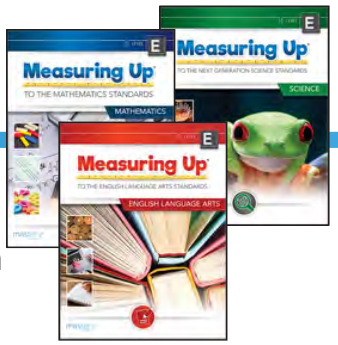
Try It Out! Sample Pack | Science | Grade 8 | Lesson 15
Measuring Up to the Standards



The **Try It Out!** sample pack features:

- 1 full student lesson with complete Teacher Edition lesson
- 1 full Table of Contents for your grade level
- Correlation to the standards

Developed to meet the rigor of the standards, ***Measuring Up*** employs support for using and applying critical thinking skills with direct standards instruction that elevate and engage student thinking.

Standards-based lessons feature introductions that set students up for success with:

- ✔ Vocabulary in Action
- ✔ Relevant real-world connections
- ✔ Clearly identified learning goals
- ✔ Connections to prior learning

Guided Instruction and Independent Learning strengthen learning with:

- ✔ Deep thinking prompts
- ✔ Collaborative learning
- ✔ Self-evaluation
- ✔ Demonstration of problem-solving logic
- ✔ Application of higher-order thinking

Flexible design meets the needs of whole- or small-group instruction. Use for:

- ✔ Introducing standards
- ✔ Reinforcement or standards review
- ✔ Intervention
- ✔ Remediation
- ✔ Test Preparation

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Measuring Up® from mastery education

WORDS TO KNOW

axis

latitude

longitude

Coriolis effect

Lesson 15

WHAT FACTORS CREATE GLOBAL CLIMATE PATTERNS?

THE BIG IDEA

- Global climates are created by a combination of energy from the sun and Earth's tilted axis.
- Air and water currents help circulate energy and create climate patterns.

WHAT I NEED TO KNOW

Earth's movement accounts for many changes and patterns on Earth, including the weather. The unequal heating and rotation of Earth directly affect weather and global climate patterns. Weather is what happens in one area over a short period of time, while climate is a region's long-term weather pattern.

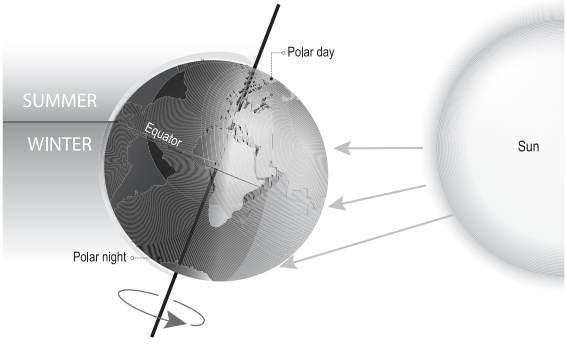
Earth spins, or rotates, on its **axis**, which is an imaginary line that passes through Earth's poles. Each rotation takes about 24 hours—the length of one Earth day. Earth also revolves, or orbits, around the sun. Each revolution around the sun takes about 365¼ days—the length of one year.

Earth's rotation explains some daily changes on the planet. For example, the sun, moon, and stars appear to rise from the eastern horizon and set along the western horizon. This is because Earth turns toward the east as it rotates.

THINK ABOUT IT

If you were viewing Earth from below the South Pole, Earth would be rotating clockwise. If viewing from above the North Pole, Earth would be rotating counterclockwise. Why?

EARTH'S SEASONS



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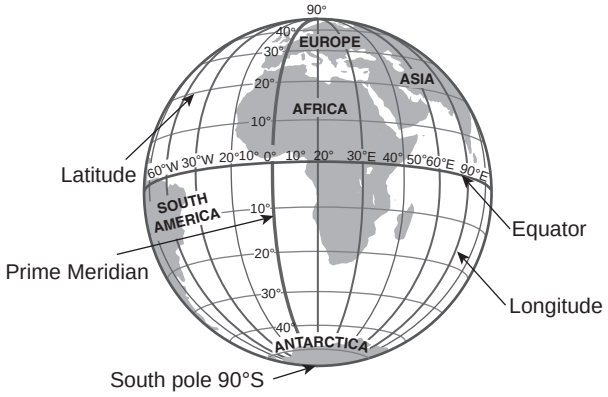
Earth's tilted axis and revolution around the sun cause changes, such as the different seasons that occur over the course of a year. The different seasons bring different weather.

Lines of **latitude** and **longitude** form a coordinate, or grid, system that is used to identify locations on Earth's surface. Latitude lines on maps and globes show distances north and south of the equator. Lines of latitude circle Earth, running east to west, parallel to the equator.

Longitude lines on maps and globes show distances east and west of the prime meridian. The prime meridian is an imaginary line that divides the Earth into eastern and western hemispheres, or halves. Lines of longitude circle Earth, running north to south and intersecting at Earth's geographic poles.



Earth's tilted axis and energy from the sun create global climates. Air masses and ocean water currents help to circulate the sun's energy and create climate patterns. Air masses and ocean currents move in a predictable way because of a force called the **Coriolis effect**. The Coriolis effect causes objects with mass (like air or water) to rotate to the right in the northern hemisphere and rotate to the left in the southern hemisphere. This predictable movement of air and water helps account for some global climate patterns.

Global climate patterns are also driven by a region's location on the planet. Higher latitudes (those from 50°–90°) receive less solar energy (direct light from the sun) than do lower latitudes (from 10°–40°), resulting in temperature differences. Elevation also affects climate. In general, areas at higher elevations, such as mountainous regions, have lower average temperatures than do areas at lower elevations, such as valleys and deserts. Landforms such as mountains deflect wind and can force it to higher elevations.

Smaller temperature changes tend to occur in oceans than on land. Because water can absorb more solar energy than land, there is a greater and more rapid temperature change on land. Therefore, the centers of landmasses, such as cities in the middle of continents, experience more rapid temperature changes than cities near oceans.

TURN AND TALK

Talk with a classmate and decide on the best way to build a model of Earth and its axis. What simple materials could you use to create it?

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WHAT I HAVE LEARNED

HINT, HINT

Lines of latitude run east to west; lines of longitude run north to south.

1. What factors influence the amount of solar energy at a particular place on Earth?

   Ⓐ Earth's tilt and velocity

   Ⓑ Earth's tilt and wind speed

   Ⓒ The particular season and latitude of the place

   Ⓓ The particular season and longitude of the place

2. What causes seasonal changes on Earth?

   Ⓐ Seasons are caused by the sun's revolution around Earth.

   Ⓑ Seasons are caused by Earth's tilt and revolution around the sun.

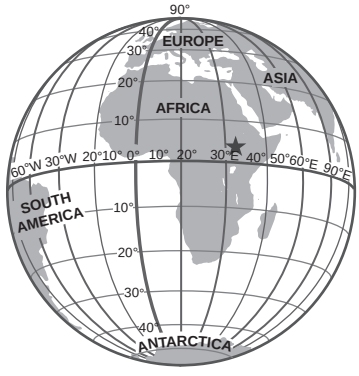
   Ⓒ Seasons are caused by the moon's revolution around Earth.

   Ⓓ Seasons are caused by Earth's tilt and revolution around the moon.

3. A student is using the graphic shown here to determine a location's climate. She knows the latitude and longitude coordinates, which are 3°N, 32°E. What can she determine about the location's general climate based on this graphic?

HINT, HINT

Pay close attention to the location. Is it near the ocean or surrounded by land? Near the equator or close to a pole?



   Ⓐ The location is hot and dry.

   Ⓑ The location is hot and rainy.

   Ⓒ The location is cold and snowy.

   Ⓓ The location is humid and snowy.

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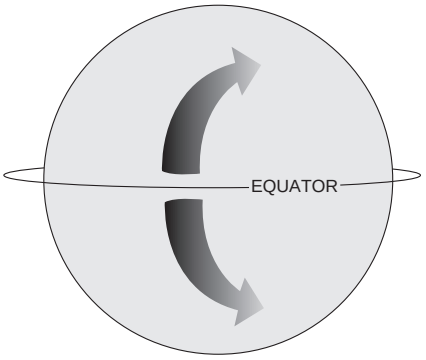
Study the image below that shows a simple representation of the Coriolis effect. Use this image to answer questions 4 and 5.



4. What conclusion can you draw based on this image?

Ⓐ The heating of air and water is unpredictable.

Ⓑ Temperatures are consistent across the globe.

Ⓒ Cool air and water move away from the poles.

Ⓓ Warm air and water move away from the equator.

5. Look again at the image. Why is warmer air near the equator?

Ⓐ The equator is where Earth's heat comes from.

Ⓑ The equator receives more thermal energy from the sun.

Ⓒ The equator receives less thermal energy from the sun.

Ⓓ There is more land mass near the equator.

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References

Correlation to the Next Generation Science Standards

This worktext is customized to the Next Generation Science Standards.

Middle School Standards	Lessons
Middle School Standards – Physical Sciences	
Disciplinary Core Idea MS-PS1: Matter and Its Interactions	
MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures. *Clarification Statements: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of particulate-level models could include drawings, 3D ball and stick structures, or computer representations showing different substances with different types of atoms.* *Assessment Boundaries: Assessment does not include valence electrons and bonding energy, discussing the individual ions composing complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.*	18
MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. *Clarification Statements: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.* *Assessment Boundaries: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.*	19, Unit 5 Inv
MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. *Clarification Statements: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.* *Assessment Boundaries: Assessment is limited to qualitative information.*	20
MS-PS1-4 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. *Clarification Statements: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.*	21
MS-PS1-5 Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. *Clarification Statements: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.* *Assessment Boundaries: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.*	22

CORRELATIONS

Middle School Standards	Lessons
MS-PS1-6 Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. *Clarification Statements: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.* *Assessment Boundaries: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.*	23
Disciplinary Core Idea MS-PS2: Motion and Stability: Forces and Interactions	
MS-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. *Clarification Statements: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.* *Assessment Boundaries: Assessment is limited to vertical or horizontal interactions in one dimension.*	38
MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. *Clarification Statements: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system (including simple machines), qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.* *Assessment Boundaries: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.*	39
MS-PS2-3 Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. *Clarification Statements: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.* *Assessment Boundaries: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.*	40
MS-PS2-4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. *Clarification Statements: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.* *Assessment Boundaries: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.*	41
MS-PS2-5 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. *Clarification Statements: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.* *Assessment Boundaries: Assessment is limited to electric and magnetic fields, and limited to qualitative evidence for the existence of fields.*	42

Middle School Standards	Lessons
Disciplinary Core Idea MS-PS3: Energy	
MS-PS3-1 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. *Clarification Statements: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.* *Assessment Boundaries: Assessment could include both qualitative and quantitative evaluations of kinetic energy.*	43, Unit 8 Inv
MS-PS3-2 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. *Clarification Statements: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems* *Assessment Boundaries: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.*	44, Unit 8 Inv
MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. *Clarification Statements: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.* *Assessment Boundaries: Assessment does not include calculating the total amount of thermal energy transferred.*	10, Unit 3 Inv
MS-PS3-4 Plan and conduct an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the temperature of the sample of matter. *Clarification Statements: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.* *Assessment Boundaries: Assessment does not include calculating the total amount of thermal energy transferred.*	11
MS-PS3-5 Construct, use, and present an argument to support the claim that when work is done on or by a system, the energy of the system changes as energy is transferred to or from the system. *Clarification Statements: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.* *Assessment Boundaries: Assessment could include calculations of work and energy.*	12
Disciplinary Core Idea MS-PS4: Waves and Their Applications in Technologies for Information Transfer	
MS-PS4-1 Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. *Clarification Statements: Emphasis is on describing waves with both qualitative and quantitative thinking.* *Assessment Boundaries: Assessment is limited to comparing standard repeating waves of only one type (transverse or longitudinal).*	46

CORRELATIONS

Middle School Standards	Lessons
MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. *Clarification Statements: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.* *Assessment Boundaries: Assessment is limited to qualitative applications pertaining to light and mechanical waves.*	47
MS-PS4-3 Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. *Clarification Statements: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.* *Assessment Boundaries: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.*	48, Unit 9 Inv
Middle School Standards – Life Sciences	
Disciplinary Core Idea MS-LS1: From Molecules to Organisms: Structures and Processes	
MS-LS1-1 Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. *Clarification Statements: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living cells, and understanding that living things may be made of one cell or many and varied cells.*	1
MS-LS1-2 Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. *Clarification Statements: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.* *Assessment Boundaries: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.*	2
MS-LS1-3 Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. *Clarification Statements: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.* *Assessment Boundaries: Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.*	3, 5, Unit 1 Inv

Middle School Standards	Lessons
MS-LS1-4 Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively. *Clarification Statements: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.*	6
MS-LS1-5 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. *Clarification Statements: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.* *Assessment Boundaries: Assessment does not include genetic mechanisms, gene regulation, biochemical processes, or natural selection.*	7
MS-LS1-6 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. *Clarification Statements: Emphasis is on tracing movement of matter and flow of energy.* *Assessment Boundaries: Assessment does not include the biochemical mechanisms of photosynthesis.*	25
MS-LS1-7 Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. *Clarification Statements: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.* *Assessment Boundaries: Assessment does not include details of the chemical reactions for respiration or synthesis.*	24
MS-LS1-8 Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. *Assessment Boundaries: Assessment does not include mechanisms for the transmission of this information.*	4, 8, Unit 1 Inv
Disciplinary Core Idea MS-LS2: Ecosystems: Interactions, Energy, and Dynamics	
MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. *Clarification Statements: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.*	26
MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. *Clarification Statements: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.*	27, Unit 6 Inv

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Middle School Standards	Lessons
MS-LS2-3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. *Clarification Statements: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.* *Assessment Boundaries: Assessment does not include the use of chemical reactions to describe the processes.*	28
MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. *Clarification Statements: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.*	29
MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services. *Clarification Statements: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.*	30
Disciplinary Core Idea MS-LS3: Heredity: Inheritance and Variation of Traits	
MS-LS3-1 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. *Clarification Statements: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.* *Assessment Boundaries: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.*	49
MS-LS3-2 Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. *Clarification Statements: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.*	9, Unit 2 Inv
MS.NS: Natural Selection and Adaptations	
MS-LS4-1 Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. *Clarification Statements: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.* *Assessment Boundaries: Assessment does not include the names of individual species or geological eras in the fossil record.*	50
MS-LS4-2 Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. *Clarification Statements: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.*	51

Middle School Standards	Lessons
MS-LS4-3 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. *Clarification Statements: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.* *Assessment Boundaries: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.*	52
MS-LS4-4 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. *Clarification Statements: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.*	53
MS-LS4-5 Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. *Clarification Statements: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.*	54
MS-LS4-6 Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. *Clarification Statements: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.* *Assessment Boundaries: Assessment does not include Hardy Weinberg calculations.*	55, Unit 10 Inv
Middle School Standards – Earth and Space Sciences	
Disciplinary Core Idea MS-ESS1: Earth's Place in the Universe	
MS-ESS1-1 Develop and use a model of the Earth-Sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and moon, and seasons. *Clarification Statements: Examples of models can be physical, graphical, or conceptual.*	56, 57, Unit 11 Inv
MS-ESS1-2 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. *Clarification Statements: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).* *Assessment Boundaries: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.*	45, 58, Unit 11 Inv

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Middle School Standards	Lessons
MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system. *Clarification Statements: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.* *Assessment Boundaries: Assessment does not include recalling facts about properties of the planets and other solar system bodies.*	59, Unit 11 Inv
MS-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. *Clarification Statements: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events or evidence could include very recent events or evidence (such as the last Ice Age or the earliest fossils of Homo sapiens) to very old events or evidence (such as the formation of Earth or the earliest evidence of life). Examples of evidence could include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.* *Assessment Boundaries: Assessment does not include recalling the names of specific periods or epochs and events within them.*	31
Disciplinary Core Idea MS-ESS2: Earth's Systems	
MS-ESS2-1 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. *Clarification Statements: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.* *Assessment Boundaries: Assessment does not include the specific identification and naming of minerals and rocks but could include the general classification of rocks as igneous, metamorphic, or sedimentary.*	32
MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. *Clarification Statements: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.*	33
MS-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. *Clarification Statements: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).* *Assessment Boundaries: Paleomagnetic anomalies in oceanic and continental crust are not assessed.*	34

Middle School Standards	Lessons
MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. *Clarification Statements: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.* *Assessment Boundaries: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.*	13
MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. *Clarification Statements: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).* *Assessment Boundaries: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.*	14
MS-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. *Clarification Statements: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.* *Assessment Boundaries: Assessment does not include the dynamics of the Coriolis effect.*	15
Disciplinary Core Idea MS-ESS3: Earth and Human Activity	
MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. *Clarification Statements: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).*	35
MS-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. *Clarification Statements: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).*	37, Unit 7 Inv

CORRELATIONS

Middle School Standards	Lessons
MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. *Clarification Statements: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).*	16, Unit 4 Inv
MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. *Clarification Statements: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.*	36
MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. *Clarification Statements: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.*	17
Disciplinary Core Idea MS-ETS1: Engineering Design	
MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	Unit 1 Inv, Unit 2 Inv, Unit 6 Inv, Unit 8 Inv
MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	Unit 2 Inv, Unit 4 Inv, Unit 6 Inv, Unit 9 Inv
MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	Unit 2 Inv, Unit 3 Inv, Unit 5 Inv, Unit 11 Inv
MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	Unit 2 Inv, Unit 7 Inv, Unit 9 Inv, Unit 10 Inv

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UNIT 4

WORDS TO KNOW

axis
latitude
longitude
Coriolis effect

Lesson 15

WHAT FACTORS CREATE GLOBAL CLIMATE PATTERNS?

THE BIG IDEA

- Global climates are created by a combination of energy from the sun and Earth's tilted axis.
- Air and water currents help circulate energy and create climate patterns.

WHAT I NEED TO KNOW

Earth's movement accounts for many changes and patterns on Earth, including the weather. The unequal heating and rotation of Earth directly affect weather and global climate patterns. Weather is what happens in one area over a short period of time, while climate is a region's long-term weather pattern.

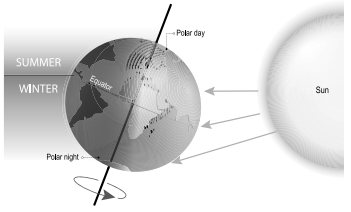
Earth spins, or rotates, on its axis, which is an imaginary line that passes through Earth's poles. Each rotation takes about 24 hours—the length of one Earth day. Earth also revolves, or orbits, around the sun. Each revolution around the sun takes about 365¼ days—the length of one year.

Earth's rotation explains some daily changes on the planet. For example, the sun, moon, and stars appear to rise from the eastern horizon and set along the western horizon. This is because Earth turns toward the east as it rotates.

THINK ABOUT IT

If you were viewing Earth from below the South Pole, Earth would be rotating clockwise. If viewing from above the North Pole, Earth would be rotating counterclockwise. Why?

EARTH'S SEASONS



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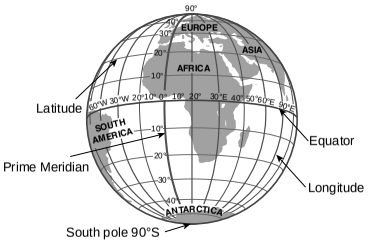
Earth's tilted axis and revolution around the sun cause changes, such as the different seasons that occur over the course of a year. The different seasons bring different weather.

Lines of latitude and longitude form a coordinate, or grid, system that is used to identify locations on Earth's surface. Latitude lines on maps and globes show distances north and south of the equator. Lines of latitude circle Earth, running east to west, parallel to the equator.

Longitude lines on maps and globes show distances east and west of the prime meridian. The prime meridian is an imaginary line that divides the Earth into eastern and western hemispheres, or halves. Lines of longitude circle Earth, running north to south and intersecting at Earth's geographic poles.



Earth's tilted axis and energy from the sun create global climates. Air masses and ocean water currents help to circulate the sun's energy and create climate patterns. Air masses and ocean currents move in a predictable way because of a force called the Coriolis effect. The Coriolis effect causes objects with mass (like air or water) to rotate to the right in the northern hemisphere and rotate to the left in the southern hemisphere. This predictable movement of air and water helps account for some global climate patterns.

Global climate patterns are also driven by a region's location on the planet. Higher latitudes (those from 50°–90°) receive less solar energy (direct light from the sun) than do lower latitudes (from 10°–40°), resulting in temperature differences. Elevation also affects climate. In general, areas at higher elevations, such as mountainous regions, have lower average temperatures than do areas at lower elevations, such as valleys and deserts. Landforms such as mountains deflect wind and can force it to higher elevations.

Smaller temperature changes tend to occur in oceans than on land. Because water can absorb more solar energy than land, there is a greater and more rapid temperature change on land. Therefore, the centers of landmasses, such as cities in the middle of continents, experience more rapid temperature changes than cities near oceans.

TURN AND TALK

Talk with a classmate and decide on the best way to build a model of Earth and its axis. What simple materials could you use to create it?

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WHAT I HAVE LEARNED

HINT, HINT

Lines of latitude run east to west; lines of longitude run north to south.

1. What factors influence the amount of solar energy at a particular place on Earth?

   Ⓐ Earth's tilt and velocity
   Ⓑ Earth's tilt and wind speed
   Ⓒ The particular season and latitude of the place
   Ⓓ The particular season and longitude of the place

   [DOK 2]

2. What causes seasonal changes on Earth?

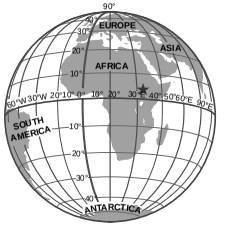
   Ⓐ Seasons are caused by the sun's revolution around Earth.
   Ⓑ Seasons are caused by Earth's tilt and revolution around the sun.
   Ⓒ Seasons are caused by the moon's revolution around Earth.
   Ⓓ Seasons are caused by Earth's tilt and revolution around the moon.

   [DOK 1]

HINT, HINT

Pay close attention to the location. Is it near the ocean or surrounded by land? Near the equator or close to a pole?

3. A student is using the graphic shown here to determine a location's climate. She knows the latitude and longitude coordinates, which are 3°N, 32°E. What can she determine about the location's general climate based on this graphic?



   Ⓐ The location is hot and dry.
   Ⓑ The location is hot and rainy.
   Ⓒ The location is cold and snowy.
   Ⓓ The location is humid and snowy. [DOK 3]

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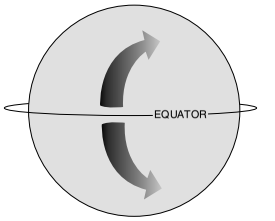
Study the image below that shows a simple representation of the Coriolis effect. Use this image to answer questions 4 and 5.



4. What conclusion can you draw based on this image?

   Ⓐ The heating of air and water is unpredictable.
   Ⓑ Temperatures are consistent across the globe.
   Ⓒ Cool air and water move away from the poles.
   Ⓓ Warm air and water move away from the equator.

   [DOK 3]

5. Look again at the image. Why is warmer air near the equator?

   Ⓐ The equator is where Earth's heat comes from.
   Ⓑ The equator receives more thermal energy from the sun.
   Ⓒ The equator receives less thermal energy from the sun.
   Ⓓ There is more land mass near the equator.

   [DOK 2]

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TEACHER NOTES

STANDARDS MS-ESS2-6

Performance Expectation

Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

Disciplinary Core Idea

ESS2.C: The Roles of Water in Earth's Surface Processes

- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.

ESS2.D: Weather and Climate

- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.

Science and Engineering Practices

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena.

- Develop and use a model to describe unobservable phenomena.

Crosscutting Concepts

Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy, matter, and information flows within systems.

Prerequisite Knowledge & Standards

- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (3-PS2-2)
- Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)
- Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (3-ESS2-2)
- Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)

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TEACHER NOTES

ELA Connection

SL.8.5: Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS2-1) (MS-ESS2-2) (MS-ESS2-6)

Misconceptions

- When air and water move, the thermal energy moves separately. (1)
- The North Pole is always pointed towards the sun. (1)
- Thermal energy cannot be transferred between air and water. (1)

TIPS FOR THE STRUGGLING LEARNER

- Some students might struggle with the some of the abstract vocabulary in this lesson. Have students work with partners to use the definitions of *axis*, *latitude*, and *longitude* to create a sketch with labels for each term. First, have students write the definition of each term provided in this lesson. Then, have partners write the definitions in their own words. Lastly, have partners create simple illustrations that portray each of their own definitions. Have groups compare and contrast their drawings and definitions.

TIPS FOR THE ENGLISH LANGUAGE LEARNER

- Make sure English language learners have the opportunity, if needed, to use both their home languages and English to discuss the science terms in this lesson. Have students use simple materials such as a small polystyrene ball and long, thin stick to model Earth's axis. Before they begin, students should first research online for models of Earth's axis. Then, allow them to work with the simple materials to create their models.

ACTIVITIES FOR THE ADVANCED LEARNER

- Challenge advanced learners to conduct online searches (for example, on the U.S. NOAA website) of locations around the world using latitude and longitude coordinates, such as 19°N, 88°W (Shreveport, LA). Then, have students find out more about each location's weather and climate. For example, have students identify the coordinates for Anchorage, Alaska, and Paris, France, and then identify the climate trends in these locations.

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