Pacing Guide

Level 4 Module 2

ENERGY

with Spotlight Lessons on Earth and Space

Each *PhD Science® Texas* Level 4 lesson requires 45 minutes of instructional time. This guide is intended for teachers who are providing in-person instruction. This guide presents lesson objectives and activities by concept and multiple pacing options to allow teachers to maximize instructional time while remaining responsive to student needs. Choose one or more options for each lesson. Note that pacing options do not omit parts of lessons. Teacher choice days are also included in this pacing guide to allow for review, reteaching, assessment, and extension activities.

Pacing Option Key

Lesson Split: This symbol identifies single lessons teachers may split across 2 days.

Cross-Curricular Activity: This symbol identifies parts of lessons teachers may incorporate during instructional time for other content areas, such as English, math, social and emotional learning, and center time. Teachers may implement these parts before or after science instruction; for example, if the class reads a *PhD Science* core text during English instruction, students can discuss the core text during science instruction rather than reading the full text during that time.

Investigation Preparation: This symbol identifies preparation the teacher may do in advance of an investigation. This advance preparation does not interfere with student learning.

Teacher Think Aloud: This symbol identifies activities that are appropriate for a teacher Think Aloud. Suggested primarily for use during station activities, this option allows completion of these activities as a class. During a teacher Think Aloud, the teacher assumes the role of a student and verbalizes the thought process of a student completing the activity to engage students with intentional questioning techniques. The teacher may also ask students to model appropriate procedures and participate in collaborative conversations.

Shared Media Experience: This symbol identifies media (e.g., videos, images) that the teacher may share with the whole class rather than having students view the media individually or in groups. After students observe the media as a class, they complete an activity.

Focal Point: This symbol identifies parts of lessons teachers should emphasize. For example, in an activity with multiple resources (e.g., videos, texts, charts), a focal point identifies the most important resources, thus ensuring the coherence of the lessons.

Instructional Note: This symbol identifies parts of lessons that have instructional notes that describe time-saving strategies. Examples of such instructional notes are Differentiation supports that provide sentence frames for writing assignments and Teacher Notes that suggest alternative activities.

Instructional Routine: This symbol identifies opportunities to use alternative instructional routines. See the Implementation Guide for information on instructional routines.

Module at a Glance

This module contains 29 lessons plus 7 spotlight lessons on Earth and Space. Even with lesson splits and teacher choice days, this module should take no more than 45 days to complete. This maximum number of days ensures the implementation of all Level 4 modules within a school year that has 150 days of science instruction.

Energy

ANCHOR PHENOMENON:

Windmills at Work

ESSENTIAL QUESTION:

How do windmills change wind to light?

Concept	Recommended Number of Days	TEKS Alignment	ELPS Alignment
Concept 1 (Lessons 1–11): Energy Classification and Transfer **Focus Question:** What is energy and how does it transfer from place to place? Energy is why things happen. Energy can transfer between objects through collisions and from place to place through water waves, electric currents, sound, thermal energy, and light.	11–17 days	4.1A, 4.1B, 4.1C, 4.1D, 4.1E, .4.1F, 4.1G, 4.2B, 4.3A, 4.3B, 4.5A, 4.5B, 4.5D, 4.5E, 4.7, 4.8A, 4.8C, 4.11A	2I, 3B, 3D, 3E, 3F, 4D
Concept 2 (Lessons 12–20): Energy Transformation **Focus Question:** How does energy transform? Energy transformation occurs when one phenomenon indicating the presence of energy changes into any other energy phenomenon.	9–10 days	4.1B, 4.1C, 4.1D, 4.1E, 4.1G, 4.2B, 4.3A, 4.3B, 4.3C, 4.5A, 4.5B, 4.5D, 4.5E, 4.8A, 4.8B, 4.8C	2E, 3D, 3E, 3H, 4A
Application of Concepts (Lessons 21–26): Engineering Challenge **Phenomenon Question:** How can we apply our knowledge of energy to solve a problem? The engineering design process can be used to create a device to transfer energy and transform it from an available form into the desired form.	6 days	4.1A, 4.1B, 4.1C, 4.1D, 4.1F, 4.1G, 4.2D, 4.3A, 4.3B, 4.3C, 4.4A, 4.4B, 4.5B, 4.5D, 4.5E, 4.5F, 4.7, 4.8A, 4.8B, 4.8C, 4.11A, 4.11B	3E
Application of Concepts (Lessons 27–29): End-of-Module Socratic Seminar, Assessment, and Debrief **Essential Question:** How do windmills change wind to light? In a system, specific indicators of energy can be produced through energy transfers and transformations.	3–4 days	4.1G, 4.2B, 4.3A, 4.3B, 4.3C, 4.5A, 4.5B, 4.5D, 4.5E, 4.7, 4.8A, 4.8B, 4.8C	3F

Spotlight Lessons on Earth and Space

Lesson Sets	Recommended Number of Days	TEKS Alignment	ELPS Alignment
Lesson 1: Patterns in Nature **Phenomenon Question:** How can gardeners identify patterns in nature? Patterns in nature are revealed by events that repeat in order.	1 day	4.1A, 4.2B, 4.3C, 4.5A, 4.9A, 4.9B	3E
Lessons 2–4: Seasonal Patterns **Phenomenon Question:** How do day length and temperature relate to strawberry growth? Seasonal day length and temperature patterns change in predictable ways.	3 days	4.1E, 4.1F, 4.2B, 4.2C, 4.3A, 4.3B, 4.3C, 4.5A, 4.5B, 4.5G, 4.9A	1A, 3C
Lesson 5: Moon Patterns **Phenomenon Question:** How does the Moon's appearance relate to Peruvian apple cactus flowers? The Moon phase visible from Earth changes in a predictable pattern each month.	1 day	4.1E, 4.2B, 4.3C, 4.5A, 4.5C, 4.9B	4G
Lessons 6–7: Nightjar Activity **Phenomenon Question:** How do seasons and Moon phases relate to nightjar migration? Seasonal and Moon phase patterns can be used to make predictions.	2–3 days	4.1E, 4.1G, 4.2B, 4.2C, 4.5A, 4.5C, 4.5G, 4.9A, 4.9B	1A, 4C

Year at a Glance

This year at a glance chart shows where all three modules fit in a year. To ensure completion of each module, it is recommended to teach science 5 days a week.

Module 1	Module 2	Module 3
August	November	February
September	December	March
October	January	April

MODULE 2

Energy

CONCEPT 1

What is energy and how does it transfer from place to place? 11–17 days

Lessons 1–3: Windmills at Work

TEKS 4.8C, 4.11A, 4.1A, 4.1C, 4.1D, 4.1E, 4.1G, 4.3A, 4.3B, 4.5B, 4.5D, 4.5E **ELPS** 3D, 3E, 4D

Lessons	Pacing Options
Lesson 1: Make observations to generate questions about how windmills harness the wind.	**Day 1:** Launch through Notice and Wonder About Windmills **Day 2:** Construct Miniature Windmill Models through Land Use English Language Development note in Notice and Wonder About Windmills. Use English Language Development and Differentiation note in Construct Miniature Windmill Models.
Lesson 2: Create a model windmill that generates electricity.	**Day 1:** Launch through Introduce and Discuss *The Boy Who Harnessed the Wind* (Kamkwamba and Mealer 2010) **Day 2:** Construct Physical Models through Land
Lesson 3: Ask questions about energy.	**Day 1:** Launch through Develop Anchor Model **Day 2:** Build Driving Question Board through Land Use first Differentiation note in Build Driving Question Board.

Lessons 4–5: Energy Indicators

TEKS 4.8A, 4.8C, 4.1C, 4.1D, 4.1E, 4.2B, 4.3A, 4.5A, 4.5B, 4.5E **ELPS** 3B

Lessons	Pacing Options
Lesson 4: Observe indicators of the presence of energy.	Think Aloud Station 4: Snap Circuits® windmill in Visit Energy Stations.
Lesson 5: Classify indicators of the presence of energy.	**Conceptual Checkpoint**

Lessons 6–7: Effect of Energy on Speed

TEKS 4.8A, 4.1A, 4.1B, 4.1D, 4.1E, 4.1F, 4.2B, 4.3A, 4.3B, 4.5A, 4.5B, 4.5E **ELPS** 2I, 3B

Lessons	Pacing Options
Lesson 6: Describe the relationship between energy and speed.	**Day 1:** Launch through Investigate Energy (groups visit 1 station) **Day 2:** Investigate Energy (groups visit remaining 2 stations) through Land Use first Teacher Note in Investigate Energy. Think Aloud Object 3 during Investigate Energy.
Lesson 7: Interpret data showing that greater energy input enables greater speed.	**Day 1:** Launch through Design a Fair Test Investigation **Day 2:** Conduct the Investigation through Land Use English Language Development note in Analyze and Interpret Data.

Lessons 8–9: Energy Changes During a Collison

TEKS 4.7, 4.8A, 4.1B, 4.1D, 4.1E, 4.1F, 4.1G, 4.2B, 4.3A, 4.5B, 4.5E **ELPS** 3F

Lessons	Pacing Options
Lesson 8: Predict the transfer of motion energy between objects during a collision.	**Day 1:** Launch through Plan the Investigation **Day 2:** Conduct the Investigation through Land Use Teacher Note in Conduct the Investigation. Use English Language Development note in Analyze and Interpret Data.
Lesson 9: Explain the transfer of motion energy between objects through forces in a collision.	Think Aloud Model Energy Before a Collision. Use second Differentiation note in Model Energy Before a Collision.

Lessons 10–11: Slowing Motion

TEKS 4.7, 4.8A, 4.1A, 4.1B, 4.1C, 4.1D, 4.1E, 4.1F, 4.2B, 4.3A, 4.3B, 4.5A, 4.5B, 4.5E **ELPS** 3F

Lessons	Pacing Options
Lesson 10: Plan and conduct an investigation to gather evidence of a force that can cause a moving object to slow down and stop.	Use Differentiation note in Develop an Investigation Plan.
Lesson 11: Analyze and interpret data to explain that friction can cause a moving object to slow down and stop.	**Conceptual Checkpoint**

CONCEPT 2

How does energy transform? 9–10 days

Lessons 12–13: Changes in Energy Indicators

TEKS 4.8A, 4.8C, 4.1C, 4.1D, 4.1E, 4.1G, 4.3A, 4.3B, 4.3C, 4.5B, 4.5E **ELPS** 3D

Lessons	Pacing Options
Lesson 12: Observe transfers of energy that produce motion, light, sound, and thermal energy.	Think Aloud one station in Observe and Model Energy in Systems.
Lesson 13: Explain that energy may transform to produce new phenomena, such as light and temperature change.	Use the second Differentiation note in Model Energy Transfer and Transformation.

Lessons 14–15: Conductors, Insulators, and Circuits

TEKS 4.8B, 4.8C, 4.1C, 4.1D, 4.1E, 4.1G, 4.2B, 4.3A, 4.5A, 4.5B, 4.5D, 4.5E **ELPS** 4A

Lessons	Pacing Options
Lesson 14: Demonstrate that in an electrical circuit electrical energy must travel in a closed loop.	Use Differentiation note in Build an Electrical Circuit. Use Teacher Note in Land.
Lesson 15: Differentiate between conductors and insulators of electrical and thermal energy.	**Day 1:** Launch through Sort Electrical Conductors and Insulators **Day 2:** Compare Thermal Conductors and Insulators through Land

Lessons 16–18: Generating Electricity

TEKS 4.8A, 4.8B, 4.8C, 4.1C, 4.1B, 4.1C, 4.1D, 4.1E, 4.1G, 4.2B, 4.3A, 4.3B, 4.5B, 4.5D, 4.5E **ELPS** 3E, 3H

Lessons	Pacing Options
Lesson 16: Plan to build generators to transform mechanical energy into electrical energy.	None
Lesson 17: Start building generators to transform mechanical energy into electrical energy.	Use Differentiation note in Determine Group Roles. Use Teacher Note in Determine Group Roles. Complete steps 6-9 from Build a Generator Procedure Sheet (Lesson 16 Resource B) for students in Build a Generator before the lesson.
Lesson 18: Finish building generators to transform mechanical energy into electrical energy.	Use Teacher Note in Build, Test, and Modify a Generator Use English Language Development note in Form Conclusions About Generating Electricity.

Lessons 19–20: Windmills at Work

TEKS 4.8A, 4.8B, 4.8C, 4.1G, 4.2B, 4.3A, 4.4A, 4.5B, 4.5D, 4.5E **ELPS** 2E

Lessons	Pacing Options
Lesson 19: Model how windmills transfer and transform energy.	None
Lesson 20: Explain that energy makes things happen when it is transferred and transformed.	Focus on pages 22 and 23 in Revisit *The Boy Who Harnessed the Wind*. **Conceptual Checkpoint**

APPLICATION OF CONCEPTS

How can we apply our knowledge of energy to solve a problem? 6 days

Lessons 21–26: Engineering Challenge

TEKS 4.7, 4.8A, 4.8B, 4.8C, 4.11A, 4.11B, 4.1A, 4.1B, 4.1C, 4.1D, 4.1F, 4.1G, 4.2D, 4.3A, 4.3B, 4.3C, 4.4A, 4.4B, 4.5B, 4.5D, 4.5E, 4.5F **ELPS** 3E

Lessons	Pacing Options
Lesson 21: Apply the engineering design process to build and improve a device that transfers and transforms energy.	**Engineering Challenge**
Lesson 22: Apply the engineering design process to build and improve a device that transfers and transforms energy.	Use the first Teacher Note in Imagine a Solution. **Engineering Challenge**
Lesson 23: Apply the engineering design process to build and improve a device that transfers and transforms energy.	Use Differentiation note in Create and Test a Device. **Engineering Challenge**
Lesson 24: Apply the engineering design process to build and improve a device that transfers and transforms energy.	Use an alternative instructional routine in Launch. Use Differentiation note in Provide Peer Feedback. **Engineering Challenge**
Lesson 25: Apply the engineering design process to build and improve a device that transfers and transforms energy.	Use first Differentiation note in Prepare to Share. **Engineering Challenge**
Lesson 26: Apply the engineering design process to build and improve a device that transfers and transforms energy.	Use Differentiation note in Share a Solution. **Engineering Challenge**

APPLICATION OF CONCEPTS

How do windmills change wind to light? 3–4 days

Lessons 27–29: End-of-Module Socratic Seminar, Assessment, and Debrief

TEKS 4.7, 4.8A, 4.8B, 4.8C, 4.1G, 4.2B, 4.3A, 4.3B, 4.3C, 4.5A, 4.5B, 4.5D, 4.5E **ELPS** 3F

Lessons	Pacing Options
Lesson 27: Explain changes in a system as the transfer and transformation of energy. (Socratic Seminar)	Use English Language Development note in Engage in Socratic Seminar. **Socratic Seminar**
Lesson 28: Explain changes in a system as the transfer and transformation of energy. (End-of-Module Assessment)	**End-of-Module Assessment**
Lesson 29: Explain changes in a system as the transfer and transformation of energy. (End-of-Module Assessment Debrief)	**End-of-Module Assessment Debrief**
Teacher Choice Day	Review, reteach, assess, or complete extension activities. Optional Assessment: Benchmark 1

SPOTLIGHT LESSONS ON

Earth and Space

How can patterns in nature be used to make predictions? 7–8 days

Lesson 1: Patterns in Nature

TEKS 4.9A, 4.9B, 4.1A, 4.2B, 4.3C, 4.5A **ELPS** 4C, 5B

Lessons	Pacing Options
Lesson 1: Analyze data to determine if patterns exist in nature.	None

Lessons 2–4: Seasonal Patterns

TEKS 4.9A, 4.1E, 4.1F, 4.2B, 4.2C, 4.3A, 4.3B, 4.3C, 4.5A, 4.5B, 4.5G **ELPS** 1A, 3H

Lessons	Pacing Options
Lesson 2: Collect observations to identify the relationship between day length and strawberry flowers.	Use the first Teacher Note in Analyze Day Length Data.
Lesson 3: Compare day length observations to identify yearlong patterns.	Use third Teacher Note in Construct Bar Graphs.
Lesson 4: Analyze temperature data to identify seasonal patterns.	Use Teacher Note in Construct a Line Graph.

Lesson 5: Moon Patterns

TEKS 4.9B, 4.1E, 4.2B, 4.3C, 4.5A, 4.5C **ELPS** 4G

Lessons	Pacing Options
Lesson 5: Identify patterns in the appearance of the Moon, and use the patterns to make a prediction.	Use an alternative collaborative conversation routine in Identify Patterns and Make Predictions About the Moon. Use Differentiation note in Identify Patterns and Make Predictions About the Moon.

Lessons 6–7: Nightjar Activity

TEKS 4.9A, 4.9B, 4.1E, 4.1G, 4.2B, 4.2C, 4.5A, 4.5C, 4.5G **ELPS** 1A, 4C

Lessons	Pacing Options
Lesson 6: Analyze data to identify and predict seasonal and Moon phase patterns. (End-of-Spotlight Assessment)	None
Lesson 7: Analyze data to identify and predict seasonal and Moon phase patterns. (End-of-Spotlight Assessment Debrief)	None
Teacher Choice Day	Review, reteach, assess, or complete extension activities.

Texas Essential Knowledge and Skills (TEKS)

Content Standards

4.7 Force, motion, and energy. The student knows the nature of forces and the patterns of their interactions. The student is expected to

- **4.7** plan and conduct descriptive investigations to explore the patterns of forces such as gravity, friction, or magnetism in contact or at a distance on an object.

4.8 Force, motion, and energy. The student knows that energy is everywhere and can be observed in cycles, patterns, and systems. The student is expected to

- **4.8A** investigate and identify the transfer of energy by objects in motion, waves in water, and sound;
- **4.8B** identify conductors and insulators of thermal and electrical energy; and
- **4.8C** demonstrate and describe how electrical energy travels in a closed path that can produce light and thermal energy.

4.9 Earth and space. The student recognizes patterns among the Sun, Earth, and Moon system and their effects. The student is expected to

- **4.9A** collect and analyze data to identify sequences and predict patterns of change in seasons such as change in temperature and length of daylight; and
- **4.9B** collect and analyze data to identify sequences and predict patterns of change in the observable appearance of the Moon from Earth.

4.11 Earth and space. The student understands how natural resources are important and can be managed. The student is expected to

- **4.11A** identify and explain advantages and disadvantages of using Earth's renewable and nonrenewable natural resources such as wind, water, sunlight, plants, animals, coal, oil, and natural gas; and
- **4.11B** explain the critical role of energy resources to modern life and how conservation, disposal, and recycling of natural resources impact the environment.

Scientific and Engineering Practices

4.1 Scientific and Engineering Practices. The student asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to

- **4.1A** ask questions and define problems based on observations or information from text, phenomena, models, or investigations;
- **4.1B** use scientific practices to plan and conduct descriptive investigations and use engineering practices to design solutions to problems;
- **4.1C** demonstrate safe practices and the use of safety equipment during classroom and field investigations as outlined in Texas Education Agency–approved safety standards;
- **4.1D** use tools, including hand lenses; metric rulers; Celsius thermometers; calculators; laser pointers; mirrors; digital scales; balances; graduated cylinders; beakers; hot plates; meter sticks; magnets; notebooks; timing devices; sieves; materials for building circuits; materials to support observation of habitats of organisms such as terrariums, aquariums, and collecting nets; and materials to support digital data collection such as computers, tablets, and cameras, to observe, measure, test, and analyze information;
- **4.1E** collect observations and measurements as evidence;
- **4.1F** construct appropriate graphic organizers used to collect data, including tables, bar graphs, line graphs, tree maps, concept maps, Venn diagrams, flow charts or sequence maps, and input-output tables that show cause and effect; and
- **4.1G** develop and use models to represent phenomena, objects, and processes or design a prototype for a solution to a problem.

4.2 Scientific and engineering practices. The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to

- **4.2B** analyze data by identifying any significant features, patterns, or sources of error;
- **4.2C** use mathematical calculations to compare patterns and relationships; and
- **4.2D** evaluate a design or object using criteria.

4.3 Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to

- **4.3A** develop explanations and propose solutions supported by data and models;
- **4.3B** communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and
- **4.3C** listen actively to others' explanations to identify relevant evidence and engage respectfully in scientific discussion.

4.4 Scientific and engineering practices. The student knows the contributions of scientists and recognizes the importance of scientific research and innovation for society. The student is expected to

- **4.4A** explain how scientific discoveries and innovative solutions to problems impact science and society; and
- **4.4B** research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field to investigate STEM careers.

Recurring Themes and Concepts

4.5 Recurring themes and concepts. The student understands that recurring themes and concepts provide a framework for making connections across disciplines. The student is expected to

- **4.5A** identify and use patterns to explain scientific phenomena or to design solutions;
- **4.5B** identify and investigate cause-and-effect relationships to explain scientific phenomena or analyze problems; and
- **4.5C** use scale, proportion, and quantity to describe, compare, or model different systems.
- **4.5D** examine and model the parts of a system and their interdependence in the function of the system;
- **4.5E** investigate how energy flows and matter cycles through systems and how matter is conserved;
- **4.5F** explain the relationship between the structure and function of objects, organisms, and systems; and
- **4.5G** explain how factors or conditions impact stability and change in objects, organisms, and systems.

English Language Proficiency Standards (ELPS)

1A Use prior knowledge and experiences to understand meanings in English.

2E Use visual, contextual, and linguistic support to enhance and confirm understanding of increasingly complex and elaborated spoken language.

2I Demonstrate listening comprehension of increasingly complex spoken English by following directions, retelling or summarizing spoken messages, responding to questions and requests, collaborating with peers, and taking notes commensurate with content and grade-level needs.

3B Expand and internalize initial English vocabulary by learning and using high-frequency English words necessary for identifying and describing people, places, and objects, by retelling simple stories and basic information represented or supported by pictures, and by learning and using routine language needed for classroom communication.

3C Speak using a variety of grammatical structures, sentence lengths, sentence types, and connecting words with increasing accuracy and ease as more English is acquired.

3D Speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency.

3E Share information in cooperative learning interactions.

3F Ask and give information ranging from using a very limited bank of high-frequency, high-need, concrete vocabulary, including key words and expressions needed for basic communication in academic and social contexts, to using abstract and content based vocabulary during extended speaking assignments.

3H Narrate, describe, and explain with increasing specificity and detail as more English is acquired.

4A Learn relationships between sounds and letters of the English language and decode (sound out) words using a combination of skills such as recognizing sound-letter relationships and identifying cognates, affixes, roots, and base words.

4C Develop basic sight vocabulary, derive meaning of environmental print, and comprehend English vocabulary and language structures used routinely in written classroom materials.

4D Use prereading supports such as graphic organizers, illustrations, and pretaught topic-related vocabulary and other prereading activities to enhance comprehension of written text.

4G Demonstrate comprehension of increasingly complex English by participating in shared reading, retelling or summarizing material, responding to questions, and taking notes commensurate with content area and grade level needs.