Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project

Grade 8 Science

Unit 2 Instructionally-embedded Assessment Task:

“Comparing Our Model to Other Models”

Gravity and Motion of Objects in the Solar System

June 2023

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SIPS Grade 8 Unit 2 Instructionally-embedded Assessment Task

Grade 8	Unit 2	Instructional Segment 2	Task Title: Comparing Our Model to Other Models

NGSS Performance Expectations Code(s) and Description(s)	
Code	**Description**
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 Statement: Examples of models can be physical, graphical, or conceptual.]

Acquisition Goals Number(s) and Description(s)	
Number	**Description**
A7.	Construct a model of Earth within the Earth-sun system that includes the tilt of Earth and that accounts for the seasonal variation in the amount of sunlight.
A8.	Construct an explanation of the relationship of the amount of solar energy in terms of Earth's position within its orbit around the sun.
A10.	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.

Evidence Statements

- Use models to show how the change in season at a given place on Earth is directly related to the orientation of the tilted Earth and the position of Earth in its orbit around the sun.
- Describe the relevant relationships between components shown in an Earth-sun model showing how the tilt of Earth accounts for the seasonal variation in the amount of sunlight.
- Develop a model of Earth within the Earth-sun system that includes the tilt of Earth and accounts for the seasonal variation in the amount of sunlight.
- Identify the evidence that supports a claim related to the relationship of the amount of solar energy reaching Earth in terms of Earth's position within its orbit around the sun.
- Construct an explanation to support a claim related to the relationship of the amount of solar energy reaching Earth in terms of Earth's position within its orbit around the sun.
- Develop and use a model to describe the cyclic patterns of lunar phases and eclipses of the sun and moon, and to describe the seasons.

Source Documentation and Information Resources References (e.g., publications, websites, citations, images, videos, etc.) Please include source name, description, citation, and a link to its original location below. Include additional rows as needed.	**Licensing:** Please mark an "X" under the appropriate licensing. If resource is not under a creative commons (CC) license, please attempt to find a source with CC licensing. If you are unable, please select other and provide additional information about the source in the source documentation section.							
	CC0/ Public Domain	*CC BY*	*CC BY-SA*	*CC BY-NC*	*CC BY-NC-SA*	*CC BY-ND*	*CC BY-NC-ND*	*Other*
Solar Panel Images and Table 1 Data • Optimum Tilt of Solar Panels [http://www.solarpaneltilt.com] Source: www.solarpaneltilt.com, used with permission from author Charles R. Landau								X
Background Information • Solar Radiation Basics [https://www.energy.gov/eere/solar/solar-radiation-basics] Source: US Department of Energy	X							

Teacher Administration Guide

Introduction

- Educators developed the accompanying classroom task to align to one or more aspects of the NGSS Performance Expectation(s) (PEs) to determine where students are in their learning at a specific point in time during an instructional sequence. Educators will need to make intentional decisions about when and how to use this task based on their students' learning needs, the purpose of giving the task, and the intended use of the evidence gathered.
- This task is designed to measure students' ability to integrate the dimensions and demonstrate their knowledge, skills, and abilities as represented by NGSS Performance Expectation **MS-ESS1-1**. By administering this task, educators can gather and evaluate evidence to make accurate and meaningful judgments about students' science learning and determine how instruction may need to be adjusted along an instructional sequence to best support students.
- The phenomenon addressed in a phenomenon-based scenario is the effect of Earth's rotation around the sun and Earth's tilt which results in seasons and changes in the angle/directness or indirectness of sunlight striking Earth's surface throughout the year.
- In this task, students figure out how to recommend an optimal location for building a solar farm and the use of solar panels to generate electricity based on their understanding of how the tilt of the Earth and its position around the sun affects changes in seasons and the amount of solar radiation received.

Administration Guidelines

- One (1) class period
- Segment 2 Lesson: "Comparing Our Model to Other Models"
- Students individually complete a series of prompts reflecting the following chain of sensemaking:
    - Students are presented with a request from a city council to recommend an optimal location to build a solar farm to capture the sun's energy to meet community needs for electricity over the course of a year.
    - Students are presented with a flawed Earth-sun system model prepared by the city council.
    - Students develop a correct model showing the Earth-sun system to represent each season in the Northern Hemisphere.
    - Students use provided science ideas with respect to Earth's tilt and its effect on the sunlight striking the ground directly or indirectly and the corrected model to explain the potential amount of electricity generated throughout the year vs. summer to the city council.
    - Students explain to the city council the reason why their solar farm will likely generate the most electricity in summer.
    - Students use provided data to identify a pattern between the latitude and daily average solar insolation per year.

- Students use provided data and knowledge of key science concepts to support an explanation about how the pattern between the latitude and the daily average per year of solar insolation is related to the shape of Earth.
- Students recommend and explain to the city council how to best position (i.e., angle) their solar panels and explain their recommendation using their knowledge of the Earth-sun system.

Accessibility Considerations

Providing a range of accessibility considerations in the task (e.g., multiple ways of representing information, multiple types of supports, multiple ways in which students respond) promotes equity and fairness across a wide range of students who may be at different points in their science learning. In turn, these considerations can promote student interest and engagement in the tasks resulting in a more complete and accurate collection of evidence of students' science learning.

Accommodations for students with a disability or Multilingual Learners that are part of their on-going instructional programs are to be provided during the administration of this task. Accommodations should be consistent with those provided in students' daily instructional strategies and assessment opportunities, including assistive technology devices if appropriate. These accessibility considerations and accommodations enable accurate inferences about student learning and inform meaningful adjustments to planning and instruction.

Ancillary Materials

- NA

Instructions for Administering the Performance Task or Implementing the Research Task, Design Project, or Lab

- NA

Scoring Guidance

- A prompt-specific scoring rubric indicates scoring criteria for each prompt or activity across a range of score points.
- Student exemplars represent high-quality responses that align to full-point rubric scores. The exemplar responses are intended to assist educators' understanding of the nature and expectations of each prompt when applying the scoring rubric. Note the exemplars serve as examples of high-quality responses, and students may respond with equally relevant, scientifically accurate responses and ideas that meet the expectations of a full-point rubric score. In general, the exemplar response associated with the highest score point in the rubric meets expectations and is scientifically accurate, complete, coherent, and consistent with the type of student evidence expected as described in the rubric.
- The approximate scoring time for each student per prompt is:
  - Prompt 1 will require approximately < 1.0 minute
  - Prompt 2 Part A and Part B will require approximately 1.5 minutes
  - Prompt 3 Part A & Part B will require approximately 1.0 minute
  - Prompt 4 Part A & Part B will require approximately 1.0 minute

Student Task

This task is about the Earth-sun system.

Task Scenario

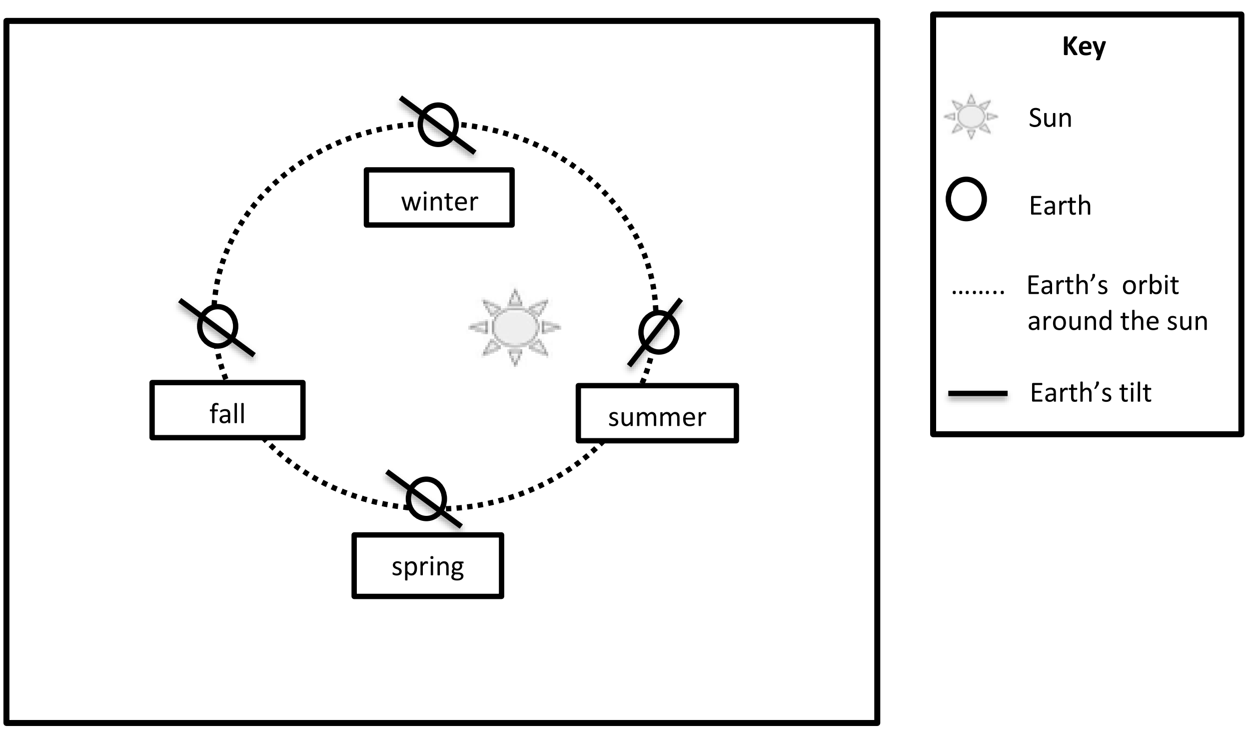
You are a Project Director for a company that builds solar farms. A solar farm is a power station with solar panels that generates energy or electricity. You have been invited to a city council meeting to discuss solar farms. The council members want to know if building a solar farm in their city located in the Northern Hemisphere will generate a consistent amount of energy on a yearly average to meet their city's energy needs.

Picture 1. Examples of Solar Farms

Prompt 1

The city council presents you with a drawing they have prepared to help explain why they believe a solar farm is only useful during the summer. Model 1 is the city council's drawing.

Model 1: City Council Earth-sun System Drawing



You evaluate the city council’s drawing shown in Model 1. You decide to provide a model that correctly shows the Earth-sun system to help the city council understand the relationship between the amount of sunlight, Earth’s orbit and tilt, and the four seasons.

Draw the following to represent the Earth-sun system in **Model 2**:

- Earth’s orbital path around the sun
- The location of the sun with respect to Earth’s orbit
- The position of Earth for each of the four seasons, as experienced by a city in the Northern Hemisphere
- Earth’s tilt during each of the four seasons, as experienced by a city in the Northern Hemisphere
- Label the season associated with each of Earth’s positions

Include all of the symbols from the key. Label the season corresponding with each symbol representing Earth.

Model 2. Earth-sun System Drawing

Key

☼	Sun
O	Earth
……..	Earth’s orbit around the sun
▬	Earth’s tilt

Prompt 2

Part A.

Explain to the city council why the solar farm will be able to generate electricity **throughout the year**, not only during the summer.

Use **Model 2** and what you know about the following science ideas to support your response.

- The cause of Earth's seasons in terms of Earth's tilt
- What happens when sunlight shines directly on the Northern Hemisphere
- What happens when the sun shines equally on the Northern and Southern Hemispheres

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Part B.

Explain to the city council the reason why their solar farm will likely generate the **most** electricity in the summer. Include the terms Northern Hemisphere, tilt, temperature, and solar radiation.

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Prompt 3

A city council member asks why solar panels generate more electricity in the summer. First, you tell them that nearly all of Earth's energy comes from incoming solar radiation or insolation. Solar insolation is the amount of solar radiation received, for example, on a solar panel over a period of time. Then you tell them that because Earth is a sphere, the sun's rays hit the different locations on Earth at different angles. So, you present Table 1.

Table 1 shows the latitude and the daily average per year of solar insolation for five cities in the Northern Hemisphere. Higher values of solar insolation represent greater power generation when solar energy is transformed into electrical energy. Latitude is a measurement of distance from the equator expressed in degrees north or south. The latitude at the equator is 0°.

Table 1: City, Latitude, and Average Solar Insolation

City	Latitude	Daily Average-Solar Insolation per Year
Quito, Ecuador	0°	6.5
Dakar, Senegal (West Africa)	15° N	6.4
Mérida, Yucatan (Mexico)	20° N	6.3
Tokyo, Japan	35° N	6.0
Winnipeg, Canada	50° N	5.1

Part A.

Describe the pattern between the latitude of the cities and the daily average per year of solar insolation in **Table 1**.

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Part B.

Explain to the city council how the pattern between the latitude and the daily average per year of solar insolation is related to the shape of Earth. In your response, use the cities of Quito and Winnipeg in Table 1 to compare:

- the angle of sunlight striking Earth's surface.
- the average daily solar insolation
- the effect of receiving direct or indirect sunlight at different locations in the Northern Hemisphere
- how the angle is related to the intensity of sunlight on the surface area

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Prompt 4

Both the location of the solar farm and the angle of the solar panels are important. One of the city council members believes the solar panels should be placed flat on the ground, facing straight upwards at a 90° angle. Another city council member believes the solar panels should be placed standing upright, facing forward at a 180° angle.

Part A.

Recommend to the city council the **best** angle to collect solar power energy more efficiently year-round for their city located at 40° N.

I would recommend the best angle to place the solar panels is ______________________ °.

Part B.

Explain your recommendation using your knowledge of the **Earth-sun system**.

This is my recommendation because ____

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Task Rubric to Evaluate Student Evidence

Task	Score Point 0	Score Point 1	Score Point 2	Score Point 3	Score Point 4
Prompt 1	No aspect of the response is correct	Response includes **one (1)** of the **five (5)** aspects of the Earth-sun system	Response includes **two (2)** of the **five (5)** aspects of the Earth-sun system	Response includes **three (3)** of the **five (5)** aspects of the Earth-sun system	Response includes **four (4)** or **five (5)** aspects of the Earth-sun system: • Earth's orbital path around the sun • The location of the sun with respect to Earth's orbit • The position of Earth for each of the four seasons, as experienced by a city in the Northern Hemisphere • Earth's tilt during each of the four seasons, as experienced by a city in the Northern Hemisphere • Labels for the seasons associated with each of Earth's positions

Prompt 2 Part A.	No aspect of the response is correct	• Response includes **one (1)** of the **four (4)** aspects	Response includes **two (2)** of the **four (4)** aspects	Response includes **three (3)** of the **four (4)** aspects	Response includes the following aspects: • Explains that throughout the year Earth receives sunlight • Describes that Earth's tilt on its axis causes the seasons • Describes the relationship between Earth's tilt, the season, and sunlight in the Northern Hemisphere • Describes the relationship between Earth's tilt, the season, and sunlight in the Northern and Southern Hemispheres
Prompt 2 Part B.	No aspect of the response is correct	Response includes **one (1)** of the **four (4)** aspects	Response includes **two (2)** of the **four (4)** aspects	Response includes **three (3)** of the **four (4)** aspects	Response includes the following aspects: • Explains why the most electricity/energy will be generated during the summer in the Northern Hemisphere

					- References Earth’s tilt - References increase in temperature - References increase in solar radiation
Prompt 3 Part A.	No aspect of the response is correct	Describes that an increase in latitude from the equator results in a decrease in the amount of solar insolation	NA	NA	NA
Prompt 3 Part B.	No aspect of the response is correct	Response includes **one (1)** of the **five (5)** aspects of the Earth-sun system	Response includes **two (2)** of the **five (5)** aspects of the Earth-sun system	Response includes **three (3)** of the **five (5)** aspects of the Earth-sun system	Response includes **four (4)** or **five (5)** of the following aspects: - Explains that patterns between latitude and daily average per year of solar insolation are related to the shape of Earth - Compares the cities of Quito and Winnipeg based on the angle of sunlight striking Earth’s surface - Compares the cities of Quito and Winnipeg based on the average daily solar insolation

					• Compares the cities of Quito and Winnipeg based on the effect of direct or indirect sunlight • Compares the cities of Quito and Winnipeg based on how the angle of the sunlight is related to the intensity of sunlight
Prompt 4	No aspect of the response is correct	Response includes: **Part A** • 40° angle **Part B** • Flawed or incomplete explanation of the relationship between the angle of the solar panels and direct sunlight	Response includes: **Part A** • 40° angle **Part B** • Explains the relationship between the angle of the solar panels and direct sunlight	NA	NA

Exemplar Responses

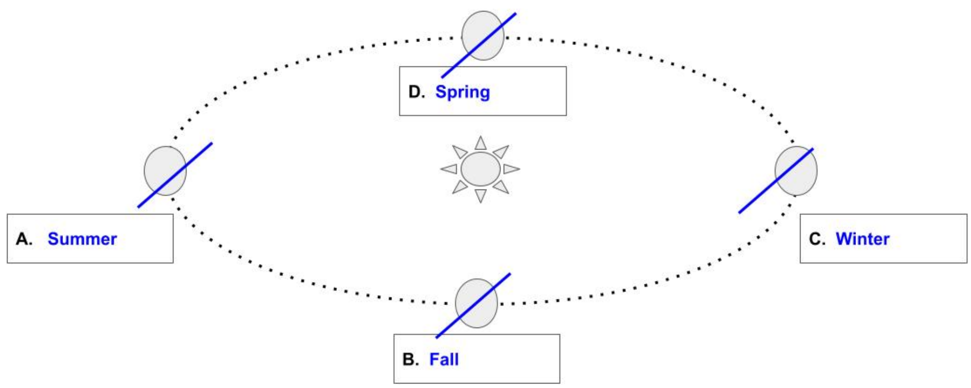
Prompt 1

*Draw the following to represent the Earth-sun system in **Model 2**:*

- *Earth's orbital path around the sun*
- *The location of the sun with respect to Earth's orbit*
- *The position of Earth for each of the four seasons, as experienced by a city in the Northern Hemisphere*
- *Earth's tilt during each of the four seasons, as experienced by a city in the Northern Hemisphere*
- *Label the seasons associated with each of Earth's positions*

Include all of the symbols in the key. Label the season corresponding with each symbol representing Earth.

Model 2. Earth-sun System Drawing



Prompt 2

Part A.

*Explain to the city council why the solar farm will be able to generate electricity **throughout the year**, not only during the summer.*

*Use **Model 2** and what you know about the following science ideas to support your response.*

- *The cause of Earth's seasons in terms of Earth's tilt*
- *What happens when sunlight shines directly on the Northern Hemisphere*
- *What happens when the sun shines equally on the Northern and Southern Hemispheres*

Earth's tilted axis causes the seasons. During the year, different parts of Earth receive the sun's most direct rays. So, when the North Pole tilts toward the sun, it's summer in the Northern Hemisphere because the sun is shining directly on that part of Earth. When the South Pole tilts toward the sun, it's winter in the Northern Hemisphere because the sun is shining indirectly on that part of Earth. During the spring and fall, the sun shines equally on both the Northern and Southern Hemispheres.

Part B.

*Explain to the city council the reason why their solar farm will likely generate the **most** electricity in the summer. Include the terms Northern Hemisphere, tilt, temperature, and solar radiation.*

Their city is located in the Northern Hemisphere. In the summer, Earth's tilt causes their city to get more direct sunlight for more hours a day, and the increase in the amount of solar radiation makes the temperatures rise. This is why the solar farm will likely generate the most electricity in the summer.

Prompt 3

Part A.

*Describe the pattern between the latitude of the cities and the daily average per year of solar insolation in **Table 1**.*

When the distance of a city increases from the equator as shown by an increase in latitude, the amount of solar insolation decreases.

Part B.

Explain to the city council how the pattern between the latitude and the daily average per year of solar insolation is related to the shape of Earth. In your response, use the cities of Quito and Winnipeg in Table 1 to compare:

- *the angle of sunlight striking Earth's surface*
- *the average daily solar insolation*
- *the effect of receiving direct or indirect sunlight at different locations in the Northern Hemisphere*
- *how the angle is related to the intensity of sunlight on the surface area*

At latitudes near the equator, (0° degree) like Quito, the Earth's surface is almost directly perpendicular to the angle of the sun's rays. The average daily solar insolation is intense because the sun's energy is concentrated over a small surface area. Winnipeg's latitude is 50° N; the sun's rays hit Earth's surface at an indirect angle as compared to the equator like Quito. This means when the sunlight hits the ground, the light gets more spread out over a larger surface area. The incoming solar radiation is spread over a larger surface area, so it is less intense than at equatorial latitudes.

Prompt 4

Part A.

*Recommend to the city council the **best** angle to collect solar power energy more efficiently year-round for their city located at 40° N.*

I would recommend the best angle to place the solar panels is 40*°.*

Part B.

*Explain your recommendation using your knowledge of the **Earth-sun system**.*

This is my recommendation because solar panels should be angled to face the sun directly or as close to perpendicular as possible. Therefore, 40° is the best angle for your solar panels that allows the panels to get the most direct, perpendicular sunlight.