

<p><u>Grade, Subject:</u> 10,11,12 physics</p>	
<p><u>Strand (Unit):</u> mechanics</p>	
<p><u>Big Idea:</u> vectors</p>	
<p><u>PA Content Standards:</u></p>	<p><u>PA Core Standards:</u></p>
<p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> 1. What are the differences between vector and scalar quantities? 2. How do we resolve displacement, velocity, acceleration, force, and linear momentum vectors into their vector components and express them in unit vector notation in an orthogonal coordinate system? 3. How do we perform mathematical operations with vectors (graphically and mathematically) such as vector addition. 	<p><u>Understandings (Cross Cutting Concepts):</u></p>
<p><u>Vocabulary:</u> vector, scalar, resultant vector, vector component, orthogonal coordinate system, unit vector</p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● perform two and three vector addition on paper and in the laboratory ● resolve vectors properly into their components in the X and Y directions

<p><u>Knowledge:</u></p> <ul style="list-style-type: none"> • vectors require magnitude and direction for a complete description • categorization of quantities as vectors or scalars is important throughout a physics course because mathematically they are treated differently 	<p><u>Resources:</u> class notes in schoology, navigational compass for lab, drawing tools, teacher constructed lab materials</p>
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Elizabethtown Area School District Curriculum

Date Adopted:2024

<p><u>Grade, Subject:</u> 10,11,12 physics</p>	
<p><u>Strand (Unit):</u> mechanics</p>	
<p><u>Big Idea:</u> motion in one dimension X-direction</p>	
<p><u>PA Content Standards:</u></p>	<p><u>PA Core Standards:</u></p>
<p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> 1. What are the mathematical relationships among position, velocity, and acceleration for an object (treated as a point particle) moving in the X-direction? 2. What are the graphical interrelationships between a position vs. time graph, a velocity vs. time graph, and an acceleration vs. time graph for constant acceleration? 3. How do we utilize the five equations for constant acceleration to solve free response problems? 	<p><u>Understandings (Cross Cutting Concepts):</u></p>

<p><u>Vocabulary:</u> displacement, distance, average velocity, average speed, instantaneous velocity, average acceleration, instantaneous acceleration, slope, tangent line, derivative, area</p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● utilize equations for constant acceleration to solve free response problems ● draw and interpret graphs of position vs. time, velocity vs. time, and acceleration vs. time for constant acceleration ● perform experimental investigations related to this unit
<p><u>Knowledge:</u></p> <ul style="list-style-type: none"> ● the slope of a line connecting two points on a graph of position vs. time represents average velocity ● the slope of a tangent line on a graph of position vs. time represents instantaneous velocity ● the slope of a line connecting two points on a graph of velocity vs. time represents average acceleration ● the slope of a tangent line on a graph of position vs. time represents instantaneous acceleration ● the area under a graph of acceleration vs. time represents change in velocity ● the area under a graph of velocity vs. time represents change in position ● any change in velocity will result in acceleration ● the direction of motion does not always indicate the direction of acceleration 	<p><u>Resources:</u> class notes in schoology, air tracks, photogates, computer, PASCO computer interface, stop watches, metersticks, motion sensor, teacher constructed lab materials</p>

<p><u>Grade, Subject:</u> 10,11,12 physics</p>	
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<p><u>Strand (Unit):</u> mechanics</p>	
<p><u>Big Idea:</u> motion in one dimension Y-direction</p>	
<p><u>PA Content Standards:</u></p>	<p><u>PA Core Standards:</u></p>
<p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> 1. What is the magnitude and direction of the acceleration of gravity? 2. What are the graphical interrelationships between a position vs. time graph, a velocity vs. time graph, and an acceleration vs. time graph for an object dropped from rest or an object thrown straight upward? 3. How do we derive constant acceleration equations for motion in one dimension in the Y-direction from our constant acceleration equations for motion in one dimension in the X-direction? 	<p><u>Understandings (Cross Cutting Concepts):</u></p>
<p><u>Vocabulary:</u> displacement, distance, average velocity, average speed, instantaneous velocity, average acceleration, instantaneous acceleration, slope, tangent line, acceleration of gravity</p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● draw and interpret graphs of position vs. time, velocity vs. time, and acceleration vs. time for an object dropped from rest or an object thrown straight upward ● utilize equations for constant acceleration to solve free response problems ● perform experimental investigations related to this unit
<p><u>Knowledge:</u></p> <ul style="list-style-type: none"> ● the magnitude and direction of the acceleration of gravity is 9.8 m/s^2 downward ● many different factors need to be considered when solving free response problems in this unit such as direction of initial velocity, and placement of origin, signs for quantities ● X-direction motion and Y-direction motion share a similar set of equations 	<p><u>Resources:</u> class notes in schoology, photogates, computer, PASCO computer interface, stop watches, metersticks, motion sensor, time of flight accessory, teacher constructed lab materials</p>

<p><u>Grade, Subject:</u> 10,11,12 physics</p>	
<p><u>Strand (Unit):</u> mechanics</p>	
<p><u>Big Idea:</u> projectile motion</p>	
<p><u>PA Content Standards:</u></p>	<p><u>PA Core Standards:</u></p>
<p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> 1. How is motion in the X-direction independent from motion in the Y-direction? 2. What are the horizontal and vertical acceleration values of an object in projectile motion? 3. How do we, and why can we utilize equations from motion in one dimension to solve problems in projectile motion? 4. How do we combine equations from motion in one dimension to obtain expressions for range, total time in the air, and maximum height of a projectile (horizontal and angled projection)? 5. How do we construct graphs of position vs. time, velocity vs. time, and acceleration vs. time for projectile motion (both X and Y directions)? 	<p><u>Understandings (Cross Cutting Concepts):</u></p>

<p><u>Vocabulary:</u> displacement, distance, average velocity, average speed, instantaneous velocity, average acceleration, instantaneous acceleration, slope, tangent line, acceleration of gravity, range</p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● combine equations from motion in one dimension to obtain expressions for range, total time in the air, and maximum height of a projectile (horizontal and angled projection) ● construct graphs of position vs. time, velocity vs. time, and acceleration vs. time for projectile motion (both X and Y directions)? ● solve free response problems for projectile motion ● perform experimental investigations related to this unit
<p><u>Knowledge:</u></p> <ul style="list-style-type: none"> ● in projectile motion each motion is independent of the other ● there is no horizontal acceleration in projectile motion, and vertical acceleration is 9.8 m/s^2 downward at all times ● all previous equations from X-direction and Y-direction will still be used in this unit <p>because X-direction motion and Y-direction motion are independent of one another</p>	<p><u>Resources:</u> class notes in schoology, photogates, computer, PASCO computer interface, stop watches, metersticks, teacher constructed lab materials</p>

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<p><u>Grade, Subject:</u> 10,11,12 physics</p>	
<p><u>Strand (Unit):</u> mechanics</p>	
<p><u>Big Idea:</u> uniform circular motion</p>	
<p><u>PA Content Standards:</u></p>	<p><u>PA Core Standards:</u></p>

<p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> 1. Why is their acceleration associated with uniform circular motion, and how is it directed? 2. What are the factors that determine an objects centripetal acceleration? 	<p><u>Understandings (Cross Cutting Concepts):</u></p>
<p><u>Vocabulary:</u> centripetal acceleration, tangential velocity, tangential acceleration, radial acceleration</p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● explain why there is acceleration associated with uniform circular motion, and calculate its value ● perform experimental investigations related to this unit
<p><u>Knowledge:</u></p> <ul style="list-style-type: none"> ● acceleration in uniform circular motion (circular motion at a constant speed) is directed inward ● changing the value of tangential velocity, and the radius of the circular path will change an objects centripetal acceleration 	<p><u>Resources:</u> class notes in schoology, photogates, computer, PASCO computer interface, stop watches, metersticks, balance, teacher constructed lab materials</p>

<u>Grade, Subject:</u> 10,11,12 physics	
<u>Strand (Unit):</u> mechanics	
<u>Big Idea:</u> force and Newton's laws	
<u>PA Content Standards:</u>	<u>PA Core Standards:</u>
<u>Essential Questions:</u> <ol style="list-style-type: none"> 1. How do we analyze, through use of a free-body diagram, situations in which an object remains at rest (static equilibrium), or moves with a constant velocity in a straight line under the influence of several forces? 2. How do we relate impulse to the change in linear momentum of an object? 3. How do we draw and accurately label a free body diagram showing all external forces that act on an object? 4. From an accurately labeled free body diagram how do we correctly summate forces in the X-direction, Y-direction, and radial direction? 5. How do we apply Newton's second law to objects that are undergoing terminal velocity? 6. How do we introduce frictional considerations into our problem solving? 7. How do we identify action/reaction pairs, determine the direction each force acts, and upon which object the force acts? 8. How do we understand the relationships between large-scale systems such as planetary bodies coupled by gravitational forces? 9. How do we identify forces as constant or variable, conservative or non-conservative? 	<u>Understandings (Cross Cutting Concepts):</u>

Vocabulary:

constant force, variable force, static frictional force, kinetic frictional force, static equilibrium, statics, dynamics, net force, normal force, free body diagram, impulse, linear momentum, coefficient of static friction, coefficient of kinetic friction, inertial frame of reference, non-inertial frame of reference

Skills (Science and Engineering Practices):

- draw and properly label complete free body diagrams
- draw and label a proper free body diagram, including all components, for an object at rest on an inclined surface
- properly summate forces in the X-direction, Y-direction, and radial directions
- solve statics free response problems with multiple coupled objects
- solve dynamics free response problems with multiple coupled objects
- apply Newton's laws to solve free response problems
- solve free response problems with frictional considerations
- understand the conditions under which an object reaches terminal velocity, and use the mathematical relationship for terminal velocity to calculate the drag coefficient
- understand the forces involved in a large-scale systems such as planetary bodies
- perform experimental investigations related to this unit

Knowledge:

- Newton's first law is only valid in an inertial frame of reference
- force is directly proportional to an object's mass and acceleration
- drawing and properly labeling a free body diagram is the first step in solving complex problems in this unit
- summing forces, from a properly labeled free body diagram, is a vector summation
- each force produces an equal and opposite reaction force, but those forces do not produce identical accelerations unless the masses are equal
- an impulsive force is a large force exerted for a short time duration
- the law of universal gravitation is an inverse square relationship
- when an object reaches terminal velocity the net force acting on the object is 0 N, and its acceleration is 0 m/s²
- static friction is between objects at rest relative to one another, and kinetic friction is between objects that are sliding relative to one another
- impulse is equal to change in linear momentum
- coefficients of static and kinetic friction are only dependent upon the nature of the surfaces in contact with one another
- a spring force is an example of a variable force
- a normal force is always directed perpendicular to the surface the object is resting upon

Resources: class notes in schoology, photogates, computer, PASCO computer interface, metersticks, force sensors, balance, teacher constructed lab materials

<p><u>Grade, Subject:</u> 10,11,12 physics</p>	
<p><u>Strand (Unit):</u> mechanics</p>	
<p><u>Big Idea:</u> centripetal force</p>	
<p><u>PA Content Standards:</u></p>	<p><u>PA Core Standards:</u></p>
<p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> 1. How do we summate forces in the radial direction for objects moving in a horizontal circle and a vertical circle? 2. How do we apply the principles from our unit on force and Newton’s laws to objects that move in a circle? 	<p><u>Understandings (Cross Cutting Concepts):</u></p>
<p><u>Vocabulary:</u> radial acceleration, centripetal acceleration, static friction, kinetic friction, coefficient of static friction, coefficient of kinetic friction, tangential velocity</p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● analyze the motion of car going around a curve with frictional considerations (proper free body diagrams, summations, and solutions) ● analyze the motion of a conical pendulum (proper free body diagrams, summations, and solutions) ● analyze the motion of objects moving in a vertical circle

<p>Knowledge:</p> <ul style="list-style-type: none"> ● centripetal forces apply to objects that are moving in horizontal and vertical circles ● the sign conventions for summing forces in the horizontal and vertical directions are inward as positive, outward as negative 	<p>Resources: class notes in schoology</p>
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<p>Grade, Subject: 10,11,12 physics</p>	
<p>Strand (Unit): mechanics</p>	
<p>Big Idea: work/power</p>	
<p>PA Content Standards:</p>	<p>PA Core Standards:</p>
<p>Essential Questions:</p> <ol style="list-style-type: none"> 1. How do we calculate the work done by a constant force on an object that undergoes a specified displacement? 2. How do we interpret work done by a constant force as the dot product of two vectors? 3. How do we calculate work from a graph of force vs. position? 4. How do we calculate the work done by a variable force? 	<p>Understandings (Cross Cutting Concepts):</p> <ul style="list-style-type: none"> ● work is a scalar quantity and is the dot product of force and displacement ● net work is a scalar summation ● net work is equal to the change in kinetic energy ● work is the area under a graph of force vs position ● calculating work done by a variable force requires integration ● work is equal to the negative of the change in potential energy ● power is the rate at which work is done ● work does not depend upon path if only conservative forces are present

<p>5. How do we relate work and kinetic energy, and work and potential energy for conservative forces?</p> <p>6. What do we call the quantity that represents the rate at which work is done?</p>	
<p><u>Vocabulary:</u> work, power, conservative force, non-conservative force, kinetic energy,</p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● calculate work done by constant and variable forces ● compute the dot product of two vectors ● calculate work from a graph of force vs. position ● properly apply the work-kinetic energy theorem ● calculate average power ● perform experimental investigations related to this unit
<p><u>Knowledge:</u></p> <ul style="list-style-type: none"> ● work is a scalar quantity and is the dot product of force and displacement ● net work is a scalar summation ● net work is equal to the change in kinetic energy ● work is the area under a graph of force vs position ● calculating work done by a variable force requires integration ● work is equal to the negative of the change in potential energy ● power is the rate at which work is done ● work does not depend upon path if only conservative forces are present 	<p><u>Resources:</u> class notes in schoology, photogates, computer, PASCO computer interface, stop watches, metersticks, force sensor, teacher constructed lab materials</p>

<p><u>Grade, Subject:</u> 10,11,12 physics</p>	
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<u>Strand (Unit):</u> mechanics	
<u>Big Idea:</u> energy	
<u>PA Content Standards:</u>	<u>PA Core Standards:</u>
<u>Essential Questions:</u> <ol style="list-style-type: none"> 1. How do we calculate kinetic energy, gravitational potential energy, and elastic potential energy? 2. How do we apply conservation of mechanical energy to situations where only conservative forces are present? 3. How do we identify mechanical energy as energy in transition, continuously being converted from one form into another? 4. How do we amend our conservation of mechanical equations to include non-conservative forces such as friction? 5. How do we apply conservation of mechanical energy principles to systems that have springs? 	<u>Understandings (Cross Cutting Concepts):</u> <ul style="list-style-type: none"> ●
<u>Vocabulary:</u> kinetic energy, mechanical energy, gravitational potential energy, elastic potential energy, conservation of mechanical energy,	<u>Skills (Science and Engineering Practices):</u> <ul style="list-style-type: none"> ● apply conservation of mechanical energy principles to complex systems ● calculate kinetic energy, gravitational potential energy, and elastic potential energy ● apply conservation of mechanical energy principles to systems with friction ● identify energy as continuously in transition and being converted from one form to another ● perform experimental investigations related to this unit

<p>Knowledge:</p> <ul style="list-style-type: none"> ● mechanical energy continuously changes from one form to another ● friction takes mechanical energy away from a system ● kinetic energy is energy due to the motion of an object ● potential energy is energy due to an objects state or position 	<p>Resources: class notes in schoology, photogates, computer, PASCO computer interface, stop watches, metersticks, balance, teacher constructed lab materials</p>
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<p>Grade, Subject: 10,11,12 physics</p>	
<p>Strand (Unit): mechanics</p>	
<p>Big Idea: simple harmonic motion</p>	
<p>PA Content Standards:</p>	<p>PA Core Standards:</p>
<p>Essential Questions:</p> <ol style="list-style-type: none"> 1. What is the characteristic equation that governs simple harmonic motion? 2. What is the relationship between the position, velocity, force, and acceleration for an object undergoing simple harmonic motion? 3. What is the interrelationship between a spring mass system, and a simple pendulum? 	<p>Understandings (Cross Cutting Concepts):</p>

<ol style="list-style-type: none"> 4. What effect does changing the length have upon the period of a simple pendulum? 5. What effect does changing the mass have upon the period of a spring mass system? 6. What effect does changing the distance from the center of mass have upon the period of a physical pendulum 	
<p><u>Vocabulary:</u> amplitude, oscillation, period, frequency, simple pendulum, spring mass, conical pendulum, physical pendulum, moment of inertia, rotational inertia,</p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● draw and label amplitude, force, velocity, and acceleration at various positions as a spring mass or simple pendulum completes one oscillation ● clearly determine what will happen to the period of a simple harmonic oscillatory system when various physical parameters are changed ● differentiate a function of position to obtain velocity and acceleration functions for simple harmonic motion ● perform experimental investigations related to this unit
<p><u>Knowledge:</u></p> <ul style="list-style-type: none"> ● period of a spring mass system depends upon mass and spring constant ● period of a simple pendulum depends upon length and acceleration of gravity ● period of a conical pendulum depends upon angle with the vertical and the acceleration of gravity ● period and frequency are inverse relationships ● period of a physical pendulum depends upon moment of inertia, mass, and length 	<p><u>Resources:</u> class notes in schoology, pendulums, meterstick, stopwatches,</p>

<u>Grade, Subject:</u> 10,11,12 physics	
<u>Strand (Unit):</u> mechanics	
<u>Big Idea:</u> linear momentum	
<u>PA Content Standards:</u>	<u>PA Core Standards:</u>
<u>Essential Questions:</u> 1. What are the three types of collisions? 2. How is momentum conserved in a collision or separation? 3. How do we calculate losses in kinetic energy after a collision?	<u>Understandings (Cross Cutting Concepts):</u>
<u>Vocabulary:</u> collision, momentum, elastic collision, inelastic collision, perfectly inelastic collision,	<u>Skills (Science and Engineering Practices):</u> <ul style="list-style-type: none"> ● identify collisions as elastic, inelastic, and perfectly inelastic ● calculate magnitude and direction of velocities of objects after collisions ● calculate losses in kinetic energy when objects undergo inelastic and perfectly inelastic collisions ● perform experimental investigations related to this unit
<u>Knowledge:</u> <ul style="list-style-type: none"> ● in an elastic collision momentum and kinetic energy are conserved ● in an inelastic collision only momentum is conserved ● in a perfectly inelastic collision only momentum is conserved and objects couple together after the collision takes place 	<u>Resources:</u> class notes in schoology, photogates, computer, PASCO computer interface, air tracks, collision carts, rubber balls, metersticks, stopwatches, balance, teacher constructed lab materials

<p><u>Grade, Subject:</u> 10,11,12 physics</p>	
<p><u>Strand (Unit):</u> circuits</p>	
<p><u>Big Idea:</u> DC circuit analysis</p>	
<p><u>PA Content Standards:</u></p>	<p><u>PA Core Standards:</u></p>
<p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> 1. What is the convention we use for current flow? 2. What are the mathematical relationships we use to define current, voltage, resistance and power? 3. How do we distinguish between series, parallel, and series-parallel circuits? 4. How to we find the equivalent resistance of series, parallel, and series parallel circuits? 5. How do we calculate all the voltages and currents across each resistor in series, parallel, and series-parallel circuits? 6. How do we analyze complex, multi-source circuits using mesh analysis? 	<p><u>Understandings (Cross Cutting Concepts):</u></p> <ul style="list-style-type: none"> ● current in a series circuit stays the same for each resistive element ● voltage in a parallel circuit stays the same for each resistive element
<p><u>Vocabulary:</u> current, voltage, power, resistance, conductor, insulator, semiconductor, superconductor, equivalent resistance, ohms, amps, watts, node, branch, mesh, loop, direct current, alternating current, short circuit, open circuit</p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● mathematically analyze different circuits and calculate an equivalent resistance ● mathematically analyze different circuits and calculate all voltages and currents through each resistor using conventional methods, or mesh analysis ● identify a circuit as series, parallel, or series parallel ● construct circuits in the laboratory and calculate the equivalent resistance ● construct circuits in the laboratory and calculate all voltages and currents through each resistor

<p><u>Knowledge:</u></p> <ul style="list-style-type: none"> ● current in a series circuit stays the same for each resistive element ● voltage in a parallel circuit stays the same for each resistive element 	<p><u>Resources:</u> class notes in schoology, power supplies, light bulbs, resistors, voltage probes, breadboards, teacher constructed lab materials</p>
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<p><u>Grade, Subject:</u> 10,11,12 physics</p>	
<p><u>Strand (Unit):</u> circuits</p>	
<p><u>Big Idea:</u> Household Electrical Usage</p>	
<p><u>PA Content Standards:</u></p>	<p><u>PA Core Standards:</u></p>
<p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> 1. What are the units you are billed for your household electrical usage? 2. How do you calculate the electrical consumption of devices commonly used in the household? 3. How do we calculate the amount of money it will cost to use common electrical devices in the household 	<p><u>Understandings (Cross Cutting Concepts):</u></p>

<p><u>Vocabulary:</u> current, voltage, resistance, KWH, power, energy</p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● calculate the power consumption of a device plugged into an electrical outlet in KW ● use equations to calculate the amount of energy an electrical device consumes in KWH ● calculate the cost to run certain devices for an hour, a day, a week, and a month
<p><u>Knowledge:</u></p> <ul style="list-style-type: none"> ● a KWH is a unit of electrical energy consumption ● the more current a devices uses, the more it will cost to operate in the household 	<p><u>Resources:</u> class notes in schoology, power supplies, light bulbs, resistors, voltage probes, teacher supplied electrical usage meters</p>

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<p><u>Grade, Subject:</u> 10,11,12 physics</p>	
<p><u>Strand (Unit):</u> geometric optics</p>	
<p><u>Big Idea:</u> wave properties of light</p>	
<p><u>PA Content Standards:</u></p>	<p><u>PA Core Standards:</u></p>

<p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> 1. Is light a wave or a particle? 2. What is the electromagnetic spectrum, and where does visible light fall in this continuum? 3. What is the mathematical relationship between velocity, frequency, and wavelength for an electromagnetic wave? 	<p><u>Understandings (Cross Cutting Concepts):</u></p>
<p><u>Vocabulary:</u></p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● identify, within the electromagnetic spectrum, what the wavelength range is for visible light ●
<p><u>Knowledge:</u></p> <ul style="list-style-type: none"> ● light displays both wave and particle properties 	<p><u>Resources:</u> class notes in schoology,</p>

<u>Grade, Subject:</u> 10,11,12 physics	
<u>Strand (Unit):</u> geometric optics	
<u>Big Idea:</u> mirrors and reflection	
<u>PA Content Standards:</u>	<u>PA Core Standards:</u>
<u>Essential Questions:</u> <ol style="list-style-type: none"> 1. How does the speed, wavelength, and frequency of light change when light passes from one medium to another? 2. How does the principle of specular reflection work? 3. How do we determine image distance, image height, and image orientation for concave and convex mirrors? 	<u>Understandings (Cross Cutting Concepts):</u>
<u>Vocabulary:</u> concave mirror, convex mirror, vertex, virtual image, real image, image height, image distance, object height, object distance	<u>Skills (Science and Engineering Practices):</u> <ul style="list-style-type: none"> ● draw scale geometric constructions showing the proper image location for a concave and convex mirrors using all three ray tracing rules ● determine the focal length of a concave mirror in the laboratory ● identify an image as real or virtual ● ●
<u>Knowledge:</u> <ul style="list-style-type: none"> ● 	<u>Resources:</u> class notes in schoology, optical bench, light source, mirrors,

<p><u>Grade, Subject:</u> 10,11,12 physics</p>	
<p><u>Strand (Unit):</u> geometric optics</p>	
<p><u>Big Idea:</u> lenses and refraction</p>	
<p><u>PA Content Standards:</u></p>	<p><u>PA Core Standards:</u></p>
<p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> 1. What is refraction? 2. What is, and how do we calculate the index of refraction for different transparent mediums? 3. How do we use Snell’s law to determine the angle of refraction as light passes from one medium to another? 4. How do we determine image distance, image height, and image orientation for converging and diverging lenses? 5. Under what conditions does total internal reflection take place? 	<p><u>Understandings (Cross Cutting Concepts):</u></p>
<p><u>Vocabulary:</u> angle of reflection, angle of refraction, index of refraction, total internal reflection, refraction, converging lens, diverging lens, optical center, real image, virtual image,</p>	<p><u>Skills (Science and Engineering Practices):</u></p> <ul style="list-style-type: none"> ● draw scale geometric constructions showing the proper image location for a converging and diverging lens using all three ray tracing rules ● determine the focal length of a converging lens in the laboratory ● determine the index of refraction for glass, plastic, and water in the laboratory ● draw scale constructions showing proper angles of reflection and refraction for light rays as they pass from one medium to another ● identify an image as real or virtual

Knowledge:

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Resources: class notes in schoology, optical bench, light source, lenses, lens holders, plastics blocks, glass blocks,