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Correlated to:
Delaware Science Standards and Grade Level Expectations – Standards 1 and 3
(Grades 9-12)

DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
SCIENCE STANDARD 1	
Nature and Application of Science and Technology - Science is a human endeavor involving knowledge learned through inquiring about the natural world. Scientific claims are evaluated and knowledge changes as a result of using the abilities and understandings of inquiry. The pursuit of scientific knowledge is a continuous process involving diverse people throughout history. The practice of science and the development of technology are critical pursuits of our society.	
Strand - Understandings and Abilities of Scientific Inquiry	
- Enduring Understanding: Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying the explanation.	
- Essential Questions: What makes a question scientific? What constitutes evidence? When do you know you have enough evidence? Why is it necessary to justify and communicate an explanation?	
Grades 9-12	
1. Understand that: Scientists conduct investigations for a variety of reasons including to explore new phenomena, to replicate other's results, to test how well a theory predicts, to develop new products, and to compare theories.	SE/TE: 1-7
- Be able to: Identify and form questions that generate a specific testable hypothesis that guide the design and breadth of the scientific investigation.	*Opportunities to address this standard are found throughout the activities in the Lab Manual and the Discover! activities in the text.*
2. Understand that: Science is distinguished from other ways of knowing by the use of empirical observations, experimental evidence, logical arguments and healthy skepticism.	SE/TE: 2-4
- Be able to: Design and conduct valid scientific investigations to control all but the testable variable in order to test a specific hypothesis.	*Opportunities to address this standard are found throughout the activities in the Lab Manual and the Discover! activities in the text.*

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3. Understand that: Theories in science are well-established explanations of natural phenomena that are supported by many confirmed observations and verified hypotheses. The application of theories allows people to make reasonable predictions. Theories may be amended to become more complete with the introduction of new evidence.	SE/TE: 2-3
- Be able to: Collect accurate and precise data through the selection and use of tools and technologies appropriate to the investigations. Display and organize data through the use of tables, diagrams, graphs, and other organizers that allow analysis and comparison with known information and allow for replication of results.	*Opportunities to address this standard are found throughout the activities in the Lab Manual and the Discover! activities in the text.*
4. Understand that: Investigating most real-world problems requires building upon previous scientific findings and cooperation among individuals with knowledge and expertise from a variety of scientific fields. The results of scientific studies are considered valid when subjected to critical review where contradictions are resolved and the explanation is confirmed.	SE/TE: 2-7
- Be able to: Construct logical scientific explanations and present arguments which defend proposed explanations through the use of closely examined evidence.	*Opportunities to address this standard are found throughout the activities in the Lab Manual and the Discover! activities in the text.*
5. Understand that: In communicating and defending the results of scientific inquiry, arguments must be logical and demonstrate connections between natural phenomena, investigations, and the historical body of scientific knowledge. (American Association for the Advancement of Science, 2001)	SE/TE: 2-7
- Be able to: Communicate and defend the results of scientific investigations using logical arguments and connections with the known body of scientific information.	*Opportunities to address this standard are found throughout the activities in the Lab Manual and the Discover! activities in the text.*

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DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
6. Understand that: Knowledge and skill from sources other than science are essential to scientific inquiry. These include mathematics, reading, writing, and technology.	SE/TE: 1-7
- Be able to: Use mathematics, reading, writing and technology when conducting scientific inquiries.	*Opportunities to address this standard are found throughout the activities in the Lab Manual and the Discover! activities in the text.*
Strand - Science, Technology, and Society	
- Enduring Understanding: The development of technology and advancement in science influence and drive each other forward.	
- Essential Question: How do science and technology influence each other?	
Grades 9-12	
1. The pursuit of science can generate the need for advanced technology. Advanced technology, in turn, can provide the opportunity to pursue new scientific knowledge.	SE/TE: 5-7
2. The social, economic, and political forces of a society have a significant influence on what science and technology programs are pursued, funded, and implemented.	*The opportunity to address this standard is found on the following pages:* SE/TE: 5-7

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DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
Strand - History and Context of Science	
- Enduring Understanding: Understanding past processes and contributions is essential in building scientific knowledge.	
- Essential Question: How have past scientific contributions influenced current scientific understanding of the world? What do we mean in science when we say that we stand on the shoulders of giants?	
Grades 9-12	
1. New disciplines of science emerge as older disciplines interface into an integrated study of the natural world. As the body of scientific knowledge grows, the boundaries between individual disciplines diminish.	SE/TE: 1-7
SCIENCE STANDARD 3	
Energy and Its Effects - The flow of energy drives processes of change in all biological, chemical, physical, and geological systems. Energy stored in a variety of sources can be transformed into other energy forms, which influence many facets of our daily lives. The forms of energy involved and the properties of the materials involved influence the nature of the energy transformations and the mechanisms by which energy is transferred. The conservation of energy is a law that can be used to analyze and build understandings of diverse physical and biological systems.	
Strand - The Forms and Sources of Energy	
- Enduring Understanding: Energy takes many forms. These forms can be grouped into types of energy that are associated with the motion of mass (kinetic energy), and types of energy associated with the position of mass and with energy fields (potential energy).	
- Essential Question: How do we know that things have energy?	
Grades 9-12	
1. Electromagnetic waves carry a single form of energy called electromagnetic (radiant) energy.	SE/TE: 436, 493, 536, 753-756

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DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
2. An object has kinetic energy because of its linear motion, rotational motion, or both. The kinetic energy of an object can be determined knowing its mass and speed. The object's geometry also needs to be known to determine its rotational kinetic energy. An object can have potential energy when under the influence of gravity, elastic forces or electric forces and its potential energy can be determined from its position.	SE/TE: 148-154
3. Mechanical waves result from the organized vibrations of molecules in substances. Kinetic energy can be transferred very quickly over large distances by mechanical waves.	SE/TE: 490, 491-497
4. Thermal (heat) energy is associated with the random kinetic energy of the molecules of a substance.	SE/TE: 406, 408-409, 411-414
5. Magnetic energy and electrical energy are different aspects of a single electromagnetic energy, which results from the motion of electrical charges.	SE/TE: 645-657, 665-674, 721-733, 741-756
6. Chemical energy is derived from the making and breaking of chemical bonds.	SE/TE: 148
7. Nuclear energy is a form of potential energy that is released when a portion of the mass of the nucleus is converted to energy through nuclear fusion, nuclear fission, or radioactive decay.	SE/TE: 808-824
Building upon the K-8 expectations, all students in Grade 9 will be able to:	
- Recognize that electromagnetic energy (radiant energy) is carried by electromagnetic waves.	SE/TE: 436, 493, 536, 753-756

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DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
- Use diagrams to illustrate the similarities shared by all electromagnetic waves and differences between them. Show how wavelength is used to distinguish the different groups of EM waves (radio waves, microwaves, IR, visible and UV waves, X-rays, and gamma waves).	SE/TE: 536
- Conduct investigations involving moving objects to examine the influence that the mass and the speed have on the kinetic energy of the object. Collect and graph data that supports that the kinetic energy depends linearly upon the mass, but nonlinearly upon the speed. Recognize that the kinetic energy of an object depends on the square of its speed, and that KE =½ mv2.	*The opportunity to address this standard is found in the activities in the lab manual and on the following pages:* SE/TE: 150
- Collect and graph data that shows that the potential energy of an object increases linearly with the weight of an object (mg) and with its height above a pre-defined reference level, h. (GPE = mgh).	*The opportunity to address this standard is found in the activities in the lab manual and on the following pages:* SE/TE: 148-149
- Conduct investigations and graph data that indicate that the energy stored in a stretched elastic material increases nonlinearly with the extent to which the material was stretched.	*The opportunity to address this standard is found in the activities in the lab manual and on the following pages:* SE/TE: 348-349
- Recognize that the energy stored in a stretched elastic material is proportional to the square of the stretch of the material, and a constant that reflects the elasticity of the material. (Elastic PE = ½ kx2)	*The opportunity to address this standard is found on the following pages:* SE/TE: 348-349
- Explain that heat energy represents the total random kinetic energy of molecules of a substance.	SE/TE: 408-422, 451
- Recognize that chemical energy is the energy stored in the bonding of atoms and molecules.	SE/TE: 148

DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
- Describe the differences between nuclear energy and chemical energy, that chemical energy is derived from the energy of the electrons that move around the nucleus, while nuclear energy is associated with the protons and neutrons in the nucleus.	SE/TE: 148, 305-306, 333, 783-787, 809, 821-822
Building upon the K-10 expectations, all students in Grade 11 will be able to:	
- Conduct investigations to identify how the rotational kinetic energy of an object depends on the object's mass, angular speed (rpm), and its geometry (for example; solid and hollow spheres, solid and hollow cylinders, rings).	*The opportunity to address this standard is found in the activities in the lab manual and on the following pages:* SE/TE: 171-174, 188-204, 216-217
- Conduct investigations to show that rolling objects have two kinds of kinetic energy, linear kinetic energy (LKE), and rotational kinetic energy (RKE). For example, a ball released on a ramp from a height, h, will consistently reach the bottom of the ramp with less linear kinetic energy than its GPE at the top of the ramp. The RKE of the rolling object explains the difference.	*The opportunity to address this standard is found in the activities in the lab manual and on the following pages:* SE/TE: 172-174
- Explain that when a chemical reaction takes place and energy is released, the reaction results in molecules that have a lower chemical energy and if energy must be added for a chemical reaction to take place, the molecules that result from that reaction have higher chemical energy.	*The opportunity to address this standard is found on the following pages:* SE/TE: 148, 331, 305-306
- Recognize that nuclear energy takes the form of mass, and that energy is released from a nuclear reaction as a consequence of the annihilation of mass.	SE/TE: 306-307, 809-817
- Explain why large amounts of energy are released when small amounts of mass are annihilated (E = mc2).	SE/TE: 305-306, 817

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Building upon the K-11 expectations, all students in Grade 12 will be able to:	
- Explain that the quantity of radiant energy delivered to a surface every second can be viewed in two different ways. Use the concept of waves to describe that the energy delivered by electromagnetic radiation depends on the amplitude and frequency of the electromagnetic waves. Use the particle model of electromagnetic radiation (energy is carried by packets of electromagnetic energy called photons) to explain that the radiant energy delivered depends on the frequency of the radiation and the number of packets striking the surface per second.	SE/TE: 436-438, 492-493, 533, 536
Strand - Forces and the Transfer of Energy	
- Enduring Understanding: Changes take place because of the transfer of energy. Energy is transferred to matter through the action of forces. Different forces are responsible for the transfer of the different forms of energy.	
- Essential Question: How can energy be transferred from one material to another? What happens to a material when energy is transferred to it?	
Grades 9-12	
1. Forces change the motion of objects. Newton's Laws can be used to predict these changes.	SE/TE: 13-22, 33-39, 87-97, 108-116
2. Forces are mechanisms that can transfer energy from one object to another. A force acting on an object and moving it through a distance does work on that object and changes its kinetic energy, potential energy, or both. Power indicates the rate at which forces transfer energy to an object or away from it.	SE/TE: 145-152, 155-163

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DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
3. The momentum of an object can be determined from the object's velocity and it's mass. An impulse represents how much the momentum of an object changes when a force acts on it. The impulse can be used to estimate the size of the force acting on the object.	SE/TE: 125-130
4. The Law of Conservation of Momentum can be used to predict the outcomes of collisions between objects and can aid in understanding the energy transfers and energy transformations in these collisions.	SE/TE: 130-134
5. Gravity is a universal force of attraction that each mass exerts on any other mass. The strength of the force depends on the masses of the objects and the distance between them. The force of gravity is generally not important unless at least one of the two masses involved is huge (a star, the Earth or another planet or a moon).	SE/TE: 93, 233-254
6. Electric forces between charged objects are attractive or repulsive. The electric forces between electrons and protons are attractive, determine the structure of atoms, and are involved in all chemical reactions. The electromagnetic forces acting between atoms or molecules are much stronger than the gravitational forces between the same atoms or molecules and are responsible for many common forces such as friction, tensions and supporting forces.	SE/TE: 330-335, 645-647, 774-776
7. Electromagnetic forces are responsible for the physical properties of materials (e.g., the boiling point of a liquid) and the mechanical properties of materials (e.g., surface tension).	*The opportunity to address this standard is found on the following pages:* SE/TE: 238

DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
8. Electric currents create magnetic fields, and changing magnetic fields induce electric currents. The electric and magnetic forces that result from this interaction are the basis for electric motors, electric generators, and other modern technologies.	SE/TE: 726-731, 743-746
9. The nuclear forces that hold the nucleus of an atom together are much stronger than the repulsive electric forces acting between the protons that would make the nucleus fly apart, therefore, most atoms have stable nuclei.	SE/TE: 332-333, 645-650
Building upon the K-8 expectations, all students in Grade 9 will be able to:	
- Recognize that electromagnetic waves transfer energy from one charged particle to another. Use graphics or computer animations to illustrate this transfer process. Give everyday examples of how society uses these transfer processes (for example, communication devices such as radios and cell phones).	SE/TE: 275, 436, 493-494, 536, 753
- Use diagrams to illustrate how the motion of molecules when a mechanical wave passes through the substance is different from the motion associated with their random kinetic energies.	SE/TE: 493-494
- Use diagrams or models to explain how mechanical waves can transport energy without transporting matter.	SE/TE: 493-494
- Reflect on why mechanical waves will pass through some states of matter better than others.	SE/TE: 515-517, 537-543
- Recognize that the gravitational force is a universal force of attraction that acts between masses, but this force is only significant when one (or both) of the objects is massive (for example, a star, planet or moon).	SE/TE: 37, 233, 237-231, 244-246, 649

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DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
- Explain that as objects move away from the surface of a planet or moon, the gravitational pull on the object will decrease.	SE/TE: 238-244
- Use examples to illustrate that near the surface of a planet or moon, the gravitational force acting on an object remains nearly constant.	SE/TE: 240-243
- Recognize that on Earth, the object would have to be moved several hundred miles above the surface before the decrease in the force of gravity would become detectable.	SE/TE: 237-245
- Explain the difference between the mass of an object and its weight. Identify that near the surface of the Earth, the gravitational force acting on the object (its weight) depends only on its mass, and that this force can be simply calculated from knowledge of the mass (FG = mg).	SE/TE: 36-37, 93
- Conduct investigations to determine the behavior of elastic materials. Graph the data and identify the relationship between the extent of the stretch and the size of the elastic force (i.e., Felastic = kx where x = stretch).	*The opportunity to address this standard is found in the activities in the lab manual and on the following pages:* SE/TE: 348-349
- Describe the role that forces play when energy is transferred between interacting objects and explain how the amount of energy transferred can be calculated from measurable quantities.	SE/TE: 145-152, 155-163
- Give examples of common forces transferring energy to (or away from) objects. For example; a pulling force can transfer energy to an object (when the object is pulled along a floor), a pushing force can transfer energy away from an object (to slow its motion), and friction and air resistance always transfer kinetic energy away from moving objects.	SE/TE: 13-22, 33-39, 47-60, 68-79, 86-97, 107-116, 125-136, 145-152, 155-163

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DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
- Identify that "work" is the process by which a force transfers energy to an object, and use measured quantities to make calculations of the work done by forces (W = energy transferred = F·D).	SE/TE: 145-152, 155-163
- Conduct investigations to determine what factors influence whether a force transfers energy to an object or away from the object, and how the direction of the force (relative to the direction of motion) influences the quantity of energy transferred by the force.	*The opportunity to address this standard is found in the activities in the lab manual and on the following pages:* SE/TE: 109, 124, 132, 144, 147
- Recognize that power is a quantity that tells us how quickly energy is transferred to an object or transferred away from the object. Give examples that illustrate the differences between power, force and energy (for example, the energy needed to propel a vehicle is stored in the chemical energy of the fuel. Static friction is the force that propels the vehicle, and the power of the vehicle's engine helps to determine how quickly the vehicle can speed up …. and how quickly its engine uses fuel!).	SE/TE: 146-165
- Use models and diagrams to illustrate the structure of the atom. Include information regarding the distribution of electric charge and mass in the atom. Identify the forces that are responsible for the stability of the atom, and which parts of the atom exert and feel these forces.	SE/TE: 327-335, 345, 645-650, 767-776
- Recognize that there are attractive forces acting within the nucleus that are different from electric forces, and that these forces are responsible for the stability of the nucleus.	SE/TE: 331-335, 645-646, 774-775

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Building upon the K-10 expectations, all students in Grade 11 will be able to:	
- Use the inverse square law to describe how the force of gravity changes over long distances (for example, describe the forces acting on the Voyager Space Probes as they moved through the solar system).	SE/TE: 240-244
- Conduct investigations to determine the relative sizes of static and kinetic frictional forces acting between two surfaces.	*The opportunity to address this standard is found throughout the activities in the lab manual.*
- Conduct investigations to determine what variables (mass, normal force, surface area, surface texture, etc.) influence the size of frictional forces that act between two objects.	*The opportunity to address this standard is found throughout the activities in the lab manual.*
- Give examples in which static friction is a force of propulsion, initiating the motion of an object. Use force diagrams to illustrate the forces acting on the object during this propulsion process.	*The opportunity to address this standard is found on the following pages:* SE/TE: 18-22, 33-34
- Use force diagrams to describe how static friction can prevent an object (that is subject to another force) from moving.	*The opportunity to address this standard is found on the following pages:* SE/TE: 18-22
- Draw force diagrams to illustrate the action of friction when it acts to slow-down an object. Use an energy argument to describe how friction slows down a moving object.	SE/TE: 18, 30-32, 90-91
- Describe the factors that contribute to the size of an electric force acting between charged particles (i.e., the size of an electric force depends upon the size of the charges involved and the distance between the charges). Recognize that the electric force is an inverse square force like the gravitational force.	SE/TE: 240-241, 333, 645-657
- Use a sketch of this force to describe how its influence changes as the distance between the charges increases.	SE/TE: 648-650

DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
- Recognize that the gravitational forces acting between objects the size of people or even large trucks is negligible compared to their weight (for example, FGrav acting between two people standing 1m apart on the Earth's surface is less than one billionth the size of their weight). Also recognize that gravitational forces between particles at the molecular level are completely negligible when compared to electric forces that act between these particles (FGrav/Felectric<10-30).	SE/TE: 237-239, 330, 333
- Describe how many of the forces acting between objects (friction and normal forces) and acting within objects (tensions, compressions and elastic forces) are manifestations of the electromagnetic forces that act between atoms and molecules in substances.	*The opportunity to address this standard is found on the following pages:* SE/TE: 13-22, 30, 90-91, 348-352, 652-657
- Use diagrams or models to show how the electric forces acting between molecules can explain the presence of these forces.	*The opportunity to address this standard is found on the following pages:* SE/TE: 330
- Use diagrams to show the similarities between the magnetic field of a permanent magnet and the magnetic field created by an electric coil.	*The opportunity to address this standard is found on the following pages:* SE/TE: 721-732
- Conduct investigations to show how forces acting between permanent magnets and conducting coils carrying electric currents can be used to create electric motors.	*The opportunity to address this standard is found throughout the activities in the lab manual.*
- Use diagrams to show how magnets and rotating coils can be used to create electric currents.	SE/TE: 726-731
- Use vector diagrams to illustrate the forces that act within the nucleus. Recognize that the stability of a nucleus depends upon the repulsive electric forces acting between the protons and the attractive nuclear forces acting between all protons and neutrons in the nucleus.	*The opportunity to address this standard is found on the following pages:* SE/TE: 327-335, 345, 645-650, 767-776, 783-784

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DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
- Use examples of mechanical or chemical systems to explain that the stability of an object is linked to the object's energy, and that stability can be used as an indicator how likely it is that an object will undergo a physical, chemical, or nuclear change.	*The opportunity to address this standard is found on the following pages:* SE/TE: 145-163303-316, 345-356, 363-374, 383-395
- Identify mid-sized nuclei as the most stable nuclei, and use the concept of stability to explain the basics of nuclear fission, fusion, and radioactive decay. Use models and diagrams to illustrate the differences between fission, fusion and radioactive decay.	SE/TE: 774-775, 783-799, 809-812, 821-824
- Use vector diagrams to illustrate how the total force is determined from a group of individual forces.	SE/TE: 13-22
- Make vector diagrams of objects moving with a constant velocity, identifying all of the forces acting on the object (for example, a car moving along a straight highway, an aircraft in flight, an elevator ascending at constant speed, etc.).	*The opportunity to address this standard is found on the following pages:* SE/TE: 50, 70-79
- Reflect on how forces can collectively act on the object and not change its motion (basis of Newton's 1st Law).	SE/TE: 29-39
- Conduct investigations to reach qualitative and quantitative conclusions regarding the effects of the size of the total force and the object's mass on its resulting acceleration (Newton's 2nd Law, a = Ftotat/m). Observe how the direction of the acceleration relates to the direction of the total force.	SE/TE: 87-97
- Use examples to illustrate the differences between mass and force and explain why only forces can change the motion of objects.	SE/TE: 13-22, 36-39
- Explain why an object with a large mass is usually more difficult to start moving than an object with a smaller mass.	SE/TE: 36-38

DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
- Use Newton's Second Law to calculate the acceleration of objects that are subject to common forces (for example, gravity, constant pushing or pulling forces and/or friction).	SE/TE: 87-97
- Use vector diagrams to show how the direction of the acceleration (relative to the direction of the velocity) can be used to determine if the speed of the object will increase or decrease, and if the direction of motion will change.	*The opportunity to address this standard is found on the following pages:* SE/TE: 51-60, 69-79
- Describe what the size of the acceleration of an object indicates about the object's motion (how quickly the object's velocity will change). Give examples of objects having large accelerations (motorcycles starting from rest, vehicles stopping abruptly, cars negotiating sharp curves), and objects having small accelerations (tractor trailers starting from rest, large ships slowing down, and vehicles traveling on long gradual curves on highways).	SE/TE: 87, 110-111
- Conduct investigations to show that the acceleration due to gravity is the same for all objects near the surface of the earth. Use graphical analysis to determine the acceleration due to gravity from experimental data.	*The opportunity to address this standard is found throughout the activities in the lab manual.*
- Use algebraic relationships that relate the acceleration of an object to its speed and position to make predictions about the motion of objects as they move along straight and circular paths.	SE/TE: 51-52, 93-97, 171-180
- Conduct investigations (or demonstrate) that under a variety of conditions when two objects collide they exert equal sized forces on each other. Use Newton's 2nd Law to explain why these two objects may react differently to equal sized forces.	*The opportunity to address this standard is found throughout the activities in the lab manual and the following pages:* SE/TE: 88-97

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- Use vector diagrams and Newton's 3rd Law to explain how a bathroom scale indirectly indicates your weight.	*The opportunity to address this standard is found on the following pages:* SE/TE: 108-111
- Recognize that momentum of an object is a property of its motion that can be calculated from its mass and its velocity ($P = mv$), and that only forces can change the momentum of an object.	SE/TE: 124-136
- Conduct investigations to determine the relationship between the force acting on an object and the change it produces in the object's momentum (i.e., the impulse) ($\Delta P = F_{avg} \cdot \Delta t$).	*The opportunity to address this standard is found in the activities in the lab manual and the following pages:* SE/TE: 124-136
- Use the concept of impulse ($I = F_{avg} \cdot \Delta t$) to make estimates of average forces when the change in an object's momentum is known. For example, explain why collision forces will be reduced when the barriers are flexible (increasing Δt decreases F_{avg}), or how the severity of the injury to a falling athlete will be influenced by the surface the athlete lands on (i.e., turf, hard ground, concrete, etc.).	SE/TE: 125-136
- Recognize that momentum (like energy) is a conserved quantity, and describe how this property of momentum makes it a useful tool in problem solving, especially problems involving collisions.	SE/TE: 125-136
- Describe that forces transfer energy from one object to another through a process called "work". Explain how calculating the work done by a force helps us make qualitative and quantitative predictions regarding the motion of objects. Use mathematics, graphing calculators and/or graphing analysis programs to investigate the work done by individual forces.	SE/TE: 145-160

DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
- Give examples of forces doing work to transfer energy to a rotating object (increasing its rotational speed), or doing work to transfer energy away from a rotating object (decreasing its rotational speed).	SE/TE: 171-180, 189-204
- Describe how the concept of torque is used to explain (and calculate) the rotational effect that forces have when they act on objects.	SE/TE: 189-204
- Conduct investigations to identify the factors that determine the torque produced by a force (Torque = force · lever distance). (For example, what conditions must be met to ensure that the sum of all torques acting on an object is zero, leaving the object in rotational equilibrium?).	*The opportunity to address this standard is found in the activities in the lab manual and the following pages:* SE/TE: 189-204
Strand - Energy Interacting With Materials; the Transformation and Conservation of Energy	
- Enduring Understanding: Energy readily transforms from one form to another, but these transformations are not always reversible. The details of these transformations depend upon the initial form of the energy and the properties of the materials involved. Energy may transfer into or out of a system and it may change forms, but the total energy cannot change.	
- Essential Question: What happens to the energy in a system — where does this energy come from, how is it changed within the system, and where does it ultimately go? How does the flow of energy affect the materials in the system?	
Grades 9-12	
1. Energy cannot be created nor destroyed. Energy can be transferred from one object to another and can be transformed from one form to another, but the total amount of energy never changes. Recognizing that energy is conserved, the processes of energy transformation and energy transfer can be used to understand the changes that take place in physical systems.	SE/TE: 153-154, 163

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DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
2. Most of the changes that occur in the universe involve the transformation of energy from one form to another. Almost all of these energy transformations lead to the production of some heat energy, whether or not heat energy is the desired output of the transformation process.	SE/TE: 145-163, 469-481
3. Waves (e.g., sound and seismic waves, waves in water, and electromagnetic waves) carry energy that can have important consequences when transferred to objects or substances.	SE/TE: 491-506, 515-526, 536-546, 579-595, 625-636
4. When waves interact with materials, the energy they transfer often leads to the formation of other forms of energy. These interactions, which depend upon the nature of the material and the wavelength of the waves, can be used to create practical devices (e.g., sonar and ultra sound imaging, solar cells, remote control units, and communication devices).	SE/TE: 275, 491-506, 515-526, 536-546, 603-616, 633-634
5. Through reflection and refraction, electromagnetic waves can be redirected to produce concentrated beams or images of their source.	SE/TE: 578-595
6. When radiant energy is absorbed or emitted by individual atoms or molecules, the changes in energy involve the jump of an electron from one distinct energy level to another. These energy changes, which are characteristic of the atom or molecule, can be used to identify the material.	*The opportunity to address this standard is found on the following pages:* SE/TE: 334-355, 645-647
Building upon the K-8 expectations, all students in Grade 9 will be able to:	
- Describe why it is significant that energy cannot be created (made) nor destroyed (consumed), and identify that that this property of energy is referred to as the Law of the Conservation of Energy.	SE/TE: 153-154

DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
- Give examples that illustrate the transfer of energy from one object (or substance) to another, and examples of energy being transformed from one to another.	SE/TE: 144, 145-157, 158-159, 160-163, 305-306, 431-443, 470-481
- Use energy chains to trace the flow of energy through physical systems. Indicate the source of the energy in each example, and trace the energy until it leaves the system or adopts a form in the system that neither changes nor is transferred. Make qualitative estimates of all the forms of the energy involved and reflect on the consequences of the energy transfers and transformations that take place. For example, trace the flow of the radiant energy carried by sunlight that strikes the roof of a home. Reflect on how the color of the roof (light vs. dark) will have an impact on the ability to heat and cool the house, and possibly the functional lifetime of the roofing materials themselves.	*The opportunity to address this standard is found on the following pages:* SE/TE: 303-316, 407-422, 431-443, 451-461470-481
- Use diagrams and energy chains to illustrate examples of the selective absorption of mechanical waves in natural phenomena and give examples of how the selective absorption of mechanical waves is used to conduct investigations in medicine, industry and science (for example ultrasound imagery, detecting the epicenter of earthquakes, testing structures for defects, and conducting explorations of the earth's crust and mantle).	*The opportunity to address this standard is found on the following pages:* SE/TE: 491-506, 623-636
- Explain that what happens to electromagnetic waves that strike a substance (reflection, transmission, absorption) depends on the wavelength of the waves and the physical properties of the substance.	SE/TE: 436, 493, 536-546, 555-573, 578-595, 623-636
- Investigate how radio waves, microwaves, infrared waves, visible waves and ultraviolet waves behave when they strike different substances.	SE/TE: 436, 493, 536-546, 555-573, 578-595, 623-636

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- Record how effectively different materials reflect, absorb and transmit different kinds of EM waves. Draw conclusions based on this data and the physical properties of the substances (e.g., some substances absorb visible waves, but not radio waves. Other materials absorb UV waves, but not visible waves).	*The opportunity to address this standard is found on the following pages:* SE/TE: 436, 493, 536-546, 555-573, 578-595, 623-636
- Give examples that illustrate how the selective absorption of EM waves explains physical phenomena. For example; how X-rays can be used to detect broken bones beneath the skin and how coating on eyeglasses and sunglasses protect the eyes by permitting visible waves to pass but absorb UV waves.	SE/TE: 555-573, 579-595, 603-616, 623-636
- Use energy chains to trace the flow of energy in a selective absorption process (e.g., sunburn, Greenhouse Effect, microwave cooking).	*The opportunity to address this standard is found on the following pages:* SE/TE: 438-443, 536-546, 578-595, 623-636
- Use energy chains to trace the flow of energy through systems involving sliding friction and air resistance (for example, the braking action in vehicles or bicycles or a vehicle rolling to rest).	*The opportunity to address this standard is found on the following pages:* SE/TE: 90-91
- Explain that through the action of resistive forces (friction and air resistance) mechanical energy is transformed into heat energy, and because of the random nature of heat energy, transforming all of the heat energy back into mechanical energy (or any other organized form of energy) is impossible. Give examples where organized forms of energy (GPE, elastic PE, the KE of large objects) are transformed into heat energy but the reverse transformations are not possible.	*The opportunity to address this standard is found on the following pages:* SE/TE: 90-91, 159-160
- Reflect on why organized forms of energy are more useful than disorganized forms (heat energy).	SE/TE: 479-481

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Building upon the K-10 expectations, all students in Grade 11 will be able to:	
- Use energy chains to trace the flow of energy through systems that involve both static and kinetic friction.	*The opportunity to address this standard is found on the following pages:* SE/TE: 30-39, 90-91, 155-160, 175-176, 648, 652
- Use diagrams to illustrate how the constructive and destructive interference of waves occurs.	SE/TE: 498-499, 628-636
- Give specific examples of how wave interference occurs in earth systems for both mechanical waves and electromagnetic waves. For example, in the case of mechanical waves, demonstrate regions of high volume (constructive interference) and low volume "dead spots" (destructive interference) in the space surrounding two speakers. Or consider the effect that wave interference has on the impact of seismic waves produced by earthquakes. In the case of EM waves, observe the colored patterns (fringes) on a soap bubble or in a thin layer of oil on a puddle of water.	*The opportunity to address this standard is found on the following pages:* SE/TE: 498-499, 628-636
- Describe how wave interference is used to create useful devices, such as noise cancellation devices (mechanical waves), window coatings to selectively transmit or reflect IR waves, diffraction gratings for spectroscopy, and lasers (EM waves).	SE/TE: 571-573, 603-616, 628-636
- Explain why the Law of Conservation of Energy must be expanded to the Law of the Conservation of Mass/Energy when nuclear energy is involved in a process.	SE/TE: 153-154, 305-306, 783-801, 808-824
- Use the concept of stability to explain why energy is released during a fission process and during a fusion process.	SE/TE: 808-824

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DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
- Use diagrams and energy chains to illustrate and explain the flow and transformations of energy that occur in fission and fusion processes, and during radioactive decay.	SE/TE: 783-801, 808-824
Building upon the K-11 expectations, all students in Grade 12 will be able to:	
- Use the model of discrete electronic energy states in an atom to describe how the atom can emit or absorb packets of electromagnetic energy (photons) having specific energies. Demonstrate how prisms, diffraction gratings or other optical devices can be used to analyze the light coming from different substances, and how this analysis can be useful in the identification of elements and compounds.	SE/TE: 571-573, 590, 630-636, 768-770
- Use diagrams to show how concave reflecting devices and convex lenses can be used to collect and focus EM waves.	SE/TE: 601-616
- Recognize that the characteristics of these devices are different for different groups of EM waves (radio waves, microwaves, infrared waves, visible waves, etc.).	*The opportunity to address this standard is found on the following pages:* SE/TE: 601-616
- Create light ray diagrams to illustrate how converging devices are used to collect and focus waves in scientific devices (e.g., telescopes and microscopes).	SE/TE: 603-612

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DELAWARE SCIENCE STANDARDS AND GRADE LEVEL EXPECTATIONS	PAGE(S) WHERE TAUGHT (If submission is not a text, cite appropriate resource(s))
Strand - The Production, Consumption and Application of Energy	
- Enduring Understanding: People utilize a variety of resources to meet the basic and specific needs of life. Some of these resources cannot be replaced. Other resources can be replenished or exist in such vast quantities they are in no danger of becoming depleted. Often the energy stored in resources must be transformed into more useful forms and transported over great distances before it can be helpful to us.	
- Essential Question: What is a "responsible" use of energy? Are there alternative forms of energy that will serve our needs, or better ways of using traditional forms of energy?	
Grades 9-12	
1. Demand for energy by society leads to continuous exploration in order to expand supplies of fossil fuels. Nuclear energy is an alternative form of energy. Through the use of fission reactors, nuclear energy is already widely used for the generation of electrical energy. Additional technologies are being developed to increase the use of other alternate energy sources.	SE/TE: 161-163, 808-824
2. The increase in energy demand and the new technologies being developed to meet these needs and improve the efficiencies of energy systems have social and environmental consequences. Societal expectations for a sustainable environment will require new, cleaner technologies for the production and use of energy.	SE/TE: 161-163, 808-824
Building upon the K-8 expectations, all students in Grade 9 will be able to:	
- Research the factors that contribute to the energy efficiency of cars and trucks. Examine the role that the power of the engine and the weight and physical size and shape of the vehicle have on the fuel efficiency of the vehicle. Identify and report on the sources of the fuels currently used by vehicles and alternative fuels being developed.	*The opportunity to address this standard is found on the following pages:* SE/TE: 159-160

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Building upon the K-10 expectations, all students in Grade 11 will be able to:	
- Use energy chains to describe the flow of energy in a nuclear-fueled electric power facility. Indicate the source of energy of the facility, how and where energy leaves the facility, and in which parts of the facility energy transformations take place.	*The opportunity to address this standard is found on the following pages:* SE/TE: 812-824
- Compare and contrast the energy diagram of the nuclear-fueled power plant to a comparable energy diagram for a fossil-fueled electric power plant.	*The opportunity to address this standard is found on the following pages:* SE/TE: 812-824
- Prepare a written report, a poster, or a computer-based presentation that explains the advantages and disadvantages of using fossil fuels, nuclear fuel, and alternative energy sources to generate electrical energy.	*The opportunity to address this standard is found on the following pages:* SE/TE: 161-163