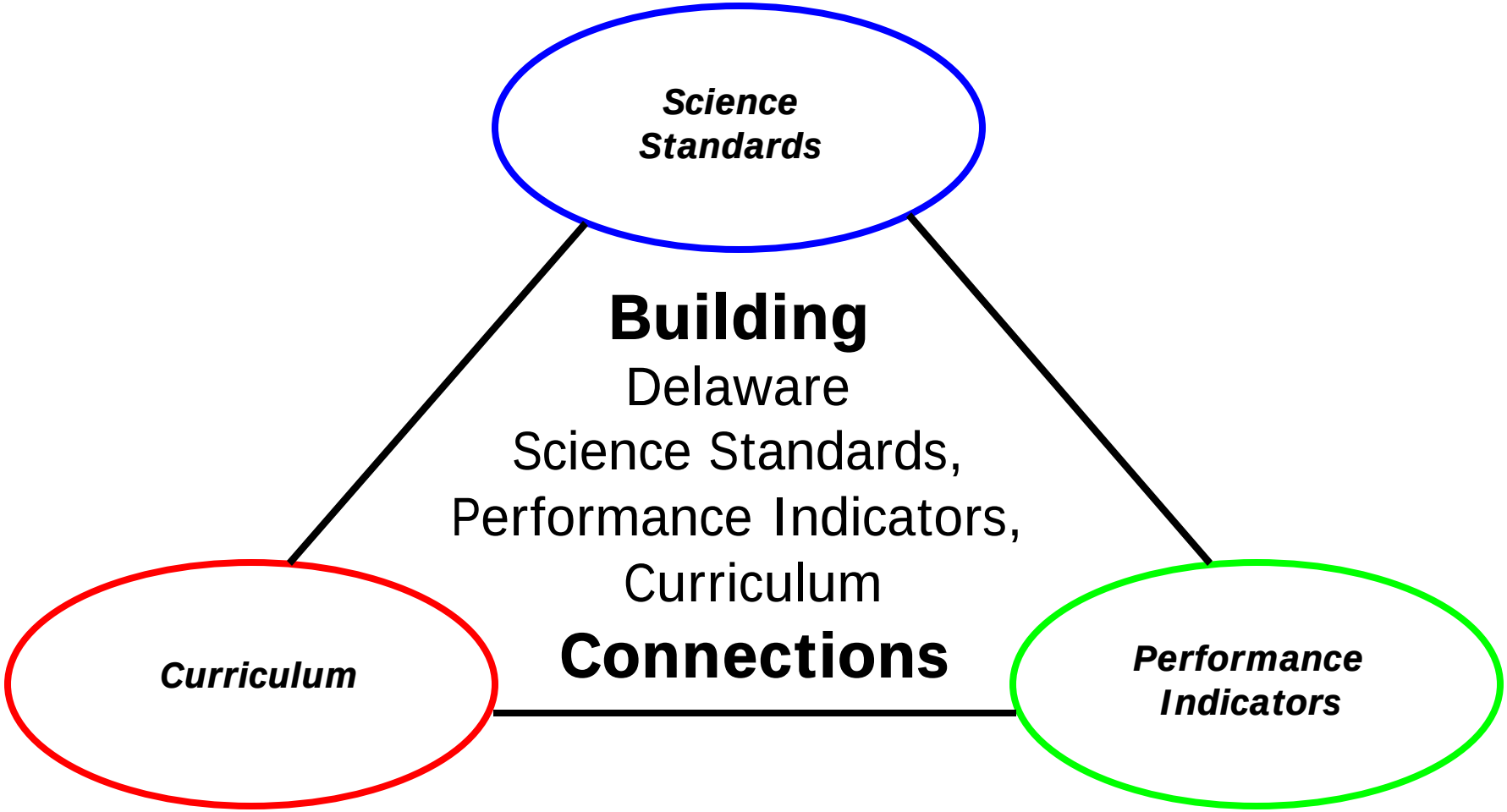


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## *Grade 11 Science Standards and Performance Indicators*
## *12-6-00 Draft*

**Standard #1 – Nature and Application of Science**

| Science Standard | Performance Indicators | Concept | Unit(s) |
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| **Science, Technology, and Society**<br>1.21 (6) The practice of science and technology is not a linear process. In many cases, the desire of the scientists to find what is real in nature creates opportunity for technology development. At the same time, technology provides scientists with tools and techniques that allow expansion of their capabilities and effectiveness. | 11.12 Compare Aristotle's theories regarding Earth's position in the Solar System to those of Copernicus. Explain how Aristotle's gravitational theory, which was based on an Earth-centered view of the Solar System, was rendered implausible when Copernicus advanced his theory that the Sun was at the center of the Solar System.<br>11.13 Read accounts on the life of Copernicus and the theories he developed regarding gravity. Recognize that although Copernicus was correct in his belief that the Sun is at the center of the Solar System, his understanding of gravity (only similar matter interacts) was incomplete.<br>11.14 Examine Galileo's life and the theories he developed. Explain his theories regarding free falling bodies, and how the theories advanced scientific understanding of motion. Recognize that in spite of his expanded understanding of free falling bodies, he was still committed to the belief that only like substances attract.<br>11.15 Describe how Kepler's analysis of data acquired from earlier astronomers' observations led to his conclusion that the Earth, the Moon, the Sun, and the waters all interact gravitationally. Describe also how Kepler's observations led to his identification of patterns of movement of the planets around the Sun. Explain the extent to which the results of Kepler's investigations influenced theories developed by Newton.<br>11.16 Discuss the life and work of Newton. Recognize that Newton's Law of Universal Gravitation and Laws of Motion provided the theoretical basis for explaining Keptlers' Laws of Planetary Motion.<br>11.17 Identify the cultural events, beliefs, and/or values that either hindered or helped promote acceptance of the Law of Universal Gravitation. Explain how cultural influences often determine societies' willingness to embrace and accept new scientific understandings. | Science and Technology<br><br>Nature of Science<br><br>History of Science | Physics – One Semester Junior Year for Those Below Grade Level in Math. Students on grade level or above in math take this senior year. Need to provide later students with study guide junior year or summer before junior year. |
| 1.22 (6) The social, economic, and political forces of a society have a significant influence on what science and technology programs are pursued, invested in, and used. | 11.12 Compare Aristotle's theories regarding Earth's position in the Solar System to those of Copernicus. Explain how Aristotle's gravitational theory, which was based on an Earth-centered view of the Solar System, was rendered implausible when Copernicus advanced his theory that the Sun was at the center of the Solar System. | Science and Social, Economic, and Political Forces | |

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| **History and Context of Science**<br>1.31 (7) Science is an international activity in which significant inventions and innovations have come from around the world. Even though scientists live and work in different cultures and come from different backgrounds, many of their activities are part of international collaborative efforts, and the knowledge created is shared in order to maximize the benefits to society. | 11.12 Compare Aristotle's theories regarding Earth's position in the Solar System to those of Copernicus. Explain how Aristotle's gravitational theory, which was based on an Earth-centered view of the Solar System, was rendered implausible when Copernicus advanced his theory that the Sun was at the center of the Solar System.<br>11.13 Read accounts on the life of Copernicus and the theories he developed regarding gravity. Recognize that although Copernicus was correct in his belief that the Sun is at the center of the Solar System, his understanding of gravity (only similar matter interacts) was incomplete.<br>11.14 Examine Galileo's life and the theories he developed. Explain his theories regarding free falling bodies, and how the theories advanced scientific understanding of motion. Recognize that in spite of his expanded understanding of free falling bodies, he was still committed to the belief that only like substances attract.<br>11.15 Describe how Kepler's analysis of data acquired from earlier astronomers' observations led to his conclusion that the Earth, the Moon, the Sun, and the waters all interact gravitationally. Describe also how Kepler's observations led to his identification of patterns of movement of the planets around the Sun. Explain the extent to which the results of Kepler's investigations influenced theories developed by Newton.<br>11.16 Discuss the life and work of Newton. Recognize that Newton's Law of Universal Gravitation and Laws of Motion provided the theoretical basis for explaining Keptlers' Laws of Planetary Motion.<br>11.17 Identify the cultural events, beliefs, and/or values that either hindered or helped promote acceptance of the Law of Universal Gravitation. Explain how cultural influences often determine societies' willingness to embrace and accept new scientific understandings.<br>11.47 Describe how an accumulation of evidence was required before scientists were willing to accept the Theory of Plate Tectonics. | Communicatio n<br><br>Collarboration<br><br>Contemporary And Historical Context of Science | |

## Standard 3 – Energy and Its Effects

| Science Standard | Performance Indicators | Concept | Unit(s) |
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| **Forms/Sources of Energy**<br>3.12 (3) Electricity results from the movement of electric charges through a complete circuit under the influence of an applied voltage. The electric current flowing in any circuit or part of a circuit depends on the voltage and resistance and can be calculated using Ohm's Law. | 11.33 Use appropriate technology (e.g., ammeters, voltmeters) to verify the relationship between electric current, voltage, and resistance. Recognize the electric current flowing in any circuit or part of a circuit depends on the voltage and resistance and can be calculated using Ohm's Law.<br>11.34 Conduct investigations to determine the extent to which various factors such as material composition, dimensions of the material (e.g., length, width, diameter) and temperature effect electrical resistance.<br>11.35 Apply Ohm's Law to series, parallel, and combination circuits to determine the relationship between current, voltage, and resistance. | Electricity<br><br>Ohm's Law | |
| 3.13 (5) 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 the physical and mechanical properties of materials (e.g., frictional forces, force of a compressed spring, surface tension, or boiling point of a liquid). | 11.29 Conduct electrostatic investigations (e.g., rubbing a glass rod against silk, rubbing a balloon and sticking it on the wall) to demonstrate the extent to which different objects will attract other objects. Explain how in these cases when two objects are put in contact, one of them looses electrons becoming positively charged, while the other gains electrons becoming negatively charged.<br>11.30 Use visual representations to trace the movement of the electrons between negatively or positively charged objects and neutral objects.<br>11.31 Recognize that objects of like charge repel each other, while objects of opposite charge attract each other. The attractive and repelling forces between the objects is the electrical force.<br>11.32 Use a Van de Graaf generator to demonstrate the build up of static charges and the visible discharge of electrons from one area to another. Relate the results of the demonstration to the phenomenon of cloud to ground lightning.<br>11.34 Conduct investigations to determine the extent to which various factors such as material composition, dimensions of the material (e.g., length, width, diameter) and temperature effect electrical resistance. | Electric Forces<br><br>Electromagnetic<br>Forces<br><br>Gravitational<br>Forces | |
| 3.14 (2) Magnetic forces and electric forces are thought of as different aspects of a single electromagnetic force. Moving electric charges produce magnetic fields which exert magnetic force on other objects and produce electric forces. The interaction of electric and magnetic forces is the basis for | 11.36 Recognize that an electric current in a wire has a detectable magnetic field and that electricity and magnetism are two aspects of a single electromagnetic force.<br>11.37 Conduct investigations to demonstrate and to explain that moving electric charges (in a current carrying wire) | Magnetic<br>Forces<br><br>Electric Forces | |

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| electric motors, electric generators, and many other modern technologies. | produce magnetic forces and that moving magnets produce electric forces. Relate the results of the electromagnetic force investigations to explain how electric motors and generators work. | Electromagnetic Forces<br><br>Applications in Daily Life | |
| **Force and Motion**<br>3.22 (5) Displacement, velocity, acceleration, and time are used to describe the motion or changes in motion of an object. | 11.01 Conduct investigations using appropriate technologies to explain the relationship between distance, time, velocity and acceleration for an object in horizontal and vertical motion.<br>11.02 Graph data collected in horizontal and vertical motion investigations and describe the relationship between the distance vs. time graphs, and the objects velocity and acceleration.<br>11.03 Calculate the average velocity ($v=d/t$) and average acceleration $a=(v-v_0)/(t-t_{0)})$ of an object in motion.<br>11.05 Use data gathered in previous motion investigations to describe the vertical motion of an object (with weight as the only force acting on the object) and demonstrate that the object rises and falls at a constant acceleration due to gravity.<br>11.06 Use data gathered in previous motion investigations to demonstrate that vertical acceleration due to gravity is unaffected by constant horizontal motion of an object. Recognize that objects fall at the same rate independent of any initial horizontal velocity. | Speed, Velocity, and Acceleration | |
| 3.23 (16) Objects can have linear motion, rotational motion, or both. Newton's Laws can be used to predict changes in linear motion and/or rotational motion. Momentum allows objects to remain in motion after the applied force is removed. The Law of Conservation of Momentum can be used to predict the outcomes of a collision between moving objects. | 11.01 Conduct investigations using appropriate technologies to explain the relationship between distance, time, velocity and acceleration for an object in horizontal and vertical motion.<br>11.02 Graph data collected in horizontal and vertical motion investigations and describe the relationship between the distance vs. time graphs, and the objects velocity and acceleration.<br>11.04 Recognize that all objects exert attractive gravitational force on other objects, and that this mutual attraction between two masses explains how objects, the atmosphere, and the seas stay fixed to the surface of the earth.<br>11.05 Use data gathered in previous motion investigations to describe the vertical motion of an object (with weight as the only force acting on the object) and demonstrate that the object rises and falls at a constant acceleration due to gravity.<br>11.06 Use data gathered in previous motion investigations to demonstrate that vertical acceleration due to gravity is unaffected by constant horizontal motion of an object. Recognize that objects fall at the same rate independent of | Motion<br><br>Newton's Laws<br><br>Momentum | |

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| | any initial horizontal velocity.<br>11.07 Apply Newton's Law of Motion when investigating the effect of force on velocity, acceleration, and equilibrium of an object. Recognize that the tendency of an object to remain at rest or in motion is called inertia. To change the motion of an object with inertia, unbalanced forces must act on the object.<br>11.08 Conduct investigations to explain the relationship between the launching angle of an object in projectile motion and the horizontal and vertical distance traveled by the object.<br>11.09 Conduct investigations using appropriate technologies to explain the relationship between an object's mass and motion, and that object's momentum. Recognize that momentum is a measure of the difficulty encountered in bringing an object to rest. The greater the object's mass and velocity, the greater is its momentum (P=mv).<br>11.10 Use data gathered in momentum investigations to demonstrate that the change in momentum of an object is dependent on the force acting on it and the time over which the force acts. Recognize that if an object is stopped very quickly the force involved is large, but if an object is stopped more slowly the force involved is smaller (Ft=m(v-vo)).<br>11.11 Apply momentum concepts to practical situations such as collisions, seat belts, airbags, sports, and rocket motion. Use the Law of Conservation of Momentum to predict the outcomes of a collision between moving objects.<br>11.18 Use Newton's Law of Universal Gravitation to explain why the Moon exerts a smaller gravitational force on an object than the Earth would on that same object. Use the same law to also explain why an object weighs less in space than it does on Earth.<br>11.19 Use tide tables and a lunar calendar as evidence to explain the mutual gravitational attraction between the Earth and the Moon.<br>11.20 Observe the circular motion of a variety of objects such as a rubber stopper wheeling around on the end of a string, a coin resting on a rotating turntable, etc. Recognize that circular motion always requires a force pulling the moving object toward the center of the circle (centripetal force). Relate this phenomenon to a satellite orbiting Earth.<br>11.21 Use results from previous projectile and vertical motion investigations to describe how it is possible to launch rockets into outer space and have them maintain their orbit.<br>11.22 Use the Law of Conservation of Momentum to explain how a spacecraft in orbit around the Earth moves out of orbit by firing its rocket motors. Recognize that when | | |

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| | burned fuel is pushed out the back of the motor, the spacecraft moves forward and the total momentum of the spacecraft and gases is unchanged.<br>11.23 Relate the results of projectile motion investigations to sports, such as, long jump, high jump, shot put, basketball, etc. Describe how the Laws of Motion that apply to the launching of rockets likewise apply in the world of sports. | | |
| **Production / Consumption / Application of Energy**<br>3.51 (1) Demand for energy by society leads to continuous exploration in order to expand supplies of fossil fuels (e.g., drilling deeper oil and gas wells, drilling offshore). In addition, technology has been developed to create alternate energy sources (e.g., solar collection, ocean thermal energy conversion) and to increase the energy efficiencies of commonly used machines and appliances. | 11.38 Research how local electric power stations use electric and magnetic forces to generate electricity. | Energy Demand Fuels Research in Technology | |
| 3.52 (2) Advances in the scientific understanding of synthetic materials have provided new devices (e.g., transistors, light emitting diodes, optical switches, superconducting ceramics) used in electronic equipment. This has revolutionized many aspects of life (e.g., communications, manufacturing, information processing, and transportation). | 11.11 Apply momentum concepts to practical situations such as collisions, seat belts, airbags, sports, and rocket motion. Use the Law of Conservation of Momentum to predict the outcomes of a collision between moving objects.<br>11.38 Research how local electric power stations use electric and magnetic forces to generate electricity. | Applications of Synthetic Materials | |

## Standard 4 – Earth in Space

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| **Solar System Models**<br>4.12 (3) The stars in the Milky Way Galaxy are separated by vast distances. Although it takes light from the Sun eight minutes to reach the Earth, it takes the light from the next nearest star four years to reach Earth. Light which reaches Earth from distant galaxies is millions of years old and is actually a view of the past. | 11.24 Construct spatial models of the solar system to accurately convey the vastness of the Universe and the smallness of the human scale in relation to the cosmic scale.<br>11.25 Construct models of cosmic evolution, such as time-lines, walks through time, or cosmic calendars, to represent the enormous length of the cosmic time scale.<br>11.26 Research and describe at least one of the significant episodes of cosmic evolution (e.g., Big Bang, formation of the Sun and planets, and future life cycle of the sun). Identify several observations which demonstrate why our understanding of the episode has become secure scientific theory, and to explain the connection between theory and evidence. | Light<br><br>Spatial Modets | |
| 4.13 (1) The distance form the center of the nebula to points of condensation determine the position of the planets in the Solar System. The masses of the condensed protoplanets determined which elements were retained, as well as their physical state. | 11.28 Use library and internet resources to identify characteristics of the Earth which permit it to support life, and compare those characteristics to properties of other planets. Based on the research, debate the possibility of life on other planets. | Elements on Planets | |
| 4.14 (1) The tilt of the Earth's axis relative to its orbital plane does not change as the Earth orbits the Sun during a year. Seasonal variations of the apparent path of the Sun through the sky determine how directly the Sun's rays strike and warm different areas of the Earth. | 11.27 Using any number of devices (e.g., models of the Earth and Sun, flashlights shining on graph paper, thermometers, observation of the sun in the real sky, and computer simulations) to demonstrate how the amount and distribution of energy that reaches the Earth from the sun, determines seasonal and global climates. | Seasons<br><br>Tilt of Earth | |

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| **Interactions in the Solar System**<br>4.21 (6) Gravitation pulls planets toward the Sun balancing each planet's energy of motion. The gravitational pull of the Sun and the Moon determine the times for high tides and the intensity of these tides on Earth. | 11.04 Recognize that all objects exert attractive gravitational force on other objects, and that this mutual attraction between two masses explains how objects, the atmosphere, and the seas stay fixed to the surface of the earth.<br>11.18 Use Newton's Law of Universal Gravitation to explain why the Moon exerts a smaller gravitational force on an object than the Earth would on that same object. Use the same law to also explain why an object weighs less in space than it does on Earth.<br>11.19 Use tide tables and a lunar calendar as evidence to explain the mutual gravitational attraction between the Earth and the Moon.<br>11.20 Observe the circular motion of a variety of objects such as a rubber stopper wheeling around on the end of a string, a coin resting on a rotating turntable, etc. Recognize that circular motion always requires a force pulling the moving object toward the center of the circle (centripetal force). Relate this phenomenon to a satellite orbiting Earth.<br>11.21 Use results from previous projectile and vertical motion investigations to describe how it is possible to launch rockets into outer space and have them maintain their orbit.<br>11.22 Use the Law of Conservation of Momentum to explain how a spacecraft in orbit around the Earth moves out of orbit by firing its rocket motors. Recognize that when burned fuel is pushed out back of the motor, the spacecraft moves forward and the total momentum of the spacecraft and gases is unchanged. | Tides<br><br>Gravitational Pull | |
| **Technology and Application**<br>4.31 (2) Space exploration expands our knowledge of the Universe and advances the technological sophistication of society. | 11.21 Use results from previous projectile and vertical motion investigations to describe how it is possible to launch rockets into outer space and have them maintain their orbit.<br>11.22 Use the Law of Conservation of Momentum to explain how a spacecraft in orbit around the Earth moves out of orbit by firing its rocket motors. Recognize that when burned fuel is pushed out the back of the motor, the spacecraft moves forward and the total momentum of the spacecraft and gases is unchanged. | Space Exploration<br><br>Technology | |

## Standard 5 – Earth's Dynamic Systems

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| **Interactions Among Earth's Systems**<br>5.21 (9) The theory of plate tectonics is supported by structural evidence (volcanoes, plateaus, mountain ranges) geophysical evidence (earthquakes waves, magnetic reversals in rock), and paleontoglogical evidence (biological similarities between flora and fauna of widely separated continents). | 11.39 Use models or computer simulations to demonstrate what occurs when two landmasses move towards each other. Describe how the properties of the sediments and the movement of the masses can result in folds or faults.<br>11.40 Use geological cross sections and three dimensional models to demonstrate how relative dating techniques can be used to determine geological events and the age of folded or faulted land forms.<br>11.41 Observe computer or video simulations to describe what occurs when two landmasses or tectonic plates separate. Explain why scientists now believe that the creation of ocean crust along the mid-ocean ridge is related to plate separation.<br>11.42 Recognize that the theory of plate tectonics supports the scientific belief that rigid plates move over the Earth's Surface, and that earthquakes, volcanoes, and mountain ranges occur at plate boundaries.<br>11.43 Use the internet, library, or other databases to compile a list of earthquakes or volcanoes which have occurred over a given period of time. Determine the location of these occurrences (by latitude and longitude) on a map or globe, and identify any patterns in the occurrence of volcanoes and earthquakes.<br>11.44 Describe how patterns identified in the previous plotting activity supports the theory of plate tectonics.<br>11.45 Recognize that the movement of continents occurs because they are part of rigid tectonic plates that move and that the energy required to move these plates comes from Earth's internal heat.<br>11.46 Work collaboratively within a group to research how specific pieces of evidence support the Theory of Plate Tectonics. Selection of evidence to be researched could include the following:<br>• palm tree fossils found in Greenland'<br>• remarkable similarity of rocks, geologic structures and fossils on opposite sides of the Atlantic Ocean;<br>• fossils of the late Paleozoic reptiles Mesosaurus found in eastern South America and western Africa and nowhere else in the world;<br>• evolution of vertebrates and land plants showed similarities in development in different continents up to the supposed break up time, but then | Plate Tectonics<br><br>Support of Theory | |

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| | divergent evolutionary paths;<br>• distribution of Permian glaciers and deposit of "Moraine" in South American, Africa, Australia, India;<br>• marsupial mammals found in Australia and South America;<br>• deep sea sediments containing fossils found on land;<br>• newer rocks and sediments found at the mid-ocean;<br>• magnetic reversals found in rocks in the Atlantic Ocean floor.<br>11.48 Explain how the Theory of Plate Tectonics demonstrates that scientific knowledge changes by evolving over time. Recognize that although some theories are initially rejected, they may be re-examined and eventually accepted in the face of new evidence. | | |
| 5.22 (9) Movement of tectonic plates releases energy, bringing new materials to Earth's surface, which balances the effects of erosion and weathering. | 11.39 Use models or computer simulations to demonstrate what occurs when two landmasses move towards each other. Describe how the properties of the sediments and the movement of the masses can result in folds or faults.<br>11.40 Use geological cross sections and three dimensional models to demonstrate how relative dating techniques can be used to determine geological events and the age of folded or faulted land forms.<br>11.41 Observe computer or video simulations to describe what occurs when two landmasses or tectonic plates separate. Explain why scientists now believe that the creation of ocean crust along the mid-ocean ridge is related to plate separation.<br>11.42 Recognize that the theory of plate tectonics supports the scientific belief that rigid plates move over the Earth's Surface, and that earthquakes, volcanoes, and mountain ranges occur at plate boundaries.<br>11.43 Use the internet, library, or other databases to compile a list of earthquakes or volcanoes which have occurred over a given period of time. Determine the location of these occurrences (by latitude and longitude) on a map or globe, and identify any patterns in the occurrence of volcanoes and earthquakes.<br>11.44 Describe how patterns identified in the previous plotting activity supports the theory of plate tectonics.<br>11.45 Recognize that the movement of continents occurs because they are part of rigid tectonic plates that move and that the energy required to move these plates comes from Earth's internal heat.<br>11.46 Work collaboratively within a group to research how | | |

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