two forms of friction (static and kinetic)
- Force is a vector quantity
- Force is measured in Newtons

Understand - What do learners need to **understand**? What is the **big idea**? ***List broad concepts or "big ideas" in a statement of enduring understanding.***

- Acceleration of an object depends on its mass and the net force acting on it.
- Every action force has an equal and opposite reaction force
- How to identify the forces acting on an object.
- How to solve problems relating acceleration, mass and net force.
- How to draw a free-body-diagram to solve net force problems.
- How static and kinetic friction impact the motion of an object.

Learning Outcome - What do learners need to be able to **accomplish** by the unit's end? ***List skills and competencies.***

- The learner will demonstrate the ability to state and apply Newton's three laws of motion to everyday life.

Literature:

Software/Resources:

Vernier probes and software, Physics Classroom Tutorial (online), Materials for inertia demonstrations

Pequea Valley School District
Science

Unit 5: Impulse and Momentum **Course: Physics** **Grade: 9-12**

Planning the Focus Based on the Desired Result
What do you want all students to know, understand and do by the end of the unit?

Unit Essential Question(s):
How can momentum and impulse be used to determine the cause of an accident?

Keystone Eligible Content/PA Core Standard
3.1.12.B - Apply concepts of models as a method to predict and understand science and technology.
3.4.10.B - Analyze energy sources and transfers of heat.
Use knowledge of conservation of energy and momentum to explain common phenomena.

Pacing: Approximate number of class sessions per unit
- 20 days

Tier 3 Vocabulary (Content specific vocabulary)
- Impulse
- Momentum
- Collision
- Elastic collision
- Inelastic collision
- Explosion
- Conservation of momentum

Know - What do learners need to **know** in order to be able to do and understand? ***List concepts, such as facts, formulas, key vocabulary and knowledge "nuggets".***
- The momentum of an object is directly proportional to its mass and velocity.
- Momentum equals mass times velocity
- Momentum is a vector quantity
- That momentum is conserved in collisions
- There are two types of collisions: elastic and inelastic
- The forces acting on objects involved in a collision follow Newton's third day of motion. They are action/reaction pairs.
- The unit for momentum is kg*m/s

- Impulse equals force times time
- Changes in momentum are due to impulses
- The unit for impulse is kg*m/s

Understand - What do learners need to **understand**? What is the **big idea**? ***List broad concepts or "big ideas" in a statement of enduring understanding.***

- How to calculate an object's momentum
- How to predict the velocity of an object after it experiences a collision
- How to calculate the impulse of an object.
- The safety measures that exist in vehicles that utilize concepts of momentum and impulse to protect occupants.
- The effect that increasing time has on the change in momentum of an object.

Learning Outcome - What do learners need to be able to **accomplish** by the unit's end? ***List skills and competencies.***

- The learner will determine who caused a car accident using concepts of momentum, impulse, and conservation of momentum.

Literature:

Software/Resources:

Physics Classroom Tutorial (online), Explore Learning Gizmos

Pequea Valley School District
Science

Unit 6: Work, Power, and Energy **Course: Physics I** **Grade: 9-12**

Planning the Focus Based on the Desired Result
What do you want all students to know, understand and do by the end of the unit?

Unit Essential Question(s):
How does the law of conservation of energy apply to the understanding of energy transfer in our daily lives?

Keystone Eligible Content/PA Core Standard
3.1.12.E - Evaluate change in nature, physical systems, and man made systems
Explain how correlation of variables does not necessarily imply causation.
3.4.10.B - Analyze energy sources and transfers of heat.
Use knowledge of conservation of energy and momentum to explain common phenomena.
3.4.10.C - Distinguish among the principles of force and motion.
Identify elements of simple machines in compound machines.
Determine the efficiency of mechanical systems by applying mathematical formulas.
3.4.12.A - Apply concepts about the structure and properties of matter.
Apply conservation of energy concept to fields as diverse as mechanics, nuclear particles and studies of the origin of the universe.

Pacing: Approximate number of class sessions per unit
- 22 days

Tier 3 Vocabulary (Content specific vocabulary)
- Work
- Power
- Joule
- Conservation of energy
- Potential energy
- Kinetic energy
- Elastic potential energy
- Hooke's Law
- Mechanical advantage
- Efficiency
- Compound machine

Know - What do learners need to **know** in order to be able to do and understand? ***List concepts, such as facts, formulas, key vocabulary and knowledge "nuggets".***

- Energy exists in many forms
- Energy is measured in joules
- Energy is often lost to heat
- The equation for work
- The equation for power
- The equation for kinetic, potential, total mechanical energy.
- The equation for work and power
- Power is measured in watts

Understand - What do learners need to **understand**? What is the **big idea**? ***List broad concepts or "big ideas" in a statement of enduring understanding.***

- Energy cannot be created or destroyed but it can change forms.
- Energy is a scalar quantity
- The difference between kinetic and potential energy
- The difference between gravitational potential energy and elastic potential energy
- The difference between work in everyday life and work in science.
- The criteria need for work to be done
- How to calculate kinetic, potential, and mechanical energy.
- How to use the law of energy conservation to determine the kinetic, potential, and total mechanical energy of an object.
- How to identify the types of energy present in a system.

Learning Outcome - What do learners need to be able to **accomplish** by the unit's end? ***List skills and competencies.***

- The learner will demonstrate the ability to explain the relationships between work and energy.
- The learner will demonstrate the ability to discuss how energy in a system is transferred from one form to another or from one object to another, and use the conservation of energy to solve simple problems.

Literature:

Software/Resources:

Pequea Valley School District
Science

Unit 7: Circular Motion **Course: Physics I** **Grade: 9-12**

Planning the Focus Based on the Desired Result
What do you want all students to know, understand and do by the end of the unit?

Unit Essential Question(s):
How can Newton's Laws be used to explain and predict the motion of an object moving in a circle?

Keystone Eligible Content/PA Core Standard
3.4.10.D - Explain essential ideas about the composition and structure of the universe.
3.4.12.C - Apply the principles of motion and force.

Pacing: Approximate number of class sessions per unit
- 20 days

Tier 3 Vocabulary (Content specific vocabulary)
- Rotation
- Revolution
- Centripetal acceleration
- Centripetal force
- Tangential velocity
- Universal gravitation
- Inverse square law
- Period
- Frequency
- Ellipse
- Free-body diagram
- Net force
- Heliocentric
- Geocentric
- Focal point

Know - What do learners need to **know** in order to be able to do and understand? ***List concepts, such as facts, formulas, key vocabulary and knowledge "nuggets".***

- Why an object moving in a circle is accelerating.
- Forces that cause circular motion.
- Equation for the speed of an object moving in a circle.
- The relationship between frequency and period.
- Equation for Newton's Law of Universal Gravitation.
- Objects moving in a circle are accelerating because their direction is constantly changing.

Understand - What do learners need to **understand**? What is the **big idea**? ***List broad concepts or "big ideas" in a statement of enduring understanding.***

- Newton's three laws of motion.
- The importance of Cavendish's experiment.
- How mass and distance affect the force on an object moving in circular motion.
- How centripetal acceleration depends upon the speed and the radius of the circle.
- Similarities and differences between linear and circular motion.
- Kepler's Laws of planetary motion and how they explain the motion of astronomical bodies.
- How to calculate the speed, velocity, and acceleration of an object moving in a circle.
- How to find the apparent weight of an object moving in a circle.

Learning Outcome - What do learners need to be able to **accomplish** by the unit's end? ***List skills and competencies.***

- The learner will demonstrate the ability to analyze and explain uniform circular motion.
- The learner will demonstrate the ability to describe the law of universal

Literature:

Software/Resources:

Pequea Valley School District
Science

Unit 8: Waves **Course: Physics I** **Grade: 9-12**

Planning the Focus Based on the Desired Result
What do you want all students to know, understand and do by the end of the unit?

Unit Essential Question(s):
How can the properties of waves be used to describe natural phenomena and technological applications?

Keystone Eligible Content/PA Core Standard
3.4.10.C - Distinguish among the principles of force and motion.
3.4.12.D - Apply the principles of motion and force.

Pacing: Approximate number of class sessions per unit
- 18 days

Tier 3 Vocabulary (Content specific vocabulary)
- Mechanical waves
- Amplitude
- Frequency
- Period
- Wavelength
- Hertz
- Transverse
- Longitudinal
- Interference
- Constructive interference
- Destructive interference
- Reflection
- Refraction
- Diffraction
- Medium

Know - What do learners need to **know** in order to be able to do and understand? ***List concepts, such as facts, formulas, key vocabulary and knowledge "nuggets".***

- Waves are caused by a disturbance
- Waves transfer energy
- Motion that has a repetitive characteristic is called simple harmonic motion.
- All waves have measurable properties
- A wave crest is the highest point on a wave
- A wave trough is the lowest point on a wave.
- The amplitude of a wave is one-half the distance from a crest to a trough
- The wavelength of a wave is the distance from one place on a wave to the same place on another wave.
- The period of a wave is the amount of time for one wave to occur and is measure in seconds.
- The frequency is defined as the number of waves that occur in one second and measured in hertz.
- Wave speed equals wavelength times frequency
- Period equals 1/frequency
- Frequency equals 1/period

Understand - What do learners need to **understand**? What is the **big idea**? ***List broad concepts or "big ideas" in a statement of enduring understanding.***

- Identify and provide examples of simple harmonic motion
- How to measure the properties of a wave.
- How to use the wave speed formula to calculate wave speed, wavelength, and frequency.
- How to find the period and frequency of a wave.

Learning Outcome - What do learners need to be able to **accomplish** by the unit's end? ***List skills and competencies.***

- The student will demonstrate the ability to describe common forms of waves in terms of basic wave characteristics and discuss the transportation and transformation of wave energy.

Literature:

Software/Resources: