8th Grade Science & Engineering Learning Expectations
Public Schools of Brookline

Overview

The Science & Engineering Learning Expectations (LEs) outline the content that students will learn and skills (practices) that students will be able to do from preK through Grade 8. They have been designed with careful consideration to how students will build their knowledge from grade to grade (learning progressions). As they progress through the grades, students will reinforce what they have learned before, continually learning certain overarching concepts in new ways and with increased sophistication.

Organization of the Learning Expectations

The Learning Expectations are organized into three strands: 1) Earth Science, 2) Life Science, and 3) Physical Science.

While the traditional Physical Science, Life Science, and Earth Science strands are referenced, it is important to be aware that none of these strands are totally separate. In fact, scientists often work in inter-disciplinary teams, across disciplines and/or alongside engineers to answer their questions and solve problems.

In addition, Science Practices (Inquiry and Nature of Science), Engineering and Environmental Education content has been woven throughout the Learning Expectations, illustrating the vital interconnections between these topics. This approach allows students to learn about these disciplines in the context of the science concepts they are learning, instead of as stand-alone, disconnected units.

Guide to This Document

This document shows the progression of Science concepts in the form of Big Ideas (left column) and Learning Expectations (right column). The Big Ideas identify the content that students will learn and the Learning Expectations illustrate what students will know and be able to do in order demonstrate that they have acquired this knowledge.

8th Grade Earth Science Learning Expectations

EARTH'S SYSTEMS	
Big Ideas	**Learning Expectations**
Weather and Climate • Meteorologists seek to understand the past, present, and future behavior of Earth's atmosphere through scientific observation and reasoning. • Earth has a thin atmosphere that sustains life and continuously interacts with the other components of the Earth System. • Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. • The ocean and land exert major influences on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean and atmospheric circulation. The patterns of differential heating, together with Earth's rotation and the configuration of continents and oceans, control the large-scale patterns of oceanic and atmospheric circulation. • Greenhouse gases in the atmosphere absorb and retain the energy radiated from land and ocean surfaces, thereby regulating Earth's average surface temperature and keeping Earth habitable. • Organisms ranging from bacteria to human beings are a major driver of the global carbon cycle, and they influence global climate by modifying the chemical makeup of the atmosphere. • The complex interactions that shape weather and climate exhibit repeating and measurable patterns. However, weather and climate forecasting is inherently probabilistic given the number and complexity of those interactions. • Large masses of air with certain properties move across the surface of the earth. The movement and interaction of these air masses is used to forecast the weather. • Severe weather events (e.g., hurricanes, floods, forest fires) are often preceded by observable phenomena that allow for reliable predictions. Constant monitoring of weather hazards in a region and the development of an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	• Create a model of Earth's atmosphere. Describe the properties of each layer and explain why it is important for life on Earth. • Describe how heat is transferred from one object to another by conduction, convection, and/or radiation. • Use past and present weather data and maps to construct explanations about how the interactions among solar radiation, water (e.g., the ocean, lakes, wetlands), ice, landforms, and the biosphere influence repeating weather patterns of temperature, precipitation, and air pressure at geographic locations. • Use representations to explain how the patterns of atmospheric and oceanic circulation (e.g., Hadley cells, jet stream, Gulf Stream) impact local climates (e.g., locations of rainforests and deserts). • Using data and maps, construct explanations about how the movements and patterns of atmospheric and oceanic circulation are influenced by latitude, altitude, and local and regional geography. • Read critically about the greenhouse effect and the global carbon cycle in order to construct a representation that tracks the flow and storage of carbon and energy within the atmosphere, hydrosphere, and biosphere. • Collect data about Earth's atmosphere by direct and indirect measurement of temperature, precipitation, wind, pressure and other variables and use the data to formulate a weather forecast. • Evaluate competing student-designed solutions for community responses to severe weather events (e.g., hurricanes, tornadoes, floods) based on patterns of the frequency and magnitude of and resulting damage from these events.
Our Earth	• Describe how Earth receives energy from the Sun and how

• All earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and the earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future.	that energy is distributed and cycled through Earth's systems. • Give evidence showing how the spheres of the Earth system (lithosphere, hydrosphere, atmosphere, and biosphere) interact.
<u>Changing Earth</u> • Greenhouse gases in the atmosphere absorb and retain the energy radiated from land and ocean surfaces, thereby regulating Earth's average surface temperature and keeping Earth habitable. • Organisms ranging from bacteria to human beings are a major driver of the global carbon cycle, and they influence global climate by modifying the chemical makeup of the atmosphere.	• Read critically about the greenhouse effect and the global carbon cycle in order to construct a representation that tracks the flow and storage of carbon and energy within the atmosphere, hydrosphere, and biosphere.
<u>Human Interactions with Earth [Social Studies Connection]</u> • Humans have become one of the most significant agents of change in the near-surface Earth system. Human activities have significantly altered the biosphere, geosphere, hydrosphere and atmosphere. • As human populations and per-capita consumption of natural resources increase, so do the impacts on Earth's systems unless the activities and technologies involved are engineering otherwise. • Continued monitoring of the changes to Earth's surface provides a deeper understanding of the way in which human activities are impacting Earth's systems, providing the basis for social policies and regulations that can reduce these impacts. • Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature ("global warming"). • Reducing the amount of greenhouse gases released into the atmosphere can reduce the degree to which global temperatures will increase. • Renewable energy resources and the technologies to exploit them are being rapidly developed.	• Use system models and representations to explain how human activities significantly impact: 1) the geosphere (e.g., changes in land use, resource development), 2) the hydrosphere (e.g., water pollution, urbanization), the atmosphere (e.g., air pollution of gases, aerosols, particulates), 3) the biosphere (e.g., changes to natural environments), and 4) global temperatures (e.g., through the release of greenhouse gases). • Analyze and graph climate change data over time. Make claims based on this evidence. Compare these findings with the claims of climate change scientists. • Analyze data to determine the carbon footprint of their school and determine what the school community can do to decrease its carbon footprint. • Describe several local changes in animal/plant populations, weather patterns and severity, climate, and other Earth features that may be attributed to climate change. Generate and revise explanations from data for the impacts on Earth's systems that result from increases in human population and rates of consumption. • Design technological and engineering solutions for stabilizing changes to communities by 1) using water efficiently, 2) minimizing human impacts on environments and local landscapes by reducing pollution (e.g., wind turbines), 3) reducing greenhouse gases.

	• Ask questions and define problems about the way continued technological monitoring of Earth's systems can provide the means of informing social policies and regulations that will reduce human impacts on Earth's systems. • Use arguments and empirical evidence to evaluate technologies that responsibly exploit renewable energy resources.

EARTH IN THE UNIVERSE

Big Ideas	Learning Expectations
• Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted and explained with models. • The universe began with a period of extreme and rapid expansion known as the Big Bang. This theory states that our solar system coalesced out of a giant cloud of gas and debris left in the wake of exploding stars about five billion years ago. Everything in and on the earth, including living organisms, is made of this material. • Nearly all observable matter in the universe is hydrogen or helium, which formed in the first minutes after the Big Bang. • Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. • The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. The system appears to have formed from a disk of dust and gas, drawn together by gravity. • Earth is the only planet in the solar system that appears able to support life. The other planets have compositions and conditions very different from the earth's. • The relative position and movements of Earth, the moon, and sun account for day and night, lunar and solar eclipses, the observed moon phases, tides, and seasons. • Earth's spin axis is fixed in direction (in the short-term) but tilted relative to its orbit around the sun; the differential intensity of sunlight on different areas of Earth over the year is a result of that tilt, as are the seasons that result. • A system can be changing but have a stable repeating cycle of changes; such observed regular patterns allow predictions about the system's future (e.g.,	• Create and manipulate models to demonstrate patterns of the motions of celestial bodies in order to explain how and why night and day, seasons, tides, eclipses and lunar phases occur. • Use evidence about the expansion and scale of the universe and the resulting prevalence of hydrogen and helium to support the Big Bang theory. • Use models of the composition, structure and motions of the objects of the solar system to support an explanation of its formation from a protoplanetary disk of dust and gas, driven by gravity. • Illustrate and describe the location of Earth and the solar system with respect to the sizes and structures of the Milky Way galaxy and the Universe. • Develop an argument to support or refute a claim that objects in the solar system may have the necessary conditions to support life. • Use a model of the solar system and Earth's motion (rotation and revolution around the Sun) to explain the apparent motion of stars, constellations and planets. • Use a model of the solar system and the relative positions and motion of the Earth, the Sun and the moon to explain patterns such as day and night, and daily and seasonal changes in the length and direction of shadows. • Use a model of the solar system to explain the pattern of lunar phases in terms of the relative positions of the Sun, Earth and Moon. • Explain the connections between global temperature patterns and the seasons. • Explain the role of gravity in the solar system. • Give examples of the types of technology that astronomers use to gather evidence about the universe. Explain how these tools have changed over time and, in turn, have impacted our ideas.

Earth orbiting the sun). • Increasingly sophisticated technology (e.g., telescopes, space probes) is used to learn about the universe.	

8th Grade Life Science Learning Expectations

Big Ideas	Learning Expectations
Characteristics of Living Things • A close look at the essential conditions for life on Earth can tell us about the possibilities of life on other planets • Scientists study the geological features of other planets/moons and compare them to known geological features on Earth in order to determine the planet/moon's history and the possibility that life may exist or have existed there.	• Research environmental conditions (e.g., temperature, presence of water, atmosphere, sunlight and chemical composition) on other planets/moons and use this evidence to make a claim about whether or not the planet/moon could support life. Explain. • Compare and analyze photos of geological features on another planet/moon with those on Earth. Make claims based on this evidence and discuss how these features may give scientists clues on the potential for life on the planet/moon.

8th Grade Physical Science Learning Expectations

MATTER	
Big Ideas	**Learning Expectations**
Properties of Matter • All things are made of matter and have mass and volume. • All matter (living and nonliving things on Earth) is made from about 100 different atoms (elements), which combine with one another in various ways. • Atoms form molecules that range in size from two to thousands of atoms. Atoms may also be packed together in crystal patterns. • Pure substances are made from a single type of atom or molecule; each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.	• Construct and use models to explain the different ways atoms combine to form new substances of varying complexity. • Design investigations and collect data to provide evidence supporting the claim that one pure substance is different from another substance based on their characteristic properties (e.g., melting and boiling points, density, solubility, reactivity, flammability, phase) . These properties can be used to identify substances. • Analyze and interpret data to communicate the relationship between molecular structure and physical properties (i.e., temperature, thermal energy, the motion of atoms and molecules in various phases). • Give examples to show how the physical characteristics of elements and types of reactions they undergo were used to create the Periodic Table. • Use the Periodic Table as a tool to predict, compare and contrast compounds and elements

• Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). • The change of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. • A substance has characteristic properties such as density, melting point, freezing point and solubility, all of which are independent of the amount of the substance and can be used to identify it. • The idea of atoms explains the conservation of matter: If the number of atoms stays the same no matter how the same atoms are rearranged, then their total mass stays the same.	• Compare and contrast an atom and a molecule. • Explain that a substance (element or compound) is a sample of matter that has a specific chemical composition and definable properties (such as melting point, boiling point, and conductivity), which are independent of the amount of the sample. • Differentiate between mixtures and pure substances (elements and compounds). • Create models to illustrate how molecules behave in gases, liquids, and solids. Explain how these models can be used to describe and predict changes of state that occur due to changes in temperature and pressure.
Chemical Reactions • Substances react chemically in characteristic ways. • In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. • The total number of each type of atom is conserved, and thus the mass does not change. • Stored energy is decreased in some chemical reactions and increased in others. • Some chemical reactions release energy, others capture or store energy.	• Analyze and interpret data to predict and describe the characteristic ways substances react chemically. • Compare and analyze the physical and chemical properties of reacting substances to the properties of new substances produced through chemical reactions to show that new properties have emerged. • Observe and record evidence to show that a chemical change is often accompanied by observable phenomena such as precipitation, gas evolution, change in temperature or change in color. • Develop representations showing how atoms rearrange during chemical reactions to account for the conservation of mass (i.e., the atoms present in the reactants are all present in the products, but the atoms are found in different combinations that result in the formation of different substances). • Plan and carry out investigations to show that in some chemical reactions, energy is released and in others, energy is absorbed (e.g., baking soda reacting with vinegar, calcium chloride reacting with baking soda). • Distinguish between physical and chemical changes. • Gather evidence to show that all chemical changes involve changes in energy.
Energy Transfer: Nuclear Fusion • Nuclear fusion can result in the merging of two nuclei to form a larger one, along with the release of significantly more energy per atom than any chemical process. It occurs only under conditions of extremely high temperature and pressure. Nuclear fusion taking place in the cores of stars provides the energy released (as light) from those stars and produced all of the more massive atoms from primordial hydrogen. Thus the elements found on Earth and throughout the universe (other than hydrogen and most of helium which are primordial) were formed in the stars by this process.	• Provide evidence to show that most of the elements on Earth and throughout the universe were formed in the stars by nuclear fusion.

FORCE & MOTION	
Big Ideas	**Learning Expectations**
• For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction. • The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. • The greater the mass of the object, the greater the force needed to achieve the same change in motion. • For any given object, a larger force causes a larger change in motion. • Forces on an object can also change its shape or orientation. • The motion of an object can be described by its position, direction of motion and speed. All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. • Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. • Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. • Long-range gravitational interactions govern the evolution and maintenance of large-scale systems in space, such as galaxies or the solar system, and determine the patterns of motion within those structures. • Forces that act at a distance (gravitational, electric, and magnetic) involve fields that can be mapped by their effect on a test object (mass, charge, or magnet, respectively). • A stable system is one in which any small change leads to forces that return the system to its prior state (e.g., a weight hanging from a string). • Many systems, both natural and engineered, rely on feedback mechanisms to maintain stability, but they can function only within a limited range of conditions. With no energy inputs, a system starting out in an unstable state will continue to change until it reaches a stable configuration (e.g., sand in an hourglass)	• Measure the mass of an object. Recognize that mass is the amount of matter in an object. Differentiate mass from weight. • Formulate questions that arise from investigating how critical the point of view (i.e., the frame of reference) of an observer and choice of units of size are to communicating the motion and position of an object. • Graphically and mathematically communicating observations and information to represent how an object's position, velocity, and direction of motion are affected by forces acting on the object. • Collect data to investigate and generate reliable evidence supporting Newton's Third Law which states that when two objects interact they exert equal and opposite forces on each other. • Plan and carry out investigations to identify the proportional relationship between the acceleration of an object and the force applied upon the object and the inversely proportional relationship to its mass. • Use mathematical and computational thinking to describe the effect forces have on an object's shape, velocity, orientation, and direction of motion. • Analyze and interpret data to determine the cause and effect relationship between the motion of an object and the sum of the forces acting upon it, and if the forces are unbalanced. • Plan and carry out investigations (e.g., observing the force produced between two charged objects at different distances, measuring the magnetic force produced by an electromagnet with a varying number of wire turns) to determine the factors that affect the strength of electric or magnetic (electromagnet) forces. • Modify a model or use various representations to determine the relationship among gravitational force, the mass of the interacting objects, and the distance between them. • Plan and carry out investigations in order to demonstrate that some forces act at a distance through fields (i.e., gravitational, electric, magnetic). • Examine given data to develop a simple mathematical model that represents the relationship of gravitational interactions and the motion of objects within the solar system (e.g., what happens when you

	change the length of a string attached to an object). • Develop or modify virtual or real world models to demonstrate that systems can withstand small changes, relying on feedback mechanisms to maintain stability (e.g., rollercoasters, Rube Goldberg machines).
ENERGY	
Big Ideas	**Learning Expectations**
Forms of Energy • Energy appears in different forms (kinetic, thermal, gravitational, elastic, chemical, electrical, light, sound. • Motion energy is properly called kinetic energy. It is proportional to the mass of the moving object and grows with the square of its speed. • A system of objects may also contain stored (potential) energy, depending on their relative positions. For example, energy is stored—in gravitational interaction with Earth—when an object is raised, and energy is released when the object falls or is lowered. Energy is also stored in the electric fields between charged particles and the magnetic fields between magnets, and it changes when these objects are moved relative to one another. • Stored energy is decreased in some chemical reactions and increased in others. • The term "heat" as used in everyday language refers both to thermal motion (the motion of atoms or molecules within a substance) and radiation (particularly infrared and light). • Temperature is not a measure of energy; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.	• Identify the basic types of energy and relate each to their observable properties. • Analyze and interpret data to explain that the kinetic energy of an object is proportional to the mass of a moving object and grows with the square of its speed. • Use qualitative representations of potential energy to analyze how much energy an object has when it's in different positions in a(n) electrical, gravitational, and magnetic field (e.g., roller coaster cart at varying positions on a hill, objects at varying heights on shelves, iron nail with magnet being moved closer together, a balloon with static electrical charge being brought closer to a classmate's hair). • Differentiate between stored (potential) energy and motion (kinetic) energy. Identify situations where energy of motion is transformed into stored energy and vice versa. • Collect, graph and analyze data to describe different variables (including mass, velocity) associated with motion energy. Make claims based on this evidence and share with others. • Design and manipulate a model to determine the effect on the temperature of different substances when thermal energy is added or removed. • Construct an argument to make claims about the effect of adding or removing thermal energy to a substance in various phases and during a phase change.
Forms of Energy: Light • The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. Lenses and prisms are applications of this effect. • When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. • A wave model of light is useful for explaining brightness, color, and the	• Plan and carry out investigations using lenses and prisms to demonstrate that light travels in straight lines except at surfaces between two different transparent materials. • Recognize patterns in data to demonstrate that certain properties of light (e.g., brightness, color, the bending of light in a prism) can be explained using a wave model. • Explain and illustrate based on first-hand evidence how light can be reflected, refracted and absorbed depending on the object's material and

frequency-dependent bending of light at a surface between media (prisms). However, because light can travel through space, it cannot be a matter wave, like sound or water waves.	the color of the light. Explain what is happening.
Energy Transfer • Energy is neither created nor destroyed, but can transformed from one form to another. • Energy can be transferred from one system to another (or from a system to its environment) in different ways: 1) thermally, when a warmer object is in contact with a cooler one; 2) mechanically, when two objects push or pull on each other over a distance; 3) electrically, when an electrical source such as a battery or generator is connected in a complete circuit to an electrical device; or 4) by electromagnetic waves. • When the motion energy of an object changes, there is inevitably some other change in energy at the same time. For example, the friction that causes a moving object to stop also results in an increase in the thermal energy in both surfaces; eventually heat energy is transferred to the surrounding environment as the surfaces cool. Similarly, to make an object start moving or to keep it moving when friction forces transfer energy away from it, energy must be provided from, say, chemical (e.g., burning fuel) or electrical (e.g., an electric motor and battery) processes. • Temperature is not a measure of energy; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. • The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. • Energy is transferred out of hotter regions or objects and into colder ones by the processes of conduction, convection, and radiation. • Machines can be made more efficient, that is, require less fuel input to perform a given task, by reducing friction between their moving parts and through aerodynamic design. Friction increases energy transfer to the surrounding environment by heating the affected materials.	• Create models or representations to communicate the means by which thermal energy is transferred during conduction, convection, and radiation (e.g., a diagram depicting thermal energy transfer through a pan to its handle, warmer water in the pan rises as cooler water sinks, model using a heat lamp for the sun and a globe for the earth) Describe how these processes are important in the Earth's system. • Present examples of how heat transfers in predictable ways, moving from warmer objects to cooler ones. • Provide evidence to show that the relationship between the temperatures and the total energy of a system depends on the types, states, and amounts of matter present and the environment (e.g., comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature). • Design a device or process that maximizes or minimizes thermal energy transfer and defend the selection of materials chosen to construct the device. • Plan and carry out investigations to examine energy transfer in moving objects due to friction and the conversion of motion energy to heat (e.g., rubbing hands together) and explain why energy must be added to moving objects to keep them in motion when they experience friction. • Define functional problems about energy dissipation in everyday machines (e.g., skateboard, bicycle, lawnmower, skis, toy car) and design and evaluate solutions that minimize friction and energy dissipation in machines (e.g., use of oil as a lubricant on a skateboard, bicycle, or in a lawnmower engine, wax on skis). • Identify and evaluate various technological devices (e.g., thermos, car brakes, solar water heaters) that are based on an understanding of the transfer of energy.
Energy Transfer: Moving Objects & Gravity • When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. For example, when energy is transferred to an Earth object system as an object is raised, gravitational field energy of the system increases. This energy is released as the object falls; the mechanism of this release is the gravitational force. Likewise,	• Gather evidence to support an explanation for the transfer of energy caused by the interaction of forces between two objects (e.g., between a bat hitting a ball and a ball hitting a bat, between a person with static electrical charge and a metal doorknob). • Explain, using examples, how when two objects interact, each one exerts a force on the other and these forces can transfer energy between them.

two magnetic and electrically charged objects interacting at a distance exert forces on each other that can transfer energy between the interacting objects.	• Demonstrate that magnetic and electrical forces between two objects at a distance can transfer energy between the interacting objects.
Energy Transfer: Waves • A simple wave has a repeating pattern with a specific wavelength, frequency and amplitude. • A sound wave needs a medium through which it is transmitted. • Appropriately designed technologies (e.g., radio, television, cell phones, wired and wireless computer networks) make it possible to detect and interpret many types of signals that cannot be sensed directly. Designers of such devices must understand both the signal and its interactions with matter. • Many modern communication devices use digitized signals (sent as wave pulses) as a more reliable way to encode and transmit information. • A system can be changing but have a stable repeating cycle of changes; such observed regular patterns allow predictions about the system's future.	• Use a model of the properties of a simple wave (e.g., frequency, wavelength, amplitude) to predict the energy transferred by a wave (e.g., seismic waves of different amplitudes). • Plan and carry out investigations (physical and/or virtual) of sound traveling through various types of mediums [and lack of medium (vacuum)] to demonstrate that a medium is necessary for the transfer of sound waves. • Evaluate the claim that waves are reflected, absorbed or transmitted through an object, dependent upon the material the object is made from the and frequency of the wave. • Apply scientific knowledge to explain the application of waves in common communication designs (e.g., cell phones, radio, remote controls, Bluetooth).
Energy Transfer: Wind Turbines [Engineering Connection] • The Engineering Design Process can be used to solve a variety of problems, including those that affect the environment. • Wind is moving matter and therefore contains energy that can be harnessed. • Generation of electricity using wind power is one option for reducing the impact of humans on Earth's resources. • Maximizing energy is a critical concept in generating electrical power. • Many variables determine the output of a wind turbine. • Although energy is conserved, it can change form and be harnessed for use. • The fields of Science and Engineering, although different in some ways, are closely interconnected. • Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. In order to design better technologies, new science may need to be explored (e.g., materials research prompted by desire for better batteries or solar cells, biological questions raised by medical problems). Technologies in turn extend the measurement, exploration, modeling, and computational capacity of scientific investigations.	• Explain how electricity is generated and power is measured. • Evaluate the effect of variables on a wind turbine built using the Engineering Design Process. • Identify evidence of lift and drag forces interacting in the wind turbine system. • Demonstrate and explain how a wind turbine convert's the wind's mechanical energy into electricity. • Evaluate the use of wind power as a source of energy for meeting our energy needs in a more sustainable way (i.e., reducing our ecological footprint).