DeRuyter Central School District

Physical Setting Physics Grade 12

58 Benchmarks

➢Standard 1

Unit 1:

PHY12.1.1 Measured quantities can be classified as either vector or scalar.

- Construct and interpret scaled vector diagrams using a student owned ruler and protractor.

PHY12.1.2 An object in linear motion may travel with a constant velocity* or with acceleration*. *(Note: Testing of acceleration will be limited to cases in which acceleration is constant.)*

- Construct and interpret graphs of position, velocity, or acceleration versus time.
- Determine and interpret slopes and areas of motion graphs.

PHY12.1.3 An object in free fall accelerates due to the force of gravity*. Friction and other forces cause the actual motion of a falling object to deviate from its theoretical motion. *(Note: Initial velocities of objects in free fall may be in any direction.)*

- Design and complete an experiment which will determine the acceleration due to gravity.
- Know that while an object in freefall is traveling upward the net force is acting downward and therefore the acceleration is directed downward.
- Know that while an object in freefall is traveling downward the net force is acting downward and therefore the acceleration is directed downward.
- Know that when an object in freefall reaches its highest point the net force is acting downward and therefore the acceleration is directed downward.

PHY12.1.4 The resultant of two or more vectors, acting at any angle, is determined by vector addition.

- Determine the resultant of two or more vectors graphically and algebraically.

PHY12.1.5 A vector may be resolved into perpendicular components.*

- Resolve a vector into components graphically and algebraically.

PHY12.1.6 The path of a projectile is the result of the simultaneous effect of the horizontal and vertical components of its motion; these components act independently. (Note: Analysis of projectiles will be limited to ideal projectile motion. For example; air friction, rotation of the earth, varying gravitational field strengths will be ignored)

- Sketch the theoretical path of a projectile.

PHY12.1.7 A projectile's time of flight is dependent upon the vertical components of its motion.

- Using vector resolution and kinematics equations determine the time of flight, and vertical components of the velocity and displacement.*
- Understand that the horizontal component of a projectile's velocity does not effect the downwards acceleration and therefore any of the vertical velocities or heights of the projectile at any time.

PHY12.1.8 The horizontal displacement of a projectile is dependent upon the horizontal component of its motion and its time of flight.

- Use vector resolution and kinematics equations to determine the time of flight, and horizontal components of the velocity and displacement.*
- Understand that the horizontal velocity of a projectile does not change because there is no net force in the horizontal direction.

PHY12.1.9 According to Newton's First Law, the inertia of an object is directly proportional to its mass. An object remains at rest or moves with constant velocity, unless acted upon by an unbalanced force.

- Understands that an object's inertia can not be changed by increasing or decreasing an object's velocity since inertia is related only to mass.

PHY12.1.10 When the net force on a system is zero, the system is in equilibrium.

- Understands that an object at rest and an object moving with a constant velocity are in equilibrium, because they are not accelerating.

PHY12.1.11 According to Newton's Second Law, an unbalanced force causes a mass to accelerate*.

- Construct and interpret free body diagrams.
- In a lab setting verify Newton's second law for linear motion.

PHY12.1.12 Weight is the gravitational force with which a planet attracts a mass.* The mass of an object is independent of the gravitational field in which it is located.

PHY12.1.13 Kinetic friction* is a force that opposes motion while an object is moving along another surface.

- Design and complete an experiment to determine the coefficient of kinetic friction for two surfaces.

PHY12.1.14 Static friction* is a force that opposes motion while an object is at rest on another surface

- Design and complete an experiment to determine the coefficient of static friction for two surfaces.

PHY12.1.15 Centripetal force* is the net force which produces centripetal acceleration*. In uniform circular motion, the centripetal force is perpendicular to the tangential velocity.

- In a lab setting verify Newton's second for uniform circular motion.
- Can identify the directions of the centripetal force, centripetal acceleration, tangential velocity and momentum vectors of an object in uniform circular motion.

PHY12.1.16 The impulse* imparted to an object causes a change in its momentum*.

PHY12.1.17 The elongation or compression of a spring depends upon the nature of the spring (its spring constant) and the magnitude of the applied force.*

- Design and complete an experiment to determine the spring constant of a spring.

PHY12.1.18 According to Newton's Third Law, forces occur in action/reaction pairs.

- Knows that when one object exerts a force on a second object, the second object exerts a force on the first object that is equal in magnitude and opposite in direction.
- Understands tension.

PHY12.1.19 Momentum is always conserved in a closed system.* *(Note: Testing will be limited to momentum in one dimension.)*

- In a lab setting verify the conservation of momentum.

PHY12.1.20 Gravitational forces are only attractive, whereas electrical and magnetic forces can be attractive or repulsive.

- Knows that the gravitational force is proportional to the product of the two masses involved and is inversely proportional to the square of the separation of their centers of mass
- Determine relative strength of fields (magnetic, electric, gravitational) by line density.

PHY12.1.21 The inverse square law applies to electrical* and gravitational* fields produced by point sources.

PHY12.1.22 Field strength* and direction are determined by using a suitable test particle. *(Notes: 1) Calculations are limited to electrostatic and gravitational fields. 2) The gravitational field near the surface of Earth and the electrical field between two oppositely charged parallel plates are treated as uniform.)*

Unit II: ENERGY

PHY12.2.1 When work* is done on or by a system, there is change in the total energy* of the system.

PHY12.2.2 Work done against friction results in an increase the internal energy of the system.

PHY12.2.3 Power* is the time-rate at which work is done or energy is expended.

- Understand how rate and time effect the power in situations when equivalent work is done.

PHY12.2.4 All energy transfers are governed by the law of conservation of energy.*

- Describe and explain the energy transformations of pendulums, springs, freely falling objects and other real world applications.

- Predict velocities, compressions/elongations, and heights in systems mentioned above.

PHY12.2.5 Energy may be converted among mechanical, electromagnetic, nuclear, and thermal forms.

PHY12.2.6 Potential energy is the energy an object possesses by virtue of its position or condition. Types of potential energy are gravitational* and elastic.*

- Design and complete an experiment to determine the energy stored in spring.

PHY12.2.7 Length is the only factor that affects the period of a pendulum.

- Verify this experimentally.

PHY12.2.8 Kinetic energy* is the energy an object possesses by virtue of its motion.

PHY12.2.9 In an ideal (frictionless) mechanical system, the sum of the macroscopic kinetic and potential energies (mechanical energy) is constant.*

Calculate and graph the total mechanical, kinetic, and potential energies of a roller coaster and other real world applications.

PHY12.2.10 In a non-ideal mechanical system, as mechanical energy decreases there is a corresponding increase in other energies such as internal energy.*

Unit III: Electricity & Magnetism

PHY12.3.1 Gravitational forces are only attractive, whereas electrical and magnetic forces can be attractive or repulsive.

- Determine relative strength of field (magnetic, electrical, gravitational) by line density
- Determine relative strength of fields (magnetic, electric, gravitational) by line density.

PHY12.3.2 Materials with equal numbers of positive and negative charges are electrically neutral.

- Knows that ordinary matter that is negatively charged has an excess of electrons.
- Knows that ordinary matter that is positively charged has a deficit of electrons.
- Knows that even a small deficit or excess of electrons produces noticeable electrostatic force.
- Determine charge gained or lost by materials (conducting and non-conducting) by applying the law of conservation of charge.

PHY12.3.3 The inverse square law applies to electrical* and gravitational* fields produced by point sources.

PHY12.3.4 Energy may be stored in electric* or magnetic fields. This energy may be transferred through conductors or space and may be converted to other forms of energy.

- Knows that the work done on or by a particle in an electric field is equal to the particle's change in energy.
- Will calculate electrical work and energy in Joules when charge is expressed in coulombs.

- Will calculate electrical work and energy in electonvolts when charge is expressed in elementary charges.
- Recognize and describe conversions among different forms of energy in real world devices such as photocells, motors, batteries, and generators.

PHY12.3.5 The factors affecting resistance in a conductor are length, cross-sectional area, temperature, and resistivity.*

- Measure and compare resistances of conductors of various lengths and cross sectional areas.
- Design and complete an experiment to determine the resistivity of a conducting material.

PHY12.3.6 All materials display a range of conductivity. At constant temperature, common metallic conductors obey Ohm's Law*.

- Differentiate between conductors, poor conductors (insulators) and superconductors.

PHY12.3.7 A circuit is a closed path in which a current* can exist

- Use Ohm's law to calculate current, voltage or resistance of a circuit or component.
- Understands the uses of switches and fuses in a circuit.
- Construct and interpret graphs relating the three variables involved on Ohm's law.
- Use conventional current instead of electron current.

PHY12.3.8 Electrical power* and energy* can be determined for electric circuits.

PHY12.3.9 Circuit components may be connected in series* or parallel.* Schematic diagrams are used to represent circuits and circuit elements.

- Measure current and voltage in a circuit using the appropriate meter(s).
- Use a schematic to construct a circuit and determine the voltage and current in the circuit.
- Draw a schematic of simple real world circuits.
- Predict the behavior of light bulbs in series and parallel.

PHY12.3.10 Magnetic fields are represented by lines of force or field lines

- Follow the convention that field lines run from north to south.
- Knows that a compass points in the direction of the field lines (which is north to south).
- Sketch magnetic fields around magnets and magnetic devices (solenoids and electromagnets).

PHY12.3.11 Moving electric charges produce magnetic fields. The relative motion between a conductor and a magnetic field may produce a potential difference in the conductor. This process is called induction.

- Knows that the interplay of magnetic and electric forces is the basis for electric motors, generators, radio, TV, and other real world technologies.

PHY12.3.12 Knows that the electrical force is proportional to the product of the two charges involved and is inversely proportional to the square of the separation of their centers of charge.

Unit IV: WAVES

PHY12.4.1 An oscillating system produces waves and the nature of the system determines the type of wave produced.

- By comparing the direction of the motion of the particles in the medium and the direction of wave travel (propagation), differentiate between transverse and longitudinal waves.
- Mechanical waves, electromagnetic waves, sound waves, earthquake waves.

PHY12.4.2 Waves carry energy and information without transferring mass.

- Differentiate between pulses and periodic waves

PHY12.4.3 The model of a wave incorporates the characteristics, of amplitude, wavelength*, frequency*, period*, wave speed*, and phase.

- Design and complete an experiment to determine the speed of sound in air
- Draw wave forms with various characteristics

PHY12.4.4 Mechanical waves require a material medium through which to travel.

PHY12.4.5 Electromagnetic radiation exhibits wave characteristics and propagates through a vacuum.

- Knows that all frequencies of electromagnetic radiation travel at the same speed in a vacuum.*
- Recognizes the categories of the electromagnetic spectrum as well as their relative wavelengths and frequencies.

PHY12.4.6 A combination of phenomena occurs when a wave strikes a boundary between two media.

- Understands reflection*, refraction, transmission, and absorption
- Observe, sketch, and interpret the behavior of wave fronts as they reflect, and refract.
- Draw ray diagrams to represent the reflection and refraction of waves.
- Design and complete an experiment to determine empirically the index of refraction of a transparent medium.
- Understand why waves refract when a wave moves from one medium into another medium obliquely.
- Knows that the angle of refraction (measured with respect to the normal) depends on the angle of incidence and the properties of the media (indices of refraction).*
- Knows that the absolute index of refraction is inversely proportional to the speed of a wave.*
- Understands Polarization.
- Realize that echoes are a waves reflecting off boundaries.

PHY12.4.7 When waves of a similar nature meet, the resulting interference may be explained using the principle of super-position.

- Predict the superposition of two waves interfering constructively and destructively
- Can explain that standing waves are a special case of interference.

- Identify nodes and antinodes on standing waves.
- Understands Beats.

PHY12.4.8 Resonance occurs when energy is transferred to a system at its natural frequency.
- Use the concept of resonance to explain real world phenomena such as the Tacoma Narrows Bridge collapse, musical instruments, swings, springs and pendulums.

PHY12.4.9 Diffraction occurs when waves pass by obstacles or through openings.
- Understands that the wavelength of the incident wave and the size of the obstacle or opening (aperture) affect how the wave spreads out.
- Observe, sketch, and interpret the behavior of wave fronts as they diffract.

PHY12.4.10 When a wave source and an observer are in relative motion the observed frequencies and wavelengths are altered.
- Predicts whether the apparent frequency and wavelength increases or decreases due to the relative motion.
- Understands the cause of red and blue shift.

Unit V: MODERN

PHY12.5.1 Energy is restricted to discrete values (quantized)
- Know that the energy of a photon is proportional to its frequency.*
- Interpret energy level diagrams.*
- Know that energy is emitted or absorbed in discrete packets called photons.*
- Correlate spectral lines with an energy level diagram.

PHY12.5.2 On the atomic level, energy and matter exhibit the characteristics of both waves and particles.

PHY12.5.3 Mass-energy and charge are conserved at all levels
- Knows that on the atomic level, charge is restricted to the elementary charge (charge on an electron or proton).
- Knows that on the sub-nuclear level charge appears as fractional values of the elementary charge (quarks).

PHY12.5.4 The Standard Model of Particle Physics has evolved from previous attempts to explain the nature of the atom
- Knows that atomic particles are composed of sub-nuclear particles. (baryons, mesons, hadrons, and leptons)
- Can differentiate particles that are fundamental and not fundamental.
- Understands that the nucleus is a conglomeration of quarks which manifest themselves as protons and neutrons.
- Knows the quark composition of a proton and neutron.
- Know that every particle has a corresponding antiparticle.

- PHY12.5.7 The fundamental source of all energy in the universe is the conversion of mass into energy.*

- Can convert mass in kg to energy in joules
- Can convert mass in universal mass units to energy in MeV.

PHY12.5.8 Behaviors and characteristics of matter, from the microscopic to the cosmic levels are manifestations of its atomic structure. The macroscopic characteristics of matter are a result of microscopic interactions.

- Know the four fundamental forces.
- Know the relative strengths and ranges of the fundamental forces.
- Understands that many common forces are actually electric forces that act between objects when they are in contact. Such forces include normal forces and frictional forces.