Moon Area School District Curriculum Map

Course: College in High School Physics (through University of Pittsburgh)
Grade Level: 11^{th} and 12^{th}
Content Area: Science
Frequency: Full-Year Course

Big Ideas

Description: This is the first term of a two-term introductory sequence in physics for science and engineering students. (PHY 174 course at University of Pittsburgh)
Prerequisite: Calculus is needed and should be taken at least concurrently

1. Measurement
   - Units of length, time, mass; in particular the SI system
   - Unit checking
   - Changing units
   - Systems of coordinates

2. Vectors
   - Vectors vs. scalars
   - Magnitude, direction, Cartesian components
   - Unit vectors i, j, k
   - Addition and subtraction by geometric and algebraic methods
   - Multiplication by a scalar
   - Scalar (dot) product
   - Vector (cross) product

3. Motion along a straight line
   - Position and displacement
   - Average velocity and average speed
   - Instantaneous velocity and instantaneous speed
   - Average acceleration and instantaneous acceleration
   - Kinematics of constant acceleration – Freely falling bodies

4. Motion in two and three dimensions – Position and displacement
   - Average velocity and average speed
   - Instantaneous velocity and instantaneous speed
   - Average acceleration and instantaneous acceleration
   - Projectile motion
   - Uniform circular motion
   - Relative velocity and acceleration (it is sufficient to do only the one-dimensional case)

5. Newton's laws of motion
   - Newton's First Law and inertial frames of reference
   - Newton's Second Law and concepts of force and mass
   - Newton's Third Law

6. Applications of Newton’s laws – Free-body diagrams – Tension and pulleys
   - Static and kinetic friction
   - Inclined planes
   - Uniform circular motion and centripetal force

7. Work and Kinetic Energy
   - Work as a scalar product
   - Work done by weight
   - Work done by a variable force
   - Hooke’s law and work done by a spring
   - Kinetic energy and the work-energy theorem – Power

8. Potential energy & conservation of energy
   - Conservative forces and potential energy
   - Examples: mgh and (1/2)kx^2
   - Conservation of mechanical energy
   - Work done by nonconservative forces and Wnoncon = □E
   - Conservation of energy (including internal energy)

9. Systems of particles
   - Center of mass
   - Newton’s second law for a system of particles
   - Linear momentum of a particle and of a system
   - Conservation of momentum

10. Collisions
    - Impulse and the impulse-momentum theorem
    - Elastic and inelastic collisions in one dimension
    - Collisions in two dimensions

11. Rotation
    - Kinematics of fixed-axis rotation
    - Linear and angular variables
    - Moment of inertia and rotational kinetic energy
    - Torque (including definition as a cross product) and rotational dynamics
    - Rolling; translational and rotational kinetic energy; conservation of energy
    - Angular momentum of a particle, a system of particles, and a rigid body
    - Conservation of angular momentum

12. Gravitation
    - Newton’s law of universal gravitation
    - Gravitational potential energy and escape speed
    - Planets and satellites
    - Kepler’s laws and their relation to conservation laws

13. Oscillations
   - Simple harmonic motion resulting from Newton's second law and Hooke's law
   - Position, velocity, and acceleration in simple harmonic motion
   - Energy considerations in simple harmonic motion
   - Simple pendulum

14. Mechanical Waves
   - Transverse and longitudinal waves
   - Wavelength and frequency
   - Speed of a traveling wave
   - Waves on a stretched string
   - Speed, energy, and power of a traveling wave on a stretched string
   - Principle of superposition; interference
   - Standing waves
   - Sound waves
   - Speed of sound – Interference of sound waves

15. Doppler effect

Essential Questions

Primary Resource(s) & Technology:

Textbook: Fundamentals of Physics, 10 ed. Halliday Resnick

Microsoft Teams, Promethean Boards, Student Laptops/iPads

Grading: The grade is determined primarily by three exams during the term and a cumulative final exam. Other work, such as quizzes and homework, may make some contribution to the grade. Approximately half of the class time each week is spent in covering new material. The remaining time is devoted to activities such as problem solving, demonstrating experiments, questions, and discussion.

Pennsylvania and/or focus standards referenced at:

www.pdesas.org

www.education.pa.gov

Big Ideas/ EQs	**Focus Standard(s)**	**Assessed Competencies (Key content and skills)**	**Timeline**
1	S & T 3.1.12.D	• Convert between the English and metric measuring system while keeping proper significant figures.	August- 1 week

2	S & T 3.1.12.C S & T 3.1.12.D	• Define a vector in terms of magnitude and direction. • Use the principle of superposition to add vectors using triangle trigonometry laws and principles. • Write a vector as the summation of its component vectors. • Use component vectors to determine the resultant vector of two or more vectors in free space. • To define and use unit vector notation to represent a vector. • Use the definition of the dot product and cross product to determine the product of two vectors. • Use unit vector notation to find the product, both dot and cross, of two vectors.	August-September (2 weeks)
3	S & T 3.1.12.D S & T 3.4.12.B S & T 3.4.12.C	• Determine the first and second derivative of polynomial equations. • Describe the difference between distance and displacement as well as speed and velocity. • Use the calculus definition of velocity and acceleration to determine the average velocity, instantaneous velocity, average acceleration, and instantaneous acceleration of an object when its position is given as a function of time. • Explain and solve problems that deal with an object experiencing one dimensional motion under constant acceleration. • Solve problems in which objects are experiencing free-fall in one dimension. •	September (3 weeks)
4	S & T 3.1.12.D S & T 3.4.12.C	• Use one dimensional equations to determine position, velocity, and or time in a two or three dimensional system. • Us unit vector notation to represent position, velocity and acceleration in a two and three dimensional system. • Use the definition of centripetal acceleration to describe the motion of an object as it rounds a bend. • Manipulate velocities between different frames of references.	October (3 weeks)

5	S & T 3.1.12.D S & T 3.4.12.C	State Newton's three laws of motion and give examples of each. Describe action/reaction pairs Use Newton's second law of motion to determine the net force acting on an object. Use component vectors to determine the net force acting on a object when individual forces are acting at an angle on an incline.	October-November (2 weeks)
6	S & T 3.1.12.D S & T 3.4.12.C	Describe weight, normal force and tension and determine each mathematically Use the coefficient of kinetic and static friction to determine the force of friction. Apply frictional forces to the inclined plane. Relate friction to air resistance through drag coefficients Describe terminal velocity in terms of Newton's second law of motion. Determine the tension between two objects in a system of forces. Determine the acceleration and tension in a system of forces at angles. Explain how friction will effect the acceleration of a system of forces. Use Newton's second law of motion, centripetal acceleration and friction to determine the maximum velocity that a car can negotiate a curve.	November (2 weeks)
7,8	S & T 3.1.12.D S & T 3.4.12.B S & T 3.4.12.C	• Define and solve problems related to kinetic energy. • Define work as the dot product of force and displacement and solve problems dealing with work. • Use the work/kinetic energy theorem to determine the net work done on a moving object. • Use Hooke's law to describe the work done in stretching a spring. • Solve problems dealing with potential energy. (gravitational and elastic) • Explain the difference between conservative and non-conservative energies. • Solve problems using the law of conservation of mechanical energy.	December (3 weeks)

		• Describe and list non-conservative forces.	
9,10	S & T 3.1.12.D S & T 3.4.12.B S & T 3.4.12.C	• Apply Newton's second law of motion to a system of particles. • Use the change in momentum of one object to describe the change in momentum of another object in the same event. • Define impulse and relate it to change in momentum, force and time. • Explain what is and what is not conserved in an elastic, inelastic, and perfectly inelastic collision. • Use conservation of momentum and conservation of energy to solve problems dealing with ballistics.	January (3 weeks)
11	S & T 3.1.12.D S & T 3.4.12.B S & T 3.4.12.C	• Use the calculus definition of angular displacement, velocity, and acceleration to determine each. • Rewrite the one dimensional equations for angular quantities. • Relate tangential velocity, centripetal acceleration, and tangential acceleration to their angular counterparts. • Define and determine the moment of inertia of a spinning object. • Use the parallel axis theorem to determine the moment of inertia of a spinning object that is not spinning around a central axis. • Determine the rotational kinetic energy of a spinning object using its moment of inertia and angular velocity. • Use the cross product of vectors to define torque. • Use Newton's second law, Summation of Torques, to solve rotational systems. • Show how to represent rolling motion as a combination of linear motion and angular motion. • Determine the kinetic energy of a rolling object. • Apply the conservation of energy to rolling object. • Determine the angular momentum of an object rotating around a central axis. • Determine the angular momentum of an object orbiting around an external axis.	February-March (4 weeks)

		• Determine the angular momentum of an object traveling in a straight line with respect to a fixed point. • Use conservation of angular momentum to determine angular and linear velocities.	
12	S & T 3.1.12.B S & T 3.1.12.D S & T 3.4.12.B S & T 3.4.12.C	• Mathematically determine the gravitational force felt between two bodies. • Use the principle of superposition to determine the net gravitational force felt between multiple objects in close proximity. • Use the universal law of gravitation to determine the acceleration caused by gravity of caused by a celestial object. • Determine the gravitational potential energy of an object relative to the center of the planet that the object is located on. • Use the law of conservation of energy derive the the equation for escape velocity. • Use Newton's law of universal gravitation and Newton's second law of motion to explain orbital velocity of a satellite at a given altitude. • Use Keppler's first law of planetary motion to describe the orbit of a planet around a sun.	March (2 weeks)
13	S & T 3.1.12.D S & T 3.4.12.B S & T 3.4.12.C	• Use the first and second derivative of sin and cosine to derive and use the equations for instantaneous velocity and acceleration as a function of position and time. In a simple harmonic oscillator. • Relate the phase and period of SHM to points of maximum, zero, and negative maximum displacement. • Determine the maximum position, velocity and acceleration of an object under SHM. • Use Hooke's law to solve problems dealing with SHM. • Use the elastic force constant k to determine the angular frequency of an object when SHM is induced by a spring. • Write kinetic and potential energy equations as a function of position and time for objects under SHM. • Use the law of conservation of mechanical energy to determine velocity or position of an object under SHM. • Determine the period of oscillation of a simple pendulum. • Describe the properties of a physical pendulum and relate them to simple pendulum.	April (3 weeks)

14	S & T 3.1.12.D S & T 3.4.12.B S & T 3.4.12.C	• Define wavelength and frequency in terms of angular wave number and angular frequency. • Use the angular wave number, amplitude and angular frequency to write the equation of a traveling wave. • Determine the position velocity and acceleration of a point on a traveling transverse wave as a function of position and time. • Use frequency and wavelength to determine the speed of a traveling wave. • Use the definition of energy to determine the energy and power associated with a transverse wave. • Write the equation of a wave produced by the interference of two identical waves traveling in the same direction, but out of phase with one another. • Write the equation of a standing wave formed from the interference of two identical waves traveling in opposite directions. • Determine the position of nodal and anti-nodal points in a standing wave. • Determine the frequency of a standing wave give the harmonic and length of the string that the standing wave is formed on.	April/May (3 weeks)
15	S & T 3.1.12.B S & T 3.1.12.D S & T 3.4.12.B S & T 3.4.12.C	• Write the position and pressure equation of a sound wave as a function of displacement and time. • Use frequency and wavelength to determine the speed of a sound wave. • Determine the position of the maximum and minimum signal when identical sounds are emitted from two separate sources. • Determine whether the observed frequency will increase or decrease when the observer or the source of a sound is moving. • Use the equation for Doppler shifts to determine the observed frequency the source and/or the detector is moving.	May (1 week)