NGSS Grade 6: Unit 2 Sequencing

Weather conditions result from the interactions among different Earth subsystems.

Sequence Developed by TUSD Teachers, May 2016

PEs Assessed: MS-ESS2-4, MS-ESS2-6, MS-PS3-3*, MS-PS3-4, MS-PS3-5, MS-ETS1-1

DCIs

PS3.A: Definitions of Energy
☐ Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1) ☐ A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)

PS3.B: Conservation of Energy and Energy Transfer ☐
When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)

PS3.A: Definitions of Energy
☐ Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)

PS3.B: Conservation of Energy and Energy Transfer ☐
☐Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)

ETS1.A: Defining and Delimiting Engineering Problems
The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)
ETS1.B: Developing Possible Solutions ☐
A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) ☐ There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) ☐ Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) ☐ Models of all kinds are important for testing solutions. (MS-ETS1-4)

ESS2.A: Earth's Materials and Systems ☐ All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)

ESS2.C: The Roles of Water in Earth's Surface Processes ☐
Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)

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☐ Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)

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. (MS-ESS2-6)

ESS2.D: Weather and Climate
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. (MS-ESS2-6)

Additional Concepts

-intro to potential and kinetic energy
-create class Rube Goldberg machines
-students design one component, focus on potential to kinetic energy transfer to set up unit
-Explicitly teach kinetic and potential , use basketball to model and students come up with their own definitions before and after Rube Goldberg

- can try and connect each RG together to show energy transfer around the room
-sets the stage for the idea of energy transfer among different Earth subsystems

-thermal energy
-movement of particles
-states of matter

-conduction, convection, radiation
-energy transfer
-variables
-graphing
-scientific method

-engineering design process
-how to evaluate solutions
-how to narrow down solutions

- conductors
- insulators
- heat energy from sun

- chemical or physical changes
- energy flow

-states of matter
-energy from sun
-deeper dive into water cycle processes - relate to energy flow and transfer among different Earth subsystems

-density
-salinity
-temperature variations
-deeper dive into global ocean currents relate to energy flow and transfer among different Earth subsystems

-difference between weather (small scale, short term) and climate (large scale, long term)
-introduce how weather & climate are each influenced by energy transfer/interactions among different subsystems

SEPs

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed worlds. ☐ Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (MS-PS3-5)

Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions. ☐ Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS3-4)

Scientific Knowledge is Based on Empirical Evidence ☐
Science knowledge is based upon logical and conceptual connections between evidence and explanations (MS-PS3-4),(MS-PS3-5)

Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. ☐ Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world. ☐
Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)

Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ☐ Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3)

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 and design systems. ☐
Develop and use a model to describe phenomena. (MSESS2-1),(MS-ESS2-6) ☐
Develop a model to describe unobservable mechanisms. (MS-ESS2-4)

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CCCs

Energy and Matter ☐
-Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3- 5) ☐
-The transfer of energy can be tracked as energy flows through a designed or natural system. (MSPS3-3)

Scale, Proportion, and Quantity ☐
Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1),(MS-PS3-4)

Influence of Science, Engineering, and Technology on Society and the Natural World ☐
-All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1)
☐-The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

Energy and Matter ☐
Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)

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. (MS-ESS2-6)

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PEs (boundaries of PE)

Types of Energy Inquiry Stations

PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.[Clarification Statement: 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 Boundary: Assessment does not include calculations of energy.]

Activity Brainstorm:
- Idea that energy is transferred and can be potential and kinetic,
- Starts with inquiry lab with 5 rotations all involving energy
- Magnets, static electricity, chemical reaction with a temperature change, bouncing ball
- Assign the inquiry stations to a type of energy
- During lab they make observations
- Students then draw and determine potential and kinetic in each station
- **Assessment-** new definition of potential and kinetic energy, what did they add/subtract from the definition and why? How is energy transferred? Examples from labs and Rube Goldbergs used as reasoning in a media product (iMovie, Explain Everything, 30 Hands, Educreations, Show Me)

Energy Transfer Investigations

MS-PS3-4. 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. [Clarification Statement: 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 Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

Activity Brainstorm:
Part 1: Directed Lab- Procedures Provided
- boiling water and melting ice- tracking temperature change around 1 minute increments
- Identify the source of energy, predict what is going to happen, create a predictive graph
- Conduct experiment and graph
- Possible video and narrate over the changes that were occurring
- Analyze and compare two graphs

Part 2: Student Developed Lab Investigation- Procedures Created
- Choose the variable, amount of water in beaker, amount of ice, starting temperature,
- Key learning goal: if the energy input is the same, what is the difference between the variables and energy transfer
- Compare final temperatures of different trials
- **Assessment:** Write conclusion paragraph to address PE

Introduce Heat Flow
- have students label thermal energy transfer from hot to cold in the lab
- Students must first draw the set up in the lab so someone could replicate
- go back to drawing at the end of lab and annotate to show heat flow

Penguin House Engineering Design Challenge

MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

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.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Activity Brainstorm
- Built into this activity is the building concepts of thermal conductors and insulators
- Ice Melting on Spoon or washers activity - modeling and predict which ice will melt faster
- Reading on insulators and conductors- tess will share article
- Soda can lab- does this change their thinking?
- Predict which material wrapped around the soda can one will keep liquid (water) inside the coolest?
- Fill soda cans with half full water and thermometer sticking out
- Cans wrapped with different materials- wool, cotton,
- Lab conclusion using reading to explain the results, use this information to plan the penguin house
- Students design a way to keep an ice cube (the penguin) from melting when under a heat lamp for a designated number of minutes
- **Assessment:** Communicate results in a paragraph or media product (iMovie, Explain Everything, 30 Hands, Educreations, Show Me)

Modeling the Water Cycle

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 Statement: 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 Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.] MS-ESS2-5. Collect data

Activity Brainstorm
- Begin with a KWL or other introductory activity to activate prior knowledge on water cycle
- Use prompt from page 49 in Earth Science Textbook, Cycling of Water- uncovering student ideas: agree or disagree?
- Class discussion, build class knowledge of water cycle
- Develop a model (draw on butcher paper as a group) and then play game to develop vocabulary
- Game- online or print out game http://www.discoverwater.org/blue-traveler/
- Add to the model as they go through game or every 10 minutes
- Revisit prompt on page 49, now which one is correct?
- **Assessment:** Revisit, revise, and reflect on energy transfer within the model and in relationship to Earth's other subsystems

Modeling Energy Transfer in the Oceans and Atmosphere

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 Statement: 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 Boundary: Assessment does not include the dynamics of the Coriolis effect.]

Activity Brainstorm:
- The focus is on the properties of water (salinity, temperature, density) and thermal energy as the theme
- Lab Investigation- one beaker half full with water and another half full with sand, measure with temp under heat lamp or sun, another set, under heat lamp and turn off heat lamp. Measure temperature change over time and graph.
- Connect type of matter to energy transfer - ideas of land breeze and sea breeze- introduce convection currents
- Phet simulation to supplement after lab to talk about uneven heating of earth's surface
- Compare area and properties of direct and indirect light using a flashlight on paper, trace the circle, change the angle and trace the circle
- Connect to uneven heating of Earth's surface and winds
- Students draw model by drawing on butcher paper all of the energy transfers within the ocean and atmosphere- include how movement of water and air is affected by prevailing winds, continents, coriolis effect (using maps and other online resources)
- **Assessment:** Students write a paragraph or create a media product using their models as a resource to explain how water and energy impact on weather and climate (humidity, seabreeze, temperature)