2.0 The student will**:**	3.0 The student will:	4.0 The student will*:*
Physics		
<u>Competency 1</u>: Energy Transformations – The student will be able to demonstrate that energy is transferred between objects during interactions and frequently transformed from one type to another in mechanical, electrical, and natural systems. The total amount of energy remains constant in closed systems.		
<u>In other words…</u> students can generate questions such as "Where did the energy go?" using various phenomena that illustrate energy transfer, like dropping a ball or swinging a pendulum and noticing that they don't return to their starting point. They can then identify patterns in data and describe reasons to support their conclusions. Students can predict what would happen if variables are changed in investigations using various physics simulations.		
• Identify the form of energy in given situations (moving objects, stretched springs, rocks on cliffs, ie. Give examples of KE and PE) • Define and describe the Law of Conservation of Energy. • Name devices that transform specific types of energy into other types (ie. Device that transforms electricity into motion). • Describe the transformations between potential and kinetic energy in simple mechanical systems (ie- pendulums, roller coasters, ski lifts).	• Apply the Law of Conservation of Energy in closed systems. • Compare and contrast the energy changes associated with closed systems with friction and closed systems without friction. • Explain why all mechanical systems require an external energy source to maintain their motion. • Explain instances of energy transfer by waves and objects in everyday activities (ie why the ground gets warm during the day, how you hear a distant sound, why it hurts when you are hit by a baseball). • Calculate the changes in kinetic and potential energy in simple mechanical systems (ie. pendulums, roller coasters, ski lifts) using the formulas for kinetic energy and potential energy.	• Create your own closed system which demonstrates the Law of Conservation of Energy • Evaluate the validity of the Law of Conservation of Energy in real-life scenarios
<u>Competency 2</u>: Motion of Objects – The student will be able to explain how the motion of an object may be represented using motion diagrams, tables and graphs, and mathematical functions. Solving problems about motion is facilitated by using functions.		
<u>In other words…</u> the students will be able to look at graphs and describe how position, velocity, and acceleration are interrelated. They will be able to solve word problems about velocity, time, speed, and acceleration. Students can measure, graph, and analyze motion. They can predict how a motion graph might change if, for example, velocity changes in a certain way, and test their predictions.		
• Describe and analyze the motion that a position-time graph represents, given the graph. • Distinguish between the variables of distance, displacement, speed, velocity, and acceleration. • Describe and analyze the motion that a velocity-time graph represents, given the graph.	• Calculate the average speed of an object using the change of position and elapsed time. • Create line graphs using measured values of position and elapsed time. • Solve problems involving average speed and constant acceleration in one dimension. • Use the change of speed and elapsed time to calculate the average acceleration for linear motion. • Apply the independence of the vertical and horizontal initial velocities to solve projectile motion problems.	• Produce a diagram, table, or a graph, or mathematical function to represent the motion of an object you created.

Competency 3: Forces (Dynamics) – The student will be able to describe and explain all three of Newton's Laws upon the interaction of two objects, by direct contact or at a distance.

In other words… Students can use simple equipment like model cars and rubber bands to develop the relationship between force, mass, and acceleration. They can pose and answer the question "How does changing the force affect the acceleration?" They develop ways of measuring acceleration. Students can use dynamics experiments, such as rolling a ball down a ramp and off a table, to make predictions about how changes in variables will affect motion.

• Recognize and describe Newton's Three Laws. • Explain how the interaction between two objects using Newton's Three Laws (by direct contact and at a distance). • Identify the magnitude and direction of everyday forces (ie wind, tension in ropes, pushes and pulls, weight) • Identify the action and reaction force from examples of forces in everyday situations (ie book on a table, walking across the floor, pushing open a door)	• Interpreting the resulting motion from free-body diagrams. (ie cars on a highway) • Solve problems involving force, mass, and acceleration in linear motion (Newton's second law). • Solve problems involving force, mass, and acceleration in 2-D projectile motion restricted to an initial horizontal velocity with no initial vertical velocity (ie ball rolling off a table)	• Creating free-body diagrams that illustrate the forces of an object and solve (inclined plane) • Predict the change in motion of an object acted on by several forces.

Competency 4: Momentum – The student will explain why a moving object has a quantity of motion (momentum) that depends on its velocity and mass. In interactions between objects, the total momentum of the objects, the total momentum of the objects does not change.

In other words… Students can investigate in momentum in many ways (ie Drop a tennis ball and basketball together, and observe how the tennis ball rebounds, compare an egg thrown into a sheet versus thrown into a wall, as examples).

• Define and describe momentum • Describe the Law of conservation of momentum.	• Apply the conservation of momentum to explain the resulting motion of colliding objects • Explain why a moving object has a quantity of motion (momentum) that depends on its velocity and mass • Apply conservation of momentum to solve simple collision problems.	• Predict the resulting motion of colliding objects by using the Law of Conservation of Momentum • Demonstrate and predict how the change in velocity of a small mass compares to the change in velocity of a large mass when the objects interact (ie collide) • Analyze why seat belts may be more important in autos than in buses.

Competency 5: Periodic Motion –The student will describe periodic motion, objects that oscillate back and forth or move in a circle and how they are quantified by their frequency.

In other words… Students can experience and investigate acceleration in circular motion on amusement park and playground rides, generating questions, collecting data, predicting results of changes in variables and designing tests of their predictions, relating patterns in data to concepts of acceleration in circular motion. They can do the same as they investigate motion of pendulums and weighted springs.

• Describe and classify various motions in a plane as one dimensional, 2-D, circular, or periodic (define terms). • Recognize periodic motion and circular motion. • Recognize how circular motion can be represented by a wave. • Describe the relationship between changes in position, velocity, and acceleration during periodic motion. • Identify the forces acting on objects moving with uniform circular motion (ie. a car on a circular track, satellites in orbit)	• Interpret periodic motion and circular motion from graphical representations. • Explain how frequency effects the movement of objects moving back and forth (oscillating) or in circular motion. • Distinguish between rotation and revolution and describe and contrast the two speeds of an object like the Earth.	• Evaluate and predict periodic motion and real world examples using the appropriate equations.

Competency 6: Gravity – The student will understand that gravity is one of four fundamental forces of nature, the attractive force between any two masses. It explains why objects fall to the Earth and why planets and satellites stay in their orbits.

In other words… Students can make predictions about what will happen if the masses and/or distance between objects are changed, relating patterns in the data to the universal law of gravitation.

• Define gravity • Describe how gravity changes depending on the mass and distance between two objects • List and summarize the four fundamental forces of nature	• Explain why objects fall to Earth and why satellites and planets stay in orbit • Explain earth-moon interactions (orbital motion) in terms of forces. • Explain how your weight on Earth could be different from your weight on another planet. • Calculate the force, masses, or distance between two bodies, given any three of these quantities, by applying the Law of Universal Gravitation, given the value of G.	• Predict how the gravitational force between objects changes when the distance between them changes.

Competency 7: Work – The student will explain and demonstrate mechanical energy (the amount of energy transferred when an object is moved equal to the work done on the object.

In other words… Students will be understanding the amount of work being done in certain situations along with mechanical energy going from potential energy to kinetic energy and vice versa.

• Describe and define mechanical energy • Describe and define work • Recognize when work is being done on an object • Describe the transformation between potential and kinetic energy in simple mechanical systems (ie pendulums, roller coasters, ski lifts)	• Explain mechanical energy (the amount of energy transferred when an object is moved equal to the work done on the object). • Represent work and energy transfers in a diagram. • Contrast the everyday meaning of "work" with the more precise scientific meaning. • Calculate the amount of work done on an object that is moved from one position to another. • Compare work done in different situations. • Explain instances of energy transfer by waves and objects in everyday activities (ie why it hurts when you are hit by a baseball) • Calculate the changes in kinetic and potential energy in simple mechanical systems (ie pendulums, roller coasters, ski lifts) using the formulas for kinetic energy and potential energy.	• Create and evaluate the work being done on an object using the appropriate equations.

Competency 8: Electromagnetic Waves – The student will describe the characteristics of electromagnetic waves which transfer energy and information from place to place without a material medium, and visible light is a form of electromagnetic radiation. All electromagnetic waves move at the speed of light in a vacuum.

In other words… students will know all about electromagnetic waves!

• Describe how energy flows from one object to another • Describe and define electromagnetic radiation and electromagnetic waves • Describe how and why electromagnetic radiation transfers energy from place to place without a material medium	• Explain the properties of waves based on their frequency, wavelength, and location on the electromagnetic spectrum. • Explain the practical applications of different types of waves (radio, microwave, infrared, visible light, ultraviolet, x-rays, and gamma rays) • Explain why radio waves can travel through space, but sound waves cannot. • Explain why there is a time delay between the time we send a radio message to astronauts on the moon and when they receive it. • Explain why we see a distant event before we hear it (ie lightning before thunder, exploding fireworks before the boom) • Explain how various materials reflect, absorb, or transmit light in diff. ways. • Given an angle of incidence and indices of refraction of two materials, calculate the path of a light ray incident on the boundary (Snell's law) • Explain how Snell's Law is used to design lenses (ie eye glasses, microscopes, telescopes, binoculars)	• Analyze and evaluate the practical applications of different types of waves and their effects on society. • Explain the relationship between the frequency of an electromagnetic wave and its technological uses. • Create and draw ray diagrams to indicate how light reflects off objects or refracts through transparent media. • Predict the path of reflected light from flat, curved, or rough surfaces (ie flat and curved mirrors, painted walls, paper)

Competency 9: Electrical Charges –The student will be able to describe how all objects are composed of electrical charges. The electric and magnetic forces are the result of the strength and motion of charges. Most interactions in everyday life (other than gravity) are the result of electric and magnetic forces.

In other words… Students can investigate static electric charges and the forces between them using balloons as an example. Students can understand and critique technological solutions to problems involving electric charges, such as the need for computer technicians to ground themselves when working with electrically sensitive computer parts.

• Define and describe electrical charges. • Define and describe electrical and magnetic forces • Describe the relationship between electricity and magnetism • Describe an everyday application of electric and magnetic forces • Identify the forces acting between objects in "direct contact" or at a distance.	• Explain how an electrical charge is produced. • Summarize the characteristics of electrical and magnetic forces. • Explain how electricity and magnetism are related. • Explain why scientists can ignore the gravitational force when measuring the net force between two electrons. • Explain how an object acquires an excess static charge (ie how your hair is affected by pulling off a wool cap) • Explain why an attractive force results from bringing a charged object near a neutral object (electrostatic induction)	• Provide examples that illustrate the importance of the electric force in everyday life. • Create and predict how the electric force between charged objects varies when the distance between them and/or the magnitude of charges change (use Coulomb's Law). • Draw the redistribution of electric charges on a neutral object when a charged object is brought near.

Competency 10: Electricity – The student will demonstrate how electric current is used to transfer energy and do work.

In other words… Students will build simple series and parallel circuits to investigate the relationships between voltage, current, and resistance.

• Describe how electricity is used to transfer energy and do work. • Describe conditions that create current in an electric circuit • Define power in electric circuits • Define electric current and the ampere • Define resistance, voltage, and current and describe Ohm's Law • Identify complete circuits, open circuits, and short circuits and explain the reasons for the classification.	• Explain how the interaction of electric and magnetic forces is the basis for electric motors, generators, and the production of electromagnetic waves. • Apply Ohm's Law to identify basic characteristics of a circuit • Explain current flow in an electrical circuit. • Explain how circuit breakers and fuses protect household appliances. • Compare the currents, voltages, and power in parallel and series circuits. • Calculate the amount of work done when a charge moves through a potential difference (V). • Explain the difference between electric power and electric energy • Compare the energy used in one day by common household appliances (ie refrigerator, lamps, hair dryer, toaster, televisions, music players)	• Create an electrical device with an on and off switch.

Competency 11: Radioactive Decay (Nuclear Physics) – The student will understand that radioactive decay is the spontaneous transmutation of one nucleus into another with the release of high-energy particles. Nuclear fission and nuclear fusion create new elements and release high-energy particles and massive amounts of radiation.

In other words… Students can discuss important social questions like "Are the risks worth the benefits – of nuclear energy, irradiated foods, radiation medicine, etc." Students can discuss the many scientific trade-offs involved in nuclear power, including waste disposal. Students can learn about careers in the nuclear medicine, power, and research fields. Students can research and discuss historical, political and social perspectives on nuclear warfare, as well as the development of theories of nuclear fission and fusion.

• Describe radioactive decay, how it occurs, and what it produces. • Compare and contrast between nuclear fission and nuclear fusion • Describe peaceful technological applications of nuclear fission and radioactive decay. • Describe possible problems caused by exposure to prolonged radioactive decay. • Identify the source of energy in fission and fusion nuclear reactions.	• Describe the applications of nuclear fission and nuclear fusion on society. • Explain how stars, including our Sun, produce huge amounts of energy (ie visible, infrared, or ultraviolet light)	• Predict the long terms effects of nuclear fission and nuclear fusion in our society.

Competency 12: Mechanical Waves – The student will explain mechanical waves (vibrations in a medium that move from source to receiver, conveying energy).

In other words… Students can use Slinkies to study both transverse and compression waves and interference patterns, changing variables, and predicting results.

• Describe and define mechanical waves in terms of wavelength, amplitude, frequency, and speed. • Describe what is required for a mechanical wave to travel • Describe how mechanical waves transfer energy • Describe how two wave pulses (propagated from opposite ends of a demonstration spring) interact as they meet.	• Summarize the relationships between wavelength, frequency, and speed of a wave. • Compare and contrast transverse and compression (longitudinal) waves in terms of wavelength, amplitude, and frequency. • Explain instances of energy transfer by waves and objects in everyday activities (ie why the ground gets warm during the day, how you hear a distant sound) • Identify everyday examples of transverse and compression (longitudinal) waves. • Calculate the amount of energy transferred by transverse or compression waves of different amplitudes and frequencies (ie seismic waves) • Explain why everyone in a classroom can hear one person speaking, but why an amplification system is often used in the rear of a large concert auditorium. • List and analyze everyday examples that demonstrate the interference characteristics of waves (ie dead spots in an auditorium, whispering galleries, colors in a CD, beetle wings)	• Predict characteristics of a wave you create (wavelength, frequency, and speed) using mathematical relationships. • Demonstrate that frequency and wavelength of a wave are inversely proportional in a given medium.