OKLAHOMA ACADEMIC STANDARDS

SCIENCE

FRAMEWORK

GRADE 6: OVERVIEW

OKLAHOMA STATE DEPARTMENT OF EDUCATION
CHAMPION EXCELLENCE

The Oklahoma State Department of Education is excited to announce the release of the first resources being offered through the Oklahoma Academic Standards Science Frameworks. The Science Frameworks represent curricular resources developed by Oklahoma teachers to help teachers translate standards into classroom practice. The *Framework Overviews* represent how a group of Oklahoma teachers, at a given grade level, might bundle performance expectations/standards found in the Oklahoma Academic Standards for Science.[1] **Bundling** is how teachers would **group performance expectations/standards** for the purpose of developing **instructional units of study.**

Once bundled, the *Science Framework* writers were then charged with completing **four categories of information** that coincided with the bundle of performance expectations/standards. The categories provide insight into how the Science Framework writers collaborated to begin to translate standards into classroom instruction. The guidance provided in the categories does **not** represent a **directive** to teachers, schools or districts for classroom instruction and should not be viewed as such.

The Oklahoma State Department of Education would like to say a special thank you to the Oklahoma educators who participated in developing the Oklahoma Science Framework Overviews, Doug Paulson of the Minnesota State Department of Education who served as a consultant, Lawton Public Schools and to Quentin Biddy, the project director.

Science Framework Writers			
Solomon Bayouth	Megan Cannon	Wendy Howard	Jenny Thompson
Elizabeth Beck	Mandi Cloud	Traci Richardson	Sarah Vann
Colleen Bennett	Benjamin Cottingham	Georgia Smith	Megan Veldhuizen
Rachel Brown	Jennifer Crabb	Stacey Stapelton	Tammy Will
Randi Butcher	Maria Harris	Amy Tankersley	Susan Wray

"The vision of the Overviews is to provide a resource for teachers that encourages them to embrace the new standards and implement them effectively in their classrooms. The suggestions provided by the frameworks project **do not** have to be implemented exactly as they are written and are **not required** to be a successful teacher, but **serve as a guide** to setting up effective lessons that will help students meet the necessary levels of success in a science classroom." - Oklahoma Science Framework Project Writer

[1] Download the Oklahoma Academic Standards for Science at http://sde.ok.gov/sde/science.

How To Read This Document

Below you will find short descriptions about each of the sections of information provided in this document. If you have questions regarding the *Framework Overviews*, please contact Tiffany Neill at 405-522-3524 or Tiffany.Neill@sde.ok.gov

Science Framework Overview: Sections

In Lay Terms

This section aims at providing a brief introduction to the goals outlined in the Performance Expectation Bundles/grouping of standards.

Three Dimensional Storyline

This section aims at providing a comprehensive instructional storyline of how the three dimensions represented in the Performance Expectation Bundles intertwine to support students engaging in science and engineering practices, crosscutting concepts and disciplinary core ideas. Keep in mind each performance expectation includes one **science and engineering practice**, one **crosscutting concept** and one **disciplinary core idea**. The **color-coding** in this section allows teachers to see where components of these three dimensions appear in the instructional storyline. To find out more about the three dimensions and how they are incorporated into the Oklahoma Academic Standards for Science, review pages 7-8 in the Oklahoma Academic Standards for Science[2] or check out the OKSci PD on Your Plan Module series, Transitioning to the Oklahoma Academic Standards for Science[3].

Lesson Level Performance Expectations

This section aims at providing **scaffolding three-dimensional learning targets** that teachers can design instruction around to meet the end goal of the Performance Expectation(s) represented in the bundles or units of study. Keep in mind the performance expectations represent the things students should know, understand and be able to do to show proficiency at the end of instruction they participate in. A teacher can **utilize** the **Lesson Level Performance Expectations** in each bundle **as a way to develop a series of instruction** to meet the end goals of the performance expectations. For example, a teacher can develop or use a lesson, which may allow students to participate in instruction that covers some of the Lesson Level Performance Expectations, but not all. In this case the teacher would then develop or conduct another lesson that covers other Lesson Level Performance Expectations in the bundle.

Misconceptions

This section aims at providing research-based misconceptions that students frequently have related to the science concepts (disciplinary core ideas) embedded in the Performance Expectation Bundles along with matching correct conceptions.

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[2] Download the Oklahoma Academic Standards for Science at http://sde.ok.gov/sde/science.

[3] Access the OKSci PD on Your Plan Modules at: https://www.evernote.com/l/AUXXlQC11VZDeLmUkOMPpjhKeJjqS-R8gww

Bundle: Cycles of Matter and Energy

MS-LS1-6

Students who demonstrate understanding can:

Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

MS-LS2-3

Students who demonstrate understanding can:

Develop a model to describe the cycling of matter and flow of energy among living and non-living parts of an ecosystem.

MS-ESS2-4

Students who demonstrate understanding can:

Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

In Lay Terms

Matter and energy cycle through both living and non-living parts of ecosystems. Almost all energy that drives the cycling of matter comes from the sun, whether it is the cycling of energy in photosynthesis or the cycling of water in the water cycle. A change in one component of the living and non-living components of an ecosystem, can result in the rest of the components in the system being impacted.

Three Dimensional Storyline

With this bundle, students can explore how matter and energy are cycled in both living and non-living parts of an ecosystem. Both matter and energy continually cycle through Earth's various systems. Water moves through and affects components of ecosystems in the water cycle. Carbon and Nitrogen are cycled through ecosystems as are utilized by living organisms at different levels within ecosystems. These cycles work together within Earth's ecosystems to support life and transfer matter and energy throughout our planet.

Within ecosystems, different organisms utilize energy from sources that are unique to them. Food webs are models that demonstrate how matter and energy are transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Plants, algae (including phytoplankton), and many microorganisms are considered producers because they *produce* their own food. Animals are considered consumers because they have to *consume* other animals and/or plants for energy. Decomposers recycle nutrients such as nitrogen from dead plant or animal matter back into the soil in terrestrial environments or into the water in aquatic environments. Students can use models to describe the transfer of energy and the movement of matter among organisms within an ecosystem. The emphasis should be on students developing models that include depictions of the interactions among components in the ecosystem and depictions of the components entering (inputs) and exiting (outputs) the ecosystem. The individual atoms that make up the organisms in an ecosystem are cycled repeatedly and move between the living and non-living parts of the ecosystem.

Producers use the process of photosynthesis to cycle matter and energy. Through this process, the chemical reaction by which plants produce complex food molecules requires an energy input to occur. During photosynthesis these organisms undergo a chemical reaction, driven by energy from sunlight to take carbon dioxide from the air and water from the soil and react to form carbon-based organic molecules (sugars) and release oxygen. These sugars may be stored for later use or used immediately. Students should be able to construct a scientific explanation to demonstrate the process of photosynthesis and design a model to trace the movement of matter and flow of energy. In developing a model students should gain an understanding of how carbon cycles through ecosystems, understanding **should not** focus on memorizing equations related to the carbon cycle.

Through the water cycle, water is also cycled and recycled through both the living and non-living components of Earth's ecosystems. The global movement of water, driven by energy from the sun and the forces of gravity, continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation, crystallization, and precipitation, as well as downhill flows on land through run-off and groundwater. Transpiration is the process plants use to carry water from their roots to their leaves, where it will then be evaporated. Evaporation uses energy from the sun to change the water from the leaves or bodies of water into moisture in the air. Once this moisture in the air is cooled, the water molecules in the gas state begin condensing to form a liquid water droplet. This condensing of gas particles to liquid is called condensation, and as the droplets collide with other droplets of water, they stick together and become heavy enough so that the force of gravity causes these drops to fall as precipitation (no matter what state the water may be in). Water may then be used by living organisms or it may move downhill propelled by gravity to rejoin bodies of water.

In all of Earth's systems, energy and matter is transferred in and out as well as cycled among the components of these various systems.

Lesson level Performance Expectations

- I can plan and carry out an investigation to demonstrate that in order for plants to produce complex food molecules, energy from the sun is required.
- I can construct an explanation to demonstrate understanding that in plants, algae and phytoplankton, the process of photosynthesis uses energy from the sun to make food in the form of sugar.
- I can analyze and interpret data that energy stored in the form of sugar during the process of photosynthesis may be used by producers immediately or stored for their later use, or stored and later used by consumers.
- I can develop a model of a food web to describe how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem.
- I can develop a model that demonstrates how matter is transferred into and out of the physical environment at every level.

- I can develop a model to describe how decomposers recycle nutrients from dead plant or animal matter back into the soil or water.
- I can develop a model to demonstrate understanding that the atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and non-living parts of the ecosystem.
- I can engage in argument from evidence to describe how global movements of water and its changes in form are propelled by sunlight and gravity and water cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation as well as downhill flows on land.

Misconceptions	Accurate Concept
1. Plants have multiple food sources, not just the sugars that they make from water and carbon dioxide.	1. Plants are producers that make their own food, sugars, through photosynthesis.
2. Substances in the soil are food for plants.	2. Plants use water and carbon dioxide to make sugars for food.
3. Minerals are food for plants.	3. Minerals are used during biological processes in plants, but not as food.
4. Plants use oxygen during photosynthesis.	4. Oxygen is a product of photosynthesis.
5. Water is food for plants.	5. Water is used in the process of photosynthesis to produce sugar as food.
6. Carbon dioxide is food for plants.	6. Carbon dioxide is used in the process of photosynthesis to produce sugar as food.
7. If a population in a food web is disturbed, there will be little or no effect on populations that are not within the linear sequence in the food web.	7. All populations in a food web have an effect on the other components in the food web as well as other systems.
8. Water evaporates into the air only when the air is very warm or very cool.	8. Water can evaporate at all temperatures.
9. When water evaporates, tiny droplets of water, not water vapor, are formed.	9. When water evaporates, water vapor is formed.
10. Cooler air can hold more water vapor than warmer air.	10. Warmer air can hold more water vapor.
11. Clouds are like vessels that hold water.	11. Clouds and rain form as air cools and water vapor in the air condenses into water droplets.
12. There are water molecules in the clouds, but not in the air outside the clouds.	12. All air contains water vapor.
13. Clouds are made of water vapor.	13. Clouds and rain form as air cools and water vapor in the air condenses into water droplets.
14. Clouds, fog, and rain form as air becomes warmer.	14. Clouds and rain form as air cools and water vapor in the air condenses into water droplets.

References

- American Association for the Advancement of Science)
  - http://assessment.aaas.org/topics/ME#/
  - http://assessment.aaas.org/topics/IE#/ and http://assessment.aaas.org/topics/WC#/

Bundle: Kinetic and Potential Energy

MS-PS3-1 Energy

Students who demonstrate understanding can:

Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MS-PS3-2 Energy

Students who demonstrate understanding can:

Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

In Lay Terms

When an object is in motion, the energy it contains is called kinetic energy. When an object is at rest, the energy it contains is called potential energy. When an object changes from being at rest to an object in motion, its energy transfers from potential to kinetic energy. Examples of this energy transfer is a bowling ball striking a set of bowling pins.

Three Dimensional Storyline

Kinetic energy is the energy an object has when it is in motion. The amount of kinetic energy an object has can change and is related to the object's mass and speed. The greater the mass of the moving object, the greater the amount of kinetic energy. Likewise, the greater the speed of the object in motion, the greater the amount of kinetic Energy. In these performance expectations, students are expected to create and read graphs. In order to construct and interpret a graph, students may be given objects of different masses. Students will plan an investigation with these differently massed objects to make observations and collect data, which can be analyzed to determine the proportional relationship between kinetic energy and the mass and speed of an object. By developing a plan and graphing and then analyzing and interpreting their data, students should come to realize that kinetic energy increases with mass and the speed of the object.

As in kinetic energy, potential energy can change. When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the other object. Students should develop models to demonstrate the relationship between distance and the amount of potential energy between two objects. Models are useful in demonstrating/experiencing this and can exhibit cause and effect. (When an elastic band is stretched, the band gains potential energy the further it is stretched. If a rubber ball is squeezed inward, the ball gains potential energy the more it is squeezed. Both of these changes in potential energy are due to elastic potential energy.) Potential energy can increase due to increased <u>or</u> decreased distances. The same can be said for potential energy due to gravity. The further away from the Earth an object is, the greater potential energy it has.

Lesson Level Performance Expectations

- Students can use evidence to explain the difference between kinetic (motion) energy and potential (stored) energy.
- Students can analyze and interpret data to prove kinetic energy is proportional to the mass of a moving object.
- Students can use models to demonstrate the amount of potential energy an object has is dependent on their relative positions.
- Students can analyze and interpret data to verify that the proportionality of kinetic energy increases with the square of its speed.
- Students can develop models to demonstrate that an object exerts a force on another object when they interact and energy can be transferred from one object to the other.

Misconceptions

1. A lighter object has more motion energy than heavier objects because lighter objects move faster than heavier objects.
2. Objects that are dropped do not have motion energy. For example, a dropped object doesn't have motion energy because gravity is just pulling it down.
3. The motion energy of an object does not depend on the mass of the object.
4. The motion energy of an object does not depend on the speed of the object (the motion energy of an object does not increase when the speed increases).
5. Springs or other elastic objects have the same amount of elastic energy regardless of how much they are stretched or compressed.
6. Energy can be created.
7. Gravitational potential energy is the potential to fall; an object will lose all of its gravitational potential energy as soon as it starts to fall.
8. Motion energy cannot be transformed into gravitational potential energy.
9. Gravitational potential energy cannot be transformed into motion energy.

Accurate Concept

1-4. Motion energy (kinetic energy) is associated with the speed and the mass of an object.

5. Elastic potential energy is associated with the stretching or compressing of an elastic object and how difficult it is to stretch or compress the object.

6. Energy can be transformed (converted) within a system but not created or destroyed.

7. Gravitational potential energy is associated with the distance an object is above a reference point, such as the center of the earth, and the mass of the object.

8-9. Energy can be transformed (converted) within a system.

References

- (American Association for the Advancement of Science) http://assessment.aaas.org/topics/EG/

Bundle: Kinetic Energy as Temperature

MS-PS1-4

Students who demonstrate understanding can:

Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS3-3

Students who demonstrate understanding can:

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

MS-PS3-4

Students who demonstrate understanding can:

Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

In Lay Terms

Students should be able to understand that temperature is a measurement used to determine how fast the particles are moving inside of a substance or how much energy the substance contains. Students should be able to understand that the state of matter is determined by the temperature and pressure of a substance, the amount of substance, and the type of substance will all affect the total amount of energy it has. Students should also understand the difference between heat and temperature, which the term heat, in science, refers to the transfer of thermal energy.

Three Dimensional Storyline

Students should understand that the temperature of matter is really a measurement of the matter's average kinetic energy. The state of matter, the amount of matter, and type of matter will affect the amount of energy it contains.

Matter in a solid state has a low energy level, the particles are in a fixed position and may vibrate in position, but will not change location. Matter in a liquid state has a higher energy level than a solid, as the particles are freer to move and change location and are constantly in contact with other liquid particles. Matter in a gas state has an even higher energy level and is spaced out and may only come in contact with other particles upon random collisions.

In this bundle, students should be able to develop models for each state of matter and predict how the model would change with the changes in state of the matter. Matter that goes through a change in internal temperature or pressure, can undergo a phase (state) change. If matter is in a solid state, and its internal temperature is increased (or the pressure is decreased or both), the matter will transform into a liquid state (called the *melting point*). If you continue to add thermal energy (and thus kinetic energy) to the matter (or further decrease pressure), the matter will reach its *boiling point* and it will begin vaporization; changing from a liquid into a gaseous state. If the particles in matter change directly from a solid state to a gaseous state; this is process is called *sublimation* and can be achieved through the addition of temperature or a decrease in pressure. If the internal temperature of matter is decreased changing from a gas to liquid, this is called, *condensation*. When matter changes from a liquid to a solid state, it has reached its *freezing point*. The process of physically changing directly from a gas to a solid is known as *deposition*. To create a solid from a liquid, you might have to decrease the temperature by a large amount and then add pressure. For example, oxygen (O_2) will solidify at -218.8 degrees Celsius at standard pressure. However, it will freeze at warmer temperatures when the pressure is increased. Students should be able to develop models to demonstrate both phase change and energy transfer within the system to predict and/or describe these processes. Students should be able to construct explanations to show that through a phase transition, no energy is created or destroyed just transformed and/or transferred within the system.

In these performance expectations, students should understand the difference between heat energy, temperature, and thermal energy. *Heat energy* is a term used in science to refer to the energy transferred due to the temperature difference between two objects. The transfer of heat is always from hotter objects to colder ones. *Temperature* is a measure of the average kinetic energy of the particles in a material. The more kinetic energy particles have, the higher the material's temperature will be. *Thermal energy* is a term used when referring to the internal energy of an object. There is a proportional relationship between temperature and total energy of a system, which depends on types, states and amount of matter in the system. The amount of matter in a system will affect the amount of energy needed to change the temperature of the matter. The more atoms, the more energy the substance will need in order to undergo a phase change. Although materials have the ability to undergo phase transitions, the total amount of energy in a system will not change. Transfers of energy happen when objects collide and when they transfer from hotter objects to colder ones. This transfer of energy can change the overall temperature of the matter and is directly proportional to the amount of energy transferred, the amount of matter present, and the environment. Energy is transferred out of hotter regions or objects and into colder ones in three different ways—by conduction within solids, by the flow of liquid or gas (convection), and by radiation, which can travel across space. Students should understand that within these energy transfers, total energy is not lost or gained. Students should be able to apply their knowledge of heat energy to construct and test a device that either minimizes or maximizes the transfer of heat energy between two objects or mediums. Students can analyze the data to detect patterns in the transfer of heat energy between objects or mediums.

Lesson Level Performance Expectations

- Students can develop a model to describe the motion of atoms and/or molecules in a solid, liquid and gas state.
- Students can construct an argument using evidence to explain that temperature is a measure of the average kinetic energy contained in the particles of matter and that temperature is not a direct measure of a system's total thermal energy.
- Students can plan and carry out an investigation to determine that total thermal energy depends on state, type of matter, and number of

atoms in the system.
- Students can use mathematics and computational thinking to describe the phenomena that the temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule
- Students can explain from evidence that the changes of state occur with variations in temperature and/or pressure.
- Students can plan an investigation to observe that the transfer of thermal energy is transferred from hotter regions or objects to colder ones.
- Students can explain from evidence that the term "heat" refers to transfer of thermal energy.
- Students can construct and test a device that either minimizes or maximizes the transfer of heat energy between two objects or mediums.
- Students can modify a design based on data analysis to improve the efficiency of a device to reduce or increase the amount of energy that is transferred.

Misconceptions	Accurate Concept
1. Atoms of a solid are not moving. 2. Particles of a gas are closely packed with no empty space between them. 3. Solid substances do not expand or contract with changes in temperature. 4. The mass of atoms or molecules of a substance increases when temperature increases and decreases when the temperature increases. 5. The molecules of a substance break down into individual atoms when the substance boils/evaporates. During evaporation, water breaks down into hydrogen and oxygen. 6. Heat is made of "heat molecules". 7. Molecules change shape during a phase change. 8. Increasing the speed/kinetic energy of a substance does not change the temperature of a substance. 9. Thermal energy is not related to the material of the matter. 10. Thermal energy is not related to the mass of the object. 11. Inanimate objects do not have any thermal energy. 12. Energy can be created. 13. Energy can be transformed into a force. 14. Energy is not transferred from one object to the other unless	1. All atoms and molecules are in constant motion. 2. There are differences in the spacing, motion, and interaction of atoms and molecules that make up solids, liquids, and gases. 3-4.For any single state of matter, increasing the temperature typically increases the distance between atoms or molecules. Therefore, most substances expand when heated. 5-7. When heated, solids can change Into liquids and liquids can change into gases. When cooled, gases can change into liquids and liquids can change into solids. These changes of state can be explained in terms of changes in the proximity, motion, and interaction of atoms and molecules. 8. For any single state of matter, the average speed of the atoms or molecules increases as the temperature of a substance increases and decreases as the temperature of a substance decreases. 9-11. Thermal energy is associated with the temperature and the mass of an object and the material of which the object is made. 12-13. Energy can be transformed (converted) within a system. 14-15. Energy can be transferred from one system to another (or from a system to its environment) in different ways: by conduction, mechanically, electrically, or by radiation (electromagnetic waves)

they are in direct contact with one another.

15. When two objects of different temperatures are in contact with each other, thermal energy is transferred from the warmer to the cooler object and "cold energy" is also transferred from the colder object to the warmer object.

References

- (American Association for the Advancement of Science)
  - http://assessment.aaas.org/topics/AM#/
  - http://assessment.aaas.org/topics/EG#/

Bundle: Forces

MS-PS2-3

Students who demonstrate understanding can:

Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MS-PS2-5

Students who demonstrate understanding can:

Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

In Lay Terms

Students should be able to understand that there are invisible forces between objects that have electric, magnetic, and/or gravitational properties. Students should be able to understand that these forces can become stronger and weaker depending on how close or far the objects are from one another. Students should also understand that there are factors that cause objects to repel one another and also factors that cause these objects to be attracted.

Three Dimensional Storyline

. Invisible forces exist between two electrically charged objects. Invisible forces exist between two magnetic objects. Invisible forces exist between an object and the center of the earth and between bodies in the solar system and universe. These objects do not have to be in contact. Forces that act at a distance can be explained by fields. These fields can be mapped by their effect on a test object. In these performance expectations, students are expected to create and carry out an investigation(s) that provides evidence that fields exist between objects even when the objects are not in contact. The amount of electric, magnetic or gravitational force an object has can be increased or decreased. This depends on how close, or far apart the object is to another object or object's field.

Objects that are always magnetic are called *permanent magnets*. This means that the material they are made of creates its own constant magnetic field. There are also *temporary magnets* that can become magnetized when they come into contact with a magnetic field of another object. The only way a non-magnetic material can become magnetized is by creating an electromagnet; such as wrapping an iron nail in an insulated wire coil and running electric current through the wire coil. When the current is flowing; a magnetic field is induced in the nail, when the current stops, the magnetic field collapses and the nail is no longer magnetic. The current in the wire can increase or decrease the strength of the magnetic field. Students should plan and carry out investigations to notice patterns in how the size of the current (or number of wraps of the wire) affects the strength of the magnetic field. The strength of the magnet and what the magnet is made of will also affect the strength of the field. Larger objects will have a larger magnetic field, and a stronger force. Smaller objects will have a smaller field and a weaker magnetic force.

After analyzing the experiment, students should be able to determine the factors that affect the strength of electric and magnetic forces.

The force of gravity is what gives *weight* to an object and causes objects to fall toward Earth's center. The mass of an object is the amount of matter inside the object. When gravity is applied, the *weight* can be calculated (Weight = mass x acceleration due to gravity), The mass of an object cannot change, but in the absence or presence of gravity; the weight of an object can change (for example, the mass of an object is the same whether the object is on the moon or on Earth, but the object will "weigh" much less on the due to less gravitational force). All objects with mass are sources of gravitational fields and are affected by the gravitational fields of all other objects with mass (even masses that are small). These forces are always attractive.

Students should ask questions to determine factors that affect the strength of force on objects. Electrically charged objects are attracted to objects with the opposite charge and repelled by objects with the same charge. This means that positive charges will be attracted to negatively charged objects and push away or repel from objects that are positive. The larger the object, the stronger the force will be. When an object is attracting another object the closer they get to each other, the stronger their force will be. Likewise, the farther apart the objects get, the weaker their force is. When objects are similarly charge, their repelling force is stronger the closer they are and weakens the further the objects are from each other.

Of all of these forces: electric, magnetic and gravitational, the size of the force (whether attractive or repulsive) is proportional to the amount of distance between the interacting objects, noting that gravity has no repulsive force.

Lesson Level Performance Expectations

- Students can ask questions to be investigated to demonstrate that electric and magnetic forces can be attractive or repulsive.
- Students can analyze data about electric and magnetic forces in order to map the fields of attraction or repulsion.
- Students can conduct an investigation to produce data demonstrating the forces of static electricity and how these forces are dependent upon distance.
- Students can ask questions to investigate electric forces and create a **hypothesis** to determine factors that increase or decrease the strength of their force.
- Students can design an investigation to determine the strength of different magnets.
- Students can ask questions to be investigated to determine how to increase the strength of an electromagnet.
- Students can argue using evidence to demonstrate that gravitational forces can be attractive.

Misconceptions	Accurate Concept

1. The gas state of a substance weighs less than the liquid or solid state.
2. Gravity is selective; it acts differently or not at all on some matter.
3. Gravity increases with height.
4. Gravity requires a medium to act through.
5. Static electricity is a buildup of electrons.
6. Fields don't exist unless there is something to detect them.
7. The electric force is the same as the gravitational force.
8. A charged body only has one type of charge.

1. Matter is conserved and the same amount of matter weighs the same, even in different states.
2. Gravity works on all objects in the same manner.
3. The effect of gravity decreases as distance between objects increases.
4. Gravity does not require a medium to act through.
5. Static electricity is a result of an *imbalance* between *quantities* of positive and negative particles already present.
6. Fields, like magnetic fields, exist whether they are detected or not.
7. Electric force and gravitational force are two different, distinct types of forces.
8. A charged body could have either a positive or a negative charge.

References

- (American Association for the Advancement of Science) http://assessment.aaas.org/topics/AM#/
- (American Institute of Physics) http://amasci.com/miscon/opphys.html
- Misconceptions Spread by K-6 Textbooks: "ELECTRICITY" William J. Beaty, Aug/1995 http://amasci.com/miscon/elect.html
- (University of Dallas "Helping Students Learn Physics Better) http://phys.udallas.edu/C3P/Preconceptions.pdf

Bundle: Cells

MS-LS1-1

Students who demonstrate understanding can

Conduct an Investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

MS-LS1-2

Students who demonstrate understanding can

Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.

MS-LS1-3

Students who demonstrate understanding can

Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

In Lay Terms

Cells are the smallest unit that can be considered alive. All living things are made of one or more cells. Some cells contain structures which carry out specific functions within the cell. In multicellular organisms, groups of cells work together to perform tasks and are called tissues, groups of tissues may work together to form organs that, together, perform a particular function in the body.

Three Dimensional Storyline

With this set of expectations, students will discover all living things are made of cells. Microscopes (or internet images) allow students to observe cells directly, while an enlarged model of the cell provides more in-depth examination of the organelles within the cell. Structure of cells and the parts of the cell is always related to function. By making and observing models, students will get a better understanding of scale and proportion and how the structure of the organelles contributes to this function. Students will also understand how the cells form a network of systems which ultimately run entire organisms.

Through this bundle, students will understand that the smallest unit of life is the cell. Students will plan and carry out investigations to discover some organisms are made up entirely of one cell (unicellular) while others may contain many different numbers (multicellular) and kinds of cells. Unicellular organisms (microorganisms), like multicellular organisms, need food, water, a way to dispose of waste, and an environment in which they can live. Cells have specialized structures which are responsible for these specialized functions within the cell to include: the cell membrane (the boundary that controls what enters and leaves the cell), nucleus (where genetic material is located within the cell, the control center of the cell), cell wall (provides support and protection in plant cells), chloroplasts (the location of photosynthesis in plant, algae or phytoplankton cells

) and mitochondria (powerhouse of the cell - where energy-rich molecules for the cell (ATP) are created) . Organelles perform their individual functions, and then work together to perform the function of the cell as a whole.

Students will engage in argument from evidence to explain that cells work as individual units, and in multicellular organisms, the body is a system of these multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues or organs that are specialized for particular body functions. A group of similar cells working together to perform a task makes up tissues, a group of tissues working together forms organs, and several organs may work together to complete the tasks for an entire organism; for example, a group of cardiac cells work together to form a valve in the heart; several kinds of tissue (including muscle tissue) make up the heart (an organ) which pumps blood to the lungs (another organ) and to the body to deliver oxygen to every cell and pick up wastes via arteries and veins. All of these subunits work together as the cardiovascular system which, is one of many body systems that work together to perform the functions of the entire body.

Lesson Level Performance Expectations

- Students can engage in an argument from evidence to differentiate between living and non-living cells.
- Students can conduct an investigation to produce data to demonstrate organisms are made up of cells.
- Students can conduct an investigation to produce data that organisms may be unicellular or multicellular.
- Students can develop a model to demonstrate that cells are the smallest unit of life.
- Students can develop a model to describe the primary role of the nucleus, chloroplast, and mitochondria.
- Students can develop a model to demonstrate the structure and function of the cell membrane, which forms the boundary that controls what enters and leaves the cell and the cell wall, which provides extra support for the plant cell.
- Students can engage in argument from evidence that plant cells contain structures that animal cells do not (ie. chloroplasts and cell wall).
- Students can use a written argument supported by evidence to explain that the body is a system of multiple interacting subsystems.
- Students can develop a model to demonstrate that the body subsystems are groups of cells that work together to form tissues and organs that perform specialized functions for the body.

Misconceptions	Accurate Concept
1. All cells are the same size and shape, (i.e. there is a generic cell).	1. Although there are many different types of cells in terms of size, structure, and function, all cells have certain characteristics in common.
2. There are no single-celled organisms.	2. All living things are composed of one or more cells.
3. Some living parts of organisms are not made of cells.	3. All living things are composed of one or more cells.
4. Cells do not carry out essential life functions for themselves: • they do not require water	4. Cells carry out essential life functions.
	5. Different body structures are made up of different types of cells.

- they do not extract energy from food
- they do not eliminate their own wastes
- they do not reproduce
- They do not make molecules for their own growth and repair.

5. Cells are not organized into the body structures of the organism they are part of.

References

- American Association for the Advancement of Science http://assessment.aaas.org/topics/CE#/

Bundle: Factors that Affect Populations

MS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem

MS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

In Lay Terms

In any ecosystem, there are physical and biological factors that affect the size of the populations. Availability or changes in availability of any of the factors can lead to changes in the populations of all of its members. In order to survive, organisms may compete, feed on, or develop a dependence on another species.

Three Dimensional Storyline

A population is the sum of all of the organisms of any one species living in the same area. Through this bundle, students should understand that organisms grow, reproduce, and perpetuate their species by obtaining necessary resources through relationships with other organisms and with their physical environment, and these same interactions can facilitate or restrain growth and enhance or limit the size of populations. These interactions maintain the balance between available resources and those who consume them. These interactions can also change the living and non-living characteristics of the environment. Students should be able to use evidence to explain that any changes to the biotic (living organisms' biological components) and /or abiotic (non-living, physical components) parts of the ecosystem can have an effect on the size and health of other populations within the system. Students must develop an understanding that as long as conditions remain stable in an ecosystem, populations in the system will remain stable, but if conditions change, then so too will populations.

Through this bundle, students should be given opportunity to collect and interpret data showing, for example, that plentiful rainfall affects the number of plants in an area. Large numbers of plants will result in large numbers of herbivores and large numbers of herbivores will result in large numbers of carnivores. If however, rainfall is scarce, the number of plants is scarce and thus the number of herbivores and carnivores is also scarce. The number of plants is a limiting factor for the herbivore and carnivore population and rainfall is a limiting factor for plant population. If the number of animals becomes scarce, carnivores will compete for these animals and consequently be limited in their growth and reproduction. Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Students should begin to see patterns in these cause and effect relationships and construct explanations that predict these patterns.

Lesson Level Performance Expectations

- Students can construct an explanation that populations are in constant fluctuation causing their characteristics to vary over time.
- Students can engage in argument from evidence that changes to the biotic and abiotic components of an ecosystem can change all of the populations in an ecosystem.
- Students can construct an explanation that includes the quantitative relationships between predators and prey to demonstrate that the population of one directly affects the population of the other.
- Students can construct an explanation of the relationship between organisms that are mutually beneficial to each other (symbiosis) and that these relationships are vital to the survival of both organisms.
- Students can interpret data and show patterns to demonstrate that populations are limited by the availability of resources like food, water, oxygen, carbon dioxide and sunlight.
- Students can construct an explanation that includes quantitative evidence that competition for available resources (both living and non-living) can restrict the size of a given population(s).
- Students can engage in argument from evidence to exhibit that reproduction rates and thus populations are dependent on the availability of living and non-living resources.

Misconceptions	Accurate Concept
1. If a population in a food web is disturbed, there will be little or no effect on populations that are not within the linear sequence in the food web. 2. Varying the size of a population of organisms will affect only those populations of organisms that are directly connected to it in a feeding relationship, not organisms that are one or more steps removed/away from it. 3. If a population in a food web is disturbed, there will be little or no effect on populations below it in the food web. 4. A change in the size of a prey population has no effect on	1-6. All organisms, both land-based and aquatic, are connected to other organisms by their need for food. This results in a global network of interconnections, which is referred to as a food web. 7-10. In all environments, individual organisms that depend on the same resource may compete for that resource when it is limited. Resources that can be limited include food, space, water, shelter, and light. 11. Given adequate resources and an absence of disease or predators, populations of organisms in ecosystems can increase at rapid rates. Finite resources and other factors limit their growth.

its predator population.

5. The top predator in a food web will never be significantly affected by changes in the populations of organisms below it in the food web.
6. Changes in a population in a food web do not affect the populations of any other organism in the food web.
7. Competition between organisms always involves direct, aggressive interaction. Exploitative competition (e.g., getting to the resource before other organisms) is not competition.
8. Plants do not compete for resources.

References

- (American Association for the Advancement of Science) http://assessment.aaas.org/topics/IE#/

Bundle: Health of Ecosystems

MS-ESS3-3 Earth and Human Activity

Students who demonstrate understanding can:

Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

In Lay Terms

An ecosystem's health is measured by its biodiversity or the variety of life it contains, both in numbers of different species, and as variations that exist within a species (e.g. darker or lighter fur, or taller or shorter stems). Humans can serve to either disrupt or provide solutions for the delicate balance of an ecosystem.

Three Dimensional Storyline

In this performance expectation, students should understand that an ecosystem with many different organisms and much variation within each species (much biodiversity) is a healthy ecosystem. When an event happens to disrupt the diversity and thus the health of an ecosystem, the ecosystem is no longer stable. Small changes or events in one part of an ecosystem might cause large changes in another part. These events can be imposed by humans (e.g. pollution or loss of habitat), or by nature (as in the case of droughts, or catastrophic events like a fire, hurricane or disease). A healthy/diverse ecosystem can recover more easily after such an event. For example, if a disease kills out a species of trees in a forest, the forest with a diverse tree population (e.g. 25 other species of trees) will recover much more quickly than the forest with only 1 other species of tree.

Ecosystem health is important to the organisms that live there and is also important to humans, as humans rely on ecosystems for resources and services, in the form of medicine, food, energy, and even pollution-cleaning aspects. The health of ecosystems is often due, at least in part to the influence of humans. Sometimes the ecosystem benefits from human involvement and sometimes, humans are harmful to the ecosystem. Humans can help the health of an ecosystem, for example, by cleaning up an old oil well site, or restoring a wetland. A harmful human effect would be over spraying fields with fertilizers, which runs off into waterways. Through this bundle, students should both discover and use methods for monitoring human impacts and discover ways to minimize human's impact on our planet. Students should apply scientific principles to design a system and design solutions to protect and/or return the health of ecosystems. No matter what the cause (e.g. the introduction of a new species or pesticides into an area or by inhabiting the space of an ecosystem), students should be able to understand the effects and construct an explanation as well as design a possible solution for reducing the negative effects humans have on ecosystems, and also be able to evaluate competing design solutions to maintain the biodiversity and thus health of ecosystems.

Lesson Level Performance Expectations

- I can analyze and interpret data that biodiversity is the variety of species in an ecosystem.
- I can engage in argument from evidence that an ecosystem's health can be measured by its biodiversity.
- I can develop and use a model to demonstrate that the health of an ecosystem can affect the resources and ecosystem services available for human use.
- I can construct an explanation demonstrating how humans affect ecosystems both negatively (as in, habitat destruction) or positively by restoring the health of an ecosystem (as in, the reintroduction of wolves into Yellowstone National Park.)
- I can construct an explanation as to how human factors can cause the extinction of species.
- I can apply scientific principles to design a system for humans to monitor the health of an ecosystem.
- I can apply scientific principles to design a system for humans to use technology and resources responsibly in order to maintain Earth's biodiversity and health.
- I can evaluate competing design solutions for maintaining biodiversity and ecosystem services based on jointly developed and agreed-upon design criteria.
- I can engage in argument from evidence that technological advances can contribute to the demise and/or maintenance of healthy ecosystems.

Misconceptions	Accurate Concept
1. If a population in a food web is disturbed, there will be little or no effect on populations that are not within the linear sequence in the food web. 2. Changes in a population in a food web do not affect the populations of any other organism in the food web. 3. Varying the population size of a species may not affect an ecosystem because some organisms are not important. 4. Ecosystems are not a functioning whole, but simply a collection of organisms 5. Ecosystems change little over time. 6. Species coexist in ecosystems because of their compatible needs and behaviors; they need to get along	1-3 All populations in a food web have an effect on the other components ir the food web as well as other systems. 4. Ecosystems include not just the organisms, but also the interactions between organisms and between the organisms and their physical environment. 5. Ecosystems are both stable and dynamic in nature. 6. Within an ecosystem, species compete for resources and feed on one another. Species live in the same ecosystem because of similar adaptations and environmental needs. 7. Traits are developed across generations in response to environmental demands. 8. Human actions are capable of affecting ecosystems across the planet.

7. Humans can't negatively impact ecosystems, because species will just evolve what they need to survive.
8. Humans are not capable of impacting ecosystems far away. Plants are dependent on humans.
9. Humans (and all other animals) are dependent on plants.

References

- American Association for the Advancement of Science
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For questions or feedback contact:

Tiffany Neill

Tiffany.Neill@sde.ok.gov

405-522-2524

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