Macomb Intermediate School District
High School Science Power Standards Document

Physics

The Michigan High School Science Content Expectations establish what every student is expected to know and be able to do by the end of high school. They also outline the parameters for receiving high school credit as dictated by state law.

To aid teachers and administrators in meeting these expectations the Macomb ISD has undertaken the task of identifying those content expectations which can be considered power standards. The critical characteristics[1] for selecting a **power standard** are:

- ***Endurance* –** knowledge and skills of value beyond a single test date.
- ***Leverage* -** knowledge and skills that will be of value in multiple disciplines.
- ***Readiness* -** knowledge and skills necessary for the next level of learning.

The selection of **power standards** is not intended to relieve teachers of the responsibility for teaching all content expectations. Rather, it gives the school district a common focus and acts as a safety net of standards that all students must learn prior to leaving their current level.

The following document utilizes the unit design including the big ideas and real world contexts, as developed in the science companion documents for the Michigan High School Science Content Expectations.

[1] Dr. Douglas Reeves, Center for Performance Assessment

Unit 1: Motion

Big Ideas

The motion of an object may be described using a) motion diagrams, b) data, c) graphs, and d) mathematical functions.

Conceptual Understandings

A comparison can be made of the motion of a person attempting to walk at a constant velocity down a sidewalk to the motion of a person attempting to walk in a straight line with a constant acceleration. These motions can be compared to the motion of a person on a bicycle attempting to maintain a constant velocity or constant acceleration

A qualitative study of the position, velocity and acceleration of an object that is tossed straight up into the air near the surface of the earth can be made. The acceleration of the object will be constant and downward. Students often have the misconceptions that the acceleration is upward during the upward phase of the ball's flight and zero at the top of its flight.

Common examples of relative motion such as the motion observed by a person standing next to a road as a car passes compared to the motion observed by the driver of the car may be used. Also, the motion observed by the driver of a second car which has a different velocity than the first may be discussed.

Power Standards	Additional Standards
P2.1A - Calculate the average speed of an object using the change of position and elapsed time. P2.1B - Represent the velocities for linear and circular motion using motion diagrams (arrows on strobe pictures). P2.1C - Create line graphs using measured values of position and elapsed time. P2.1D - Describe and analyze the motion that a position-time graph represents, given the graph. P2.2A - Distinguish between the variables of distance, displacement, speed, velocity, and acceleration. P2.2B - Use the change of speed and elapsed time to calculate the average acceleration for linear motion. P2.2C - Describe and analyze the motion that a velocity-time graph represents, given the graph.	P2.1g - Solve problems involving average speed and constant acceleration in one dimension. P2.2e - Use the area under a velocity-time graph to calculate the distance traveled and the slope to calculate the acceleration. P2.3a - Describe and compare the motion of an object using different reference frames.

<u>Unit 2:</u> <u>Two Dimensional Motion and Forces</u>

Big Ideas

The motion of an object that moves both horizontally and vertically at the same time can be analyzed with the principles of linear motion and force.

Conceptual Understandings

The use of kinematics equations for motion is extensive in this unit, as problem solving and calculations are required in each expectation. Additionally laboratory exercises with horizontally, vertically and angled projectile launches will allow application of the paper-pencil problem solving.

Sketching the motion of a projectile, teasing out the horizontal and vertical velocity vectors will help visualize the motion. Additionally adding a vector for acceleration is helpful. Velocity vs. time graphs can be completed of for the horizontal and vertical components of the projectile's motion.

Power Standards	Additional Standards
While this unit has value, it did not contain content expectations that met the power standard criteria set by the committee.	P2.2g **–** Apply the independence of the vertical and horizontal initial velocities to solve projectile motion problems. P3.4e **–** Solve problems involving force, mass and acceleration in two dimensional projectile motion restricted to an initial horizontal velocity with no initial vertical velocity (e.g., a ball rolling off a table). P3.2d **–** Calculate all the forces on an object on an inclined plane and describe the object's motion based on the forces using free-body diagrams.

Unit 3: Dynamics

Big Ideas

When two objects interact with each other, by direct contact or at a distance, all three of Newton's Laws describe and explain that interaction.

Conceptual Understandings

When teaching about falling objects, it is useful to compare two different masses (different densities but equal volumes) falling from equal heights in approximately equal times (ignoring air resistance) and to explain how some objects fall more slowly than others when they have substantial air resistance (e.g., parachute).

Describe all the forces (action and reaction) involved in sliding a box across the floor at constant velocity, speeding up, and slowing down.

Discussion of forces should include 2nd Law pairs (forces that add up on a single object that affect its motion) and 3rd Law pairs (action-reaction forces between two objects that act on each other). It is important that these two categories of forces are distinguished as different pairs of forces.

Use examples of frictional forces that act on an object in the direction of the object's motion (traction) and that act on an object opposite the direction of motion (drag).

Examine all three Newton's Laws of Motion as they relate to contact and non-contact scenarios such as two magnets in contact with each other or just near each other.

Power Standards	Additional Standards
P3.1A - Identify the force(s) acting between objects in "direct contact" or at a distance. P3.2A - Identify the magnitude and direction of everyday forces (e.g., wind, tension in ropes, pushes and pulls, weight). P3.2C - Calculate the net force acting on an object. P3.3A - Identify the action and reaction force from examples of forces in everyday situations (e.g., book on a table, walking across the floor, pushing open a door). P3.4A - Predict the change in motion of an object acted on by several forces. P3.4B - Identify forces acting on objects moving with constant velocity (e.g., cars on a highway). P3.4C - Solve problems involving force, mass, and acceleration in linear motion (Newton's second law). P3.6C - Explain how your weight on Earth could be different from your weight on another planet.	P3.1d - Identify the basic forces in everyday interactions.

Unit 4: Momentum

Big Ideas

Interaction between objects produces predictable motion.

The product of mass times velocity is conserved in any interaction.

Conceptual Understandings

Collisions are of two main types elastic and inelastic in which momentum is always conserved. They are differentiated by the conversion of kinetic energy in the inelastic collisions to other types of energy such as heat, sound, deformation (work). In perfectly inelastic collisions the objects stick together and travel as one mass.

The formula used in Newton's Second Law (F=ma) is commonly derived from his original relationship between force, mass and changing velocity during an interaction: FDt mDv. This is commonly referred to in high school textbooks as the impulse given to an object (FDt) that causes a change in the object's momentum (p). Formula for change in momentum (Dp mDv).

There are numerous examples of how time of impact affects the force on an object in sports. For example, "following through" with a swing lengthens the time of impact of the force resulting in a larger change in velocity of a mass and "rolling with the punch" in boxing lessens the force by increasing the time that velocity is changed on the boxer.

Tossing an egg into a sheet or blanket illustrates how force can be minimized by increasing the time factor for the egg, therefore making the acceleration less on the mass. Contrast the throwing of the egg into a sheet with throwing the egg with a similar initial velocity into a brick wall.

Power Standards	Additional Standards
P3.5a - Apply conservation of momentum to solve simple collision problems.	P3.4f - Calculate the changes in velocity of a thrown or hit object during and after the time it is acted on by the force. P3.4g- Explain how the time of impact can affect the net force (e.g., air bags in cars, catching a ball). P3.3b - Predict how the change in velocity of a small mass compares to the change in velocity of a large mass when the objects interact (e.g., collide). P3.3c - Explain the recoil of a projectile launcher in terms of forces and masses. P3.3d - Analyze why seat belts may be more important in autos than in buses.

Unit 5: Periodic Motion

Big Ideas

Periodic motion is the cyclic, repeating motion of an object moving back and forth along a straight line or in a cyclic type of motion.

Conceptual Understandings

Understanding the ideal motion of a simple harmonic oscillator provides a basis for understanding more complex vibratory motion such as the vibration of a piano string, the vibration of the prongs of a tuning fork, the vibration of a tall building during an earthquake, the vibration of a speaker membrane as it produces sound, the oscillation of alternating household current, etc. Understanding this type of periodic motion opens the door to understanding a wide variety of disparate phenomena.

Uniform circular motion occurs all around us. The motion of a merry-go-round, a car taking a curve, the orbit of a planet (most are nearly circular), the turning of a crank shaft, the rotation of a storm cell etc., all require an understanding of the basic ideas of centripetal force and centripetal acceleration. Understanding these concepts allows an understanding of a wide range of phenomena.

The force of gravity changes with the square of the distance between the objects. This means that if the distance between two objects is doubled (multiplied by 2), the force between the objects is one quarter (divided by 22) of its original value. If the distance between two objects is tripled (multiplied by 3), the force between them is one-ninth (divided by 32) its original value.

Power Standards	Additional Standards
P2.1E - Describe and classify various motions in a plane as one dimensional, two dimensional, circular, or periodic. P2.2D - State that uniform circular motion involves acceleration without a change in speed. P3.4D - Identify the force(s) acting on objects moving with uniform circular motion (e.g., a car on a circular track, satellites in orbit).	P2.1F - Distinguish between rotation and revolution and describe and contrast the two speeds of an object like the Earth. P2.1h - Identify the changes in speed and direction in everyday examples of circular (rotation and revolution), periodic, and projectile motions. P2.2f - Describe the relationship between changes in position, velocity, and acceleration during periodic motion. P3.6A - Explain earth-moon interactions (orbital motion) in terms of forces. P3.6B - Predict how the gravitational force between objects changes when the distance between them changes. P3.6d - Calculate force, masses, or distance, given any three of these quantities, by applying the Law of Universal Gravitation, given the value of G. P3.6e - Draw arrows (vectors) to represent how the direction and magnitude of a force changes on an object in an elliptical orbit.

Unit 6: Mechanical Energy

Big Ideas

Doing work on an object requires transferring energy to the object resulting in a change of position and possibly a change in speed.

Conceptual Understandings

Use pendulums, roller coasters, ski lifts to explain PE and KE

Use examples of various forms of PE such as stretched or compressed springs and rubber bands; energy stored in the chemical bonds of food, gasoline and other fuels; objects elevated above the Earth's surface

The amount of work done lifting a box, holding a box over your head, studying for a test are good ways to explain the difference between the scientific meaning and the everyday meaning of the term work.

Discuss the amount of KE and PE present at various points when bungee jumping and sky diving

Compare the KE of a moving car, a bullet fired from a gun and a freight train at rest and then moving at a speed of (for example) 40 m/s.

Power Standards	Additional Standards
P3.2A – Identify the magnitude and direction of everyday forces (e.g., wind, tension in ropes, pushes and pulls, weight) P3.2B – Compare work done in different situations. P4.3A - Identify the form of energy in given situations (e.g., moving objects, stretched springs, rocks on cliffs, energy in food). P4.3B - Describe the transformation between potential and kinetic energy in simple mechanical systems (e.g., pendulums, roller coasters, ski lifts). P4.3C - Explain why all mechanical systems require an external energy source to maintain their motion.	P4.1c - Explain why work has a more precise scientific meaning than the meaning of work in everyday language. P4.1d - Calculate the amount of work done on an object that is moved from one position to another. P4.1e - Using the formula for work, derive a formula for change in potential energy of an object lifted a distance *h*. P4.3d - Rank the amount of kinetic energy from highest to lowest of everyday examples of moving objects. P4.3e - Calculate the changes in kinetic and potential energy in simple mechanical systems (e.g., pendulums, roller coasters, ski lifts) using the formulas for kinetic energy and potential energy. P4.3f - Calculate the impact speed (ignoring air resistance) of an object dropped from a specific height or the maximum height reached by an object (ignoring air resistance), given the initial vertical velocity.

Unit 7: Mechanical Waves

Big Ideas

Mechanical waves are vibrations in a medium that move from source to receiver, conveying energy.

Conceptual Understandings

A demonstration spring or slinky is helpful to study the properties of waves. It is helpful to relate work done to produce the wave to the energy given to the wave. For example, applying a force and moving the spring twice the distance gives more amplitude and therefore more energy to the waves. Changing the frequency and its affect on wavelength can be visualized. Wave interference should be demonstrated with the spring or slinky. A slinky can be used to show both transverse and longitudinal waves, and to show how the speed of a wave changes in a different medium.

Wave tanks or ripple tanks or wave tables can also be used to show the properties of waves. The fishing bobber expectation can be addressed using these tools.

A recent example of wave energy transfer is the Asian Tsunami in the Indian Ocean. Use this as an example of the transfer of energy via waves from deep in the ocean to the coastline of a continent, and how the energy is transferred not the medium. Internet source: A Nova program about the physics of the Asian Tsunami, *Wave That Shook the World*, http://www.pbs.org/wgbh/nova/tsunami/)

Discuss the difference in sound transfer in solids, liquids and gases (transfer of energy by longitudinal waves in different mediums). Discuss the rationale in old western movies in which the "tracker" for the posse uses the ground to tell the location of the "outlaws".

Interference of waves involves additive amplitudes (constructive interference) or subtractive amplitudes (destructive interference). This can be demonstrated easily with a spring or string. It can also be demonstrated with a wave tank, two sound speakers at the same frequency or with laser light through double slits.

A discussion of the direction of particle vibration versus the transfer of energy when describing wave properties is appropriate. For example, the transverse wave particles and the direction of energy flow have a perpendicular relationship and the compression wave has a parallel one.

A discussion of the lack of sound in space due to the absence of a medium to transfer the energy would be appropriate.

Power Standards	Additional Standards
P4.4A - Describe specific mechanical waves (e.g., on a demonstration spring, on the ocean) in terms of wavelength, amplitude, frequency, and speed. P4.4B - Identify everyday examples of transverse and compression (longitudinal) waves. P4.4C - Compare and contrast transverse and compression (longitudinal) waves in terms of wavelength, amplitude, and frequency. P4.5A - Identify everyday examples of energy transfer by waves and their sources.	P4.4d - Demonstrate that frequency and wavelength of a wave are inversely proportional in a given medium. P4.4e - *Calculate* the amount of energy transferred by transverse or compression waves of different amplitudes and frequencies (e.g., seismic waves). P4.8c - Describe how two wave pulses propagated from opposite ends of a demonstration spring interact as they meet. P4.8d – List and analyze everyday examples that demonstrate the interference characteristics of waves (e.g., dead spots in an auditorium, whispering galleries, colors in a CD, beetle wings).

P4.5B - Explain why an object (e.g., fishing bobber) does not move forward as a wave passes under it. P4.5C - Provide evidence to support the claim that sound is energy transferred by a wave, not energy transferred by particles. P4.5D - Explain how waves propagate from vibrating sources and why the intensity decreases with the square of the distance from a point source. P4.5E - 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.	

Unit 8: Electromagnetic Waves

Big Ideas

Electromagnetic waves 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.

Conceptual Understandings

Using recordings of communications between astronauts on the moon and mission control during the Apollo missions, one can identify the delay between transmission and reception and estimate the speed of EM radiation.
Delays can also be detected when a news anchor communicates with a reporter in the field via satellite.

Microwaves can be used for communication (e.g. cell phones). They can also be used to cook food. The microwave frequencies used in microwave ovens are at the resonant frequencies of water molecules. When the water molecules in food absorb this energy their kinetic energy goes up, and the food is warmer.

Melanin and sun block absorb and scatter ultraviolet radiation that can damage the nuclei of skin cells. Avoiding such damage can reduce the risk of some types of skin cancer.

X-rays are a form high frequency EM radiation that comes from the vibration of the inner shell electrons of an atom. Some X-rays may also be emitted by atomic nuclei.

Power Standards	Additional Standards
P4.6A - Identify the different regions on the electromagnetic spectrum and compare them in terms of wavelength, frequency, and energy. P4.6B - Explain why radio waves can travel through space, but sound waves cannot. P4.6C - 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. P4.6D - Explain why we see a distant event before we hear it (e.g., lightning before thunder, exploding fireworks before the boom). P4.9B - Explain how various materials reflect, absorb, or transmit light in different ways. P4.9C - Explain why the image of the Sun appears reddish at sunrise and sunset.	P4.6e - Explain why antennas are needed for radio, television, and cell phone transmission and reception. P4.6f - Explain how radio waves are modified to send information in radio and television programs, radio-control cars, cell phone conversations, and GPS systems. P4.6g - Explain how different electromagnetic signals (e.g., radio station broadcasts or cell phone conversations) can take place without interfering with each other. P4.6h - Explain the relationship between the frequency of an electromagnetic wave and its technological uses. P4.8A - Draw ray diagrams to indicate how light reflects off objects or refracts into transparent media. P4.8B - Predict the path of reflected light from flat, curved, or rough surfaces (e.g., flat and curved mirrors, painted walls, paper). P4.8e - 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).

	P4.8f - Explain how Snell's Law is used to design lenses (e.g., eye glasses, microscopes, telescopes, binoculars). P4.9A - Identify the principle involved when you see a transparent object (e.g., straw, a piece of glass) in a clear liquid.

Unit 9: Electric Forces

Big Ideas

All objects are composed of electrical charges. Certain characteristics of these charges determine the electric and magnetic forces experienced by objects that interact with each other at a distance.

Conceptual Understandings

Many of the Expectations listed in this unit are generally taught using the concepts of electric and magnetic fields. These are useful ways of explaining electric and magnetic forces at a distance. Students are expected to know and use these concepts and terminology.

The ability of a charged object to lift up a tiny piece of paper, demonstrating that between two charged particles, the electric force is larger than Earth's gravitational force

An electrophorus & an electroscope can be used to explain charging by contact & charging by induction.

Using examples of "static cling" such as clothes from the dryer and balloons stuck to a wall is a good way to show the difference in magnitude between gravitational forces and electric forces

Electric motors and generators are good ways to explain how to utilize moving electric charges to produce magnetic forces and how to utilize changing magnetic fields produces electric forces. Both of these principles combined can be used to explain how accelerating electric charges produces electromagnetic disturbances which can be described as EM waves when these disturbances have a regular pattern.

Power Standards	Additional Standards
P3.7A - Predict how the electric force between charged objects varies when the distance between them and/or the magnitude of charges change. P3.7B - Explain why acquiring a large excess static charge (e.g., pulling off a wool cap, touching a Van de Graaff generator, combing) affects your hair.	P3.1b - Explain why scientists can ignore the gravitational force when measuring the net force between two electrons. P3.1c - Provide examples that illustrate the importance of the electric force in everyday life. P3.7c - Draw the redistribution of electric charges on a neutral object when a charged object is brought near. P3.7d - Identify examples of induced static charges. P3.7e - Explain why an attractive force results from bringing a charged object near a neutral object. P3.7f - Determine the new electric force on charged objects after they touch and are then separated. P3.7g - Propose a mechanism based on electric forces to explain current flow in an electric circuit. P3.8b - Explain how the interaction of electric and magnetic forces is the basis for electric motors, generators, and the production of electromagnetic waves.

Unit 10: Electric Current

Big Ideas

Electrical current is used to transfer energy and to do work.

Conceptual Understandings

Typical ways that electrical energy is produced are coal, oil, natural gas, wind, hydroelectric, solar and nuclear. The coal, oil, natural gas and nuclear isotopes are the fuel to heat water, producing steam which drives a turbine (chemical energy to heat energy or nuclear energy to heat energy). The turbine turns a generator which produces the electricity (heat energy to mechanical energy to electrical energy). In the case of hydroelectric energy (falling water), the falling water turns a turbine which runs the generator which produces the electrical energy (potential energy to mechanical energy to electrical energy). Solar energy can be used in homes to produce electricity on a more limited basis (solar lighting or heat). This involves electromagnetic energy to heat and/or electrical energy conversions.

An example of a common device that transforms electrical energy to other forms of energy is a television which produces light, sound and heat energy.
Other devices can be used similarly as illustrations.

Although in a few textbooks it is explained electrons are the mobile charge carriers responsible for electric current in conductors such as wires, it has long been the convention to take the direction of electric current as if it were the positive charges which are moving. Because the vast majority of references use the conventional current direction, that convention will be used for the content expectations dealing with current and direction of current (positive to negative).

Home wiring is an example of parallel circuits and maximum load. Fuses or circuit breakers are used in home wiring to protect against circuit overload. A common example of a series circuit is the flashlight.

Power Standards	Additional Standards
P4.10A - Describe the energy transformations when electrical energy is produced and transferred to homes and businesses. P4.10B - Identify common household devices that transform electrical energy to other forms of energy, and describe the type of energy transformation. P4.10C - Given diagrams of many different possible connections of electric circuit elements, identify complete circuits, open circuits, and short circuits and explain the reasons for the classification. P4.10D - Discriminate between voltage, resistance, and current as they apply to an electric circuit.	P4.10e - Explain energy transfer in a circuit, using an electrical charge model. P4.10f - Calculate the amount of work done when a charge moves through a potential difference, *V*. P4.10g - Compare the currents, voltages, and power in parallel and series circuits. P4.10h - Explain how circuit breakers and fuses protect household appliances. P4.10i - Compare the energy used in one day by common household appliances (e.g., refrigerator, lamps, hair dryer, toaster, televisions, music players). P4.10j - Explain the difference between electric power and electric energy as used in bills from an electric company.

<u>Unit 11:</u> <u>Energy Transformations</u>

Big Ideas

Energy is constantly being transformed from one form to another. During these transformations the total amount of energy must remain constant although some energy is usually "lost" by the system in the form of heat.

Conceptual Understandings

An energy transfer diagram (see example below) can show quantitative and qualitatively how energy is transformed by simple and complex processes.

The engine of a car is an example of a complex device that ultimately changes the chemical energy of gasoline into kinetic energy, heat, sound and light.

When a car is moving at a constant velocity, energy is being transformed into heat by friction and into the motion of air by air resistance.

When a driver presses on the brake pedal, the car's kinetic energy is mostly transformed into thermal energy. This increases the temperature of the brake pads and much of this thermal energy is released to the surroundings as heat because of a temperature difference.

A simple pendulum continually transforms kinetic energy into potential energy and back again.

During a collision between two pool balls, energy leaves the system in the form of sound and heat.

When a body falls, it eventually reaches a steady velocity as gravity transforms some of its stored (potential) energy into kinetic energy. Air resistance transforms some its kinetic energy into the kinetic energy of the air which ultimately becomes heat. Friction with the air also warms the object. This is seen in dramatic terms for a spacecraft reentering the atmosphere.

Roller coasters, pendulum clocks, water waves, sound waves, nuclear reactors, sun's interior, atomic and thermonuclear reactions all represent essential ways energy is transformed from one form to another.

When two liquids of different temperature are combined, the final combination comes to an equilibrium temperature. This temperature is determined by the heat transferred between the two liquids. Heat transfer depends upon the mass, specific heat and initial temperature of the two liquids.

Power Standards	Additional Standards
P4.1A - Account for and represent energy into and out of systems using energy transfer diagrams. P4.2A - Account for and represent energy transfer and transformation in complex processes (interactions). P4.2B - Name devices that transform specific types of energy into other types (e.g., a device that transforms electricity into motion). P4.2C - Explain how energy is conserved in common systems (e.g., light incident on a transparent material, light incident on a leaf, mechanical energy in a collision).	P4.2e - Explain the energy transformation as an object (e.g., skydiver) falls at a steady velocity. P4.2f - Identify and label the energy inputs, transformations, and outputs using qualitative or quantitative representations in simple technological systems (e.g., toaster, motor, hair dryer) to show energy conservation. P4.11b - Calculate the final temperature of two liquids (same or different materials) at the same or different temperatures and masses that are combined

Unit 12: Energy and Society

Big Ideas

Energy takes many forms and is able to be transformed from one form to another.

Conceptual Understandings

Observations of nuclear energy through observations of changes in systems containing radioactive substances, such as:
· Using water to cool down nuclear power plants: observable temp increase in the water
· Radioactive isotopes of elements: emission of alpha, beta, and gamma particles
· Thermonuclear reactions: light and charged particle emission

When teaching about radioactive decay, alpha, beta, and gamma radiation along with the concept of half-life are commonly used terminology. These are useful concepts for understanding the Expectations related to radioactive decay. However, students will not be assessed on these terms in state-wide assessments.

Various uses of nuclear medicine and the benefits/misconceptions associated with irradiated foods are great ways to teach about some of the peaceful uses of radioactive substances.

Other useful applications of nuclear physics include smoke detectors, which have nuclear components and x-ray sources which are used to detect lead paint in buildings and are used at road construction sites to determine if the roadbed is packed tightly enough.

Illnesses and medical conditions caused by exposure to radioactivity (radiation sickness, cancers, birth defects) help students understand some of the safety issues surrounding radioactive substances.

Current issues and technologies related to nuclear fission and nuclear fusion as sources of usable energy should be addressed when teaching these topics

The design and use of hot water heaters (gas, electric, LP) and their efficiencies needs to be included in this unit of instruction

Power Standards	Additional Standards
P4.1B - Explain instances of energy transfer by waves and objects in everyday activities (e.g., why the ground gets warm during the day, how you hear a distant sound, why it hurts when you are hit by a baseball). P4.2D - Explain why all the stored energy in gasoline does not transform to mechanical energy of a vehicle.	P4.11a - Calculate the energy lost to surroundings when water in a home water heater is heated from room temperature to the temperature necessary to use in a dishwasher, given the efficiency of the home hot water heater. P4.12A - Describe peaceful technological applications of nuclear fission and radioactive decay. P4.12B - Describe possible problems caused by exposure to prolonged radioactive decay. P4.12C - Explain how stars, including our Sun, produce huge amounts of energy (e.g., visible, infrared, or ultraviolet light). P4.12d - Identify the source of energy in fission and fusion nuclear reactions.